DOCUMENT RESUME

ED 368 201 FL 021 982

TITLE Integrating Mathematics, Science, and Language: An Instructional Program (Volume 2, Grades 2-3).
INSTITUTION Southwest Educational Development Lab., Austin, Tex.
SPONS AGENCY Office of Educational Research and Improvement (ED), Washington, DC.
PUB DATE 93
CONTRACT R168D00166-90
NOTE 434p.; For volume 1, see FL 021 981.
PUB TYPE Guides - Classroom Use - Teaching Guides (For Teacher) (052)

EDRS PRICE MF01/PC18 Plus Postage.
DESCRIPTORS Class Activities; Classroom Techniques; Curriculum Design; *English (Second Language); Grade 2; Grade 3; Hispanic Americans; *Interdisciplinary Approach; *Limited English Speaking; *Mathematics Instruction; Primary Education; *Science Instruction; Second Language Instruction; Second Languages; Spanish Speaking
IDENTIFIERS Hispanic American Students

ABSTRACT

The curriculum and resource guide for integrating mathematics, science, and English-as-a-Second-Language instruction is designed to help elementary school teachers organize classrooms and instructional activities to improve achievement of Hispanic children whose first language is not English. It offers a curriculum plan, instructional strategies and activities, suggested teacher and student materials, and assessment procedures that focus on acquisition of higher-order cognitive skills, understanding of relationships between mathematics and science concepts, specific knowledge, and language for communication and knowledge gain. An introductory section presents the assumptions underlying the guide, explains the guide's structure, and outlines classroom language activities related to mathematics and science processes. Subsequent sections present three grade 2 units (on oceans, weather, and the sun and stars) and three grade 2 units (on matter, sound, and simple machines). Each unit consists of seven or eight lessons on subtopics. Each unit begins with: information on students' expected prior knowledge; objectives for science, mathematics, and language acquisition; a vocabulary list in Spanish and English; teacher background information; and a grid of objectives for the lessons. Lessons contain notes for the teacher on presenting content information, assessment, and suggested class activities. (MSE)

Integrating Mathematics, Science and Language: An Instructional Program.

Developed through

SEDL Paso Partners Project
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This publication is based on work sponsored wholly, or in part, by the Office of Educational Research and Improvement, U.S. Department of Education, under Grant Number R168D00166-90. The content of this publication does not necessarily reflect the views of the Office of Educational Research and Improvement, the Department, or any other agency of the U.S. Government.

Preface

Of the 42 million schoolchildren in the United States, about 1.5 million are in programs for Limited English Proficient students, and perhaps another 3.5 million qualify for such assistance. The majority of these students are Hispanic, and they face the double challenge of mastering academic subject matter and learning a new language at the same time. To attack the problem of poor mathematics and science achievement among Limited English Proficient Hispanic students in grades K-3, the Southwest Educational Development Laboratory (SEDL) organized Paso Partners — a partnership of three public schools, an institution of higher education and staff from SEDL's Follow Through Program.

The Paso Partners Project was a three-year project funded by the Dwight D. Eisenhower National Mathematics and Science Program, administered by the Office of Educational Research and Improvement of the U.S. Department of Education. It combined SEDL's Follow Through Model with the best emerging strategies and materials for teaching and integrating mathematics, science and language development; it trained teachers; and it provided technical assistance to help the teachers implement improved strategies and materials in K-3 classrooms in three primarily low-income Hispanic school districts on the U.S.-Mexico border near El Paso, Texas. During the first year, teachers from the districts received graduate college credit for special mathematics and science curriculum courses taught by faculty from The University of Texas at El Paso. Faculty from the University and SEDL Follow Through staff provided technical assistance in the development of curriculum materials for the integration of mathematics, science and language.

The Paso Partners Project produced this two-volume curriculum and resources guide to supplement existing teaching materials for use with young students, particularly Limited English Proficient Hispanic children. A regional conference, professional presentations and integration of the concepts into other federally funded SEDL service projects have given regional and national exposure to the project and to this curriculum and resources guide.

Acknowledgements

Many people have contributed to the development of **Integrating Mathematics, Science and Language: An Instructional Program.** The curriculum and resources guide was developed through a joint effort by representatives from each of the consortium members: The University of Texas at El Paso, three school districts (Canutillo ISD, San Elizario ISD, Socorro ISD) and the Southwest Educational Development Laboratory.

Dr. Norma G. Hernandez and Dr. James P. Milson, mathematics and science teacher educators from The University of Texas at El Paso, guided the selection and preparation of the mathematics and science content and provided inservice training for the participating teachers. Dr. Hernandez served as the Project Coordinator. She managed the day-to-day operation of the project, directed the development and preparation of the content and authored substantial portions of the guide. Ms. Rosa Gomez, Secretary for the project, typed various drafts of the materials and provided invaluable support services throughout the project.

Administrators and supervisors from the school districts served in advisory and support roles. Teachers from the school districts assisted by planning the guide, by drafting materials and by testing drafts of the materials in their classrooms. We gratefully acknowledge the invaluable contributions made by the following school personnel:

Canutillo Independent School District

Superintendent:	Wilson P. Knapp
Principals:	Edgar Bullock; Velia Minjarez
Mathematics Coordinator:	Vodene Schultz
Bilingual Coordinator:	Marge Gianelli
Teachers:	Amy Craig; Sheila Britton; Mary Brockett; Margaret Gonzales; Inez Lopez; Irene Mendoza; Linda Ochoa; Majorie Rodriguez; Carmela Sanchez; Consuelo Trujillo

San Elizario Independent School District

Superintendent:	Beatriz Reyna Curry
Assistant to Superintendent:	Robert Langoria
Principals:	Norma Valdivia; Rafaela Pitcher
Assistant Principals:	George Augustain; Max Padilla
Teachers:	Martha Amayua; Cathy Barnes; Glynanne Edens; Dora Garner; Nora Guerra; Bernie Hernandez; Rosa Hernandez; Terry Jurado; Maria Lorentzen; Mary Mendiola; Diana Noriega, Nora Rueda; Adriana Velez, Maria Zuniga

Socorro Independent School District

Superintendent:	R. Jerry Barber
Principals:	Elfida Gutierrez; Al Cardenas; Mary Ross
Assistant Principals:	Juan Aranda; Jesus Melero; Alfredo Solis
Director of Special Populations:	Ann Garrett
Teachers:	Berit Ahumada; Helen de Anda; Martha Hernandez; Terry Jaime; Elsa Medina; Socorro Esparza Nava; Sandra Rios; Tina Vasquez; Gloria Vega

Southwest Educational Development Laboratory (SEDL) organized the Paso Partners consortium and administered the project. Dr. Betty J. Mace-Matluck served as the project director and manager. She was responsible for overseeing the preparation and publication of the materials and for the dissemination activities. She also assisted in editing the final draft. Ms. Maria Torres provided guidance in developing the language component and assisted in writing the materials. She also assisted in providing inservice training for the teachers. Ms. Cris Garza and Ms. Suzanne Ashby of SEDL's Follow Through Program provided inservice training in language development and instructional strategies during the early stages of the project. Ms. Rosalind Alexander-Kasparik contributed her expertise in the area of format and design and worked with the graphic artist, design specialist, technical editor and publisher to create the final product.

Dr. Neil Devereaux, Angelo State University, prepared the Spanish language translation. Dr. Mary Ellen Quinn, Our Lady of the Lake University, and Dr. Rudolfo Chavez Chavez, New Mexico State University, reviewed the materials for the accuracy and appropriateness of the content. Ms. Miriam Kuznets edited the final draft of the manuscript. Mr. Peter Szymczak created the design of the guide, formatted the materials, assisted with the editing and worked tirelessly to create the final product. Ms. Amy Young rendered the illustrations and assisted in the design of the cover.

Table of Contents
(Volume 2, Grades 2-3)

Introduction

Integrating Mathematics, Science and Language: An Instructional Program is a two-volume curriculum and resources guide designed to help elementary school teachers organize their classrooms and instructional activities in order to increase achievement of Hispanic primary-grade children whose first language is not English. The guide offers a curriculum plan, instructional strategies and activities, suggested teacher and student materials and assessment procedures that focus on the acquisition of:

- higher-order thinking skills to apply newly learned knowledge and understanding;
- understanding of relations between mathematics and science concepts;
- knowledge, i.e., specific items of information and understanding of relevant concepts; and
- language to gain and communicate knowledge and understanding.

Motivational strategies and materials compatible with the students' own social and cultural environment are incorporated into the instructional materials to develop and enhance positive attitudes and values toward mathematics, science and language learning.

Assumptions Underlying the Materials

A number of assumptions about teaching and learning have guided the development of the materials.

Assumptions about Learning

1. All children, even the very young, learn mathematics and science concepts by developing cognitive structures through interactions with the environment.
2. In the process of learning mathematics and science, students "experience" instructional activities as an integrated whole, i.e., as an affective, cognitive and relevant activity.
3. Language development is an integral aspect of the acquisition of mathematics and science concepts and skills. It becomes an even greater factor in cognitive growth and development for children whose first language is not the same as the language of school instruction. Effective learning occurs when the student acquires language in the context of academic instruction as well as in social interaction.
4. Children learn mathematics and science constructively, i.e., children build or construct meaning by using their own experience and previous knowledge as a guide.
5. Children acquire language within the context of everyday experience. Language concepts and skills are not learned in isolation, but rather as a consequence of interaction within a setting that is compatible with the experiential and cultural background of the students.

6. Students construct concepts through experiences that involve using manipulatives, pictures, verbal interactions and other models representing the concepts to learn.
7. Mental structures effectively develop through educational activities that allow students to explore, investigate, apply and solve problems related to "tentative constructs" that students modify during the learning process.
8. In learning mathematics and science, as well as in acquiring and developing language, the students assimilate experiences into a construct that is available to them through subjective representation. However, the meaning of the representation must be consistent with experience, with the meaning of related constructs and with conventional meanings constructed by others.

Assumptions about Teaching

1. The design and the implementation of an effective instruction activity include cognitive, affective and relevant aspects of the social and cultural context in which the science, mathematics and language concepts develop.
2. Teachers help create effective and appropriate mathematics, science and language constructs through a variety of approaches that include:
   - **spontaneous** opportunities that provide and provoke suitable questions, conflicts, material and explanations to induce inquiry;
   - **inductive and deductive** sequences that provide students relevant examples to help them extract the common features and important ideas of a concept or generalization; and
   - **pragmatic or practical** opportunities for students to grapple with and solve real-world problems that students discuss with their peers and the teacher in order to verify and affirm their thinking.
3. To assist students in developing mathematics, science and language constructs, teachers provide many carefully selected and structured examples that facilitate abstraction of common features to form a concept. Also, teachers present interesting and challenging problems. Teachers use manipulatives, pictures, graphs and verbal interactions to support and encourage learning.
4. Teachers facilitate acquisition of mathematics and science concepts by children whose first language is not English through appropriate language development strategies that assume a language-rich environment in which students may use either the home language (e.g., Spanish) or English or both to communicate knowledge and understanding.
5. For children whose first language is not English, teachers give specific attention to the development of specific concepts (science and mathematics, in this case) within the overall context of both Spanish and English language development.

Structure of the Guide

The guide is bound into two volumes. Volume One contains materials for use in Kindergarten and Grade One. Materials in Volume Two are for use with students in Grades Two and Three. Depending on the students' academic backgrounds and local curriculum expectations, the materials for each grade level may provide a full academic year of instruction. Each volume contains an introductory section and three units for each grade level.

Structure of each Unit

Each unit is designed to assist teachers in offering up-to-date science and mathematics content, along with appropriate language usage, through teaching and learning strategies that will excite children about the world of mathematics, science and language. The selection and arrangement of the material is planned to engage children's natural inquisitive nature and to stimulate them to investigate, explore and learn. Teachers are helped to create dissonance in familiar situations in order to stimulate questioning, hypothesizing, exploring and problem solving.

Each unit contains three types of materials: (1) unit overview materials and background information for the teacher, (2) the lessons and (3) an annotated bibliography and list of teacher reference/resource materials.

Spanish language translation. Preceding each complete unit in English is a Spanish version of background information for the teacher, as well as a Spanish version of the formal introductory portion of the lesson cycle.

Unit overview materials and background information for the teacher. Presented first in the unit is a recommended list of content and/or skills students should have as **Prior Knowledge** before initiating unit activities. Next **Specific Mathematics, Science and Language Objectives** are listed followed by a **Topic Concept Web.** The web shows relationships among the various science content elements that teachers will present in the unit. In turn, the web prompts the identification of two major ideas, one in science and one in mathematics, that the class will develop in each lesson. It also encourages teachers to view teaching as providing children opportunities to develop cognitive structures that are more global and complex than those that students can demonstrate by performance on objective-defined tasks. Therefore, the application, or problem-solving, phase of the lessons takes on a specific character and increased importance — it allows the student and the teacher to look for dimensions in understanding that go beyond the level that can be universally required of all students. There is no vertical or horizontal "cap" or "ceiling" in thinking that circumscribes the students' progress.

Next is a list of key **Vocabulary** items, in both English and Spanish, that the teacher will use in presenting the unit. The students will gain an understanding of the terms and may incorporate some, or most, of them into their active vocabularies.

The **Teacher Background Information** section, which follows the Vocabulary section, contains science and mathematics content. This content, also in both English and Spanish, is provided as a ready reference for teachers to draw upon as they implement the unit.

Next is The **Lesson Focus** that lists each of the **Big Ideas** presented in each of the lessons. Each Big Idea is stated as an overarching concept, or principle, in science and/or mathematics that generates the lesson activities. The Big Idea is what each student is to construct. The construct has many other ideas that relate to it, both in mathematics and science, thus forming a web of ideas. The construct, however, develops within a language context — either in English or Spanish — in order to formalize the concept. Once assimilated, the Big Idea can facilitate students' future learning in related content areas. Thus, the Lesson Focus, together with the array of objectives, gives the teacher a view of the extent and directio. of development of the Big Idea in each lesson.

Following The Lesson Focus is an **Objectives Grid** displaying the unit objectives by content area and by lesson activity. Objectives, in and of themselves, cannot dictate the scope of the instruction. Learning takes place when the students "experience" instructional activities as an integrated whole, i.e., as an affective, cognitive and relevant activity. Thus, the grid serves to provide direction and indicators of student progress. The objectives are used to develop assessment procedures by which to measure, in part, student achievement.

Lesson Design

Each lesson design assists the teacher in developing the Big Ideas selected for a given lesson. The term "lesson" as used in this guide means a set of activities selected to teach the Big Ideas. It is not meant to convey the notion that the material included in a "lesson" is to be taught within a single period of time on any given day. One "lesson" may extend over several days.

Each lesson provides the instructional context and the activities for the students to acquire the concepts, or build the constructs, contained in the lesson's Big Ideas. The lesson does suggest a sequence in which to implement the activities, but there is no "single" sequence or a given time limit in which to present the unit. Indeed, a number of the units require previous preparation on the part of the teacher, and in some cases on the part of the students. Some units, for example, require the students to collect, organize and summarize data and then to apply their findings. This process may require a period of three or four weeks. Nonetheless, prior to initiating the unit, teachers should construct an overall and day-to-day schedule for the implementation of the unit.

The lesson's content develops through a process that reflects a cycle. The process moves through various phases of the learning cycle. Learning cycles to facilitate the organization of science and mathematics instruction have been proposed for some years; many cycles incorporate an inquiry approach to learning with emphasis on problem solving. Typically, a learning cycle includes an experimentation phase during which the learner actively experiments with concrete materials to develop, or "construct", an idea. Although scholars vary in their opinions as to the required nature, design and number of such phases, all include at least three phases: experimentation, concept introduction and development, and application.

The Lesson Cycle

For the purpose of this guide, a five-phase lesson cycle has been employed:

1. Encountering the Idea
2. Exploring the Idea
3. Getting the Idea
4. Organizing the Idea
5. Applying the Idea

Each phase of the cycle is described briefly below.

Encountering the Idea, or developing a "readiness" state, is the first phase in the cycle. During this time the teacher provides a background, or enabling structures, to facilitate the development of "new constructs." This phase of the teaching cycle is important for students whose early childhood experiences may not have been sufficiently varied to provide them with some of the necessary underlying concepts on which to build the Big Ideas that the lesson promotes. Therefore, this cycle shapes a backdrop on which to develop the new ideas. Additionally, the readiness activities alert the students to the direction of the lesson by providing provocative questions and conflicting situations designed to bring the students into an exploration perspective.

Because language development is a fundamental co-requisite for learning mathematics and science concepts, processes and skills, many of the lessons begin with literature (e.g., oral stories, children's books) and discussion activities that set the stage for posing questions and presenting conflicting situations related to the mathematics and science Big Ideas that are the focus of the lesson. The use of well-selected literature, in addition to being an effective tool in language development, is an effective motivational strategy. Other language development strategies are presented below in the section, **Language Activities Related to Mathematics and Science Processes.**

Exploring the Idea, or experimentation, is the phase in which learners are involved with concrete or familiar materials in activities designed to have them encounter new information that they can assimilate in their attempt to find responses to the questions posed earlier and/or to hypothesize a resolution to the conflicting situation presented. During this stage, the learner explores the new ideas through the use of materials in learning centers, with the teacher providing relatively little structure. As students realize that there are new ideas they have not dealt with previously and that produce some confusion, doubt or interest, they discuss among themselves and with the teacher what these ideas may mean. At this point, the teacher moves the students into the next phase of the cycle.

Getting the Idea, or concept introduction and development, is the phase in which the teacher helps the learners assimilate and accommodate the new information into a new structure that signifies the development of a new understanding. The students begin to work with new words conveying the new concepts. They work with new ideas in many different ways to ensure that a new idea is valid. The main emphasis during this phase is to see what is happening. What do we know? How do we know this is true? How can we explain this? Students may want to brainstorm and ask related questions, or they may choose to go back to the exploration or experimentation phase to validate the new ideas.

Organizing the Idea is the phase in which the students consciously consider the new ideas in their own right. They attempt to understand a new idea as a whole. New terminology, notation and symbols are introduced at this time. Students may then express their ideas and opinions through a variety of activities.

During this phase, the students may relate the new ideas to associated ideas in other areas of subject matter. They make new connections, generalizations and abstractions. They may decide that the best manner to organize and communicate the new ideas is through charts, tables, number sentences, graphs, diagrams or verbal and written explanations. Thus, the information is organized in a logical and quantitative manner. The students may report the results of their experiments, observations, conclusions and interpretations to the class. Students may to do additional reading or listening to tapes. Once the students have grasped the concepts, they are ready for the application phase of the lesson.

Applying the Idea is the phase in which students develop a broad grasp of the concepts. In this phase the students relate the new ideas to their own world — to something "real" — and to associated ideas in other areas of subject matter. They are then able to solve problems and answer related questions. They may also formulate their own problems.

Assessment of Student Achievement is ongoing on an informal basis throughout the lesson through teacher observation of the students' interactions and behaviors. Assessment strategies are provided in the final phase of each lesson or unit to assist the teacher in determining the extent to which the students have grasped the Big Ideas presented in a given lesson and/or unit.

Language Activities Related to Mathematic and Science Processes

Because language development is a fundamental co-requisite for learning mathematics and science concepts, processes and skills, the lessons in many instances begin with literature (e.g., stories, books) and discussion activities that set the stage for posing questions and presenting conflicting situations related to the Big Ideas in mathematics and science that are the focus of the lesson.

Language development strategies specifically related to mathematic and science processes were incorporated into the lessons. Some examples of these are described briefly below.

Sequencing. The students tell or write a story, indicating the sequence of events by using ordinal numbers. They may also use such words as "then", "next", and "finally" to show sequence. The students may take a nature walk around the school and report their observations in order of occurrence.

Questioning. In the initial stage of a unit the students may list, in the form of questions, information that they would like to have about the topic. As they proceed through the unit and gather further information, they may record answers to the questions that they formulated.

Comparing/contrasting. Student may design and make charts, graphs or diagrams that compare or contrast two concepts. For example, the students may use Venn diagrams to compare and contrast spiders with insects.

One-to-one correspondence/counting. In comparing objects, students use comparative adjectives (e.g., "longer", "shorter", "bigger", "smaller"). In comparing groups or sets in preparation for counting, the students begin to use the notion of "more than" and "less than." In making these comparisons, they may compare two groups physically by laying them side by side. In increasing the accuracy of their statements, students can say, for example, "The tiger cage in the zoo has three tigers, and the bear cage has six bears; the zoo has more bears than tigers." They can put three tigers alongside six bears, show that the three tigers are "tied" with three bears and that there are three extra bears. They conclude that there are three more bears than tigers, and that six is three more than three.

Predicting/hypothesizing. During the initial stage of a unit, and after the students have listed the questions that they would like to answer, they hypothesize answers or solutions to as many of the questions or problems as they can. During the implementation of the unit, they explore hypotheses and confirm or reject them as they gather evidence. The students verbalize their reasons for confirming or rejecting the hypotheses.

Validating/persuading. During problem-solving sessions, the students study the nature or character of the evidence they can use to confirm or reject a hypothesis. They suggest reasons why in some cases one negative example is sufficient to reject a hypothesis, while in other cases several positive examples are not sufficient to confirm or reject a hypothesis.

Conferring. Students ask for a conference with the teacher and/or other students to discuss or exchange opinions about an important, a difficult or a complex matter. For example, a student is preparing to write in her journal but needs clarification about an idea. She asks the teacher to meet her at the "conference table" (which is inaccessible to other students for the duration of the conference) in order to discuss her ideas prior to writing about them in her journal. The student may ask that another student join the conference, particularly if the students have done the work collaboratively. The student initiates the conference, gives it direction and decides when the purpose of the conference has been met. A student may also request a conference for the purpose of assessing her achievement or progress.

List and Recommended Sequence of K- 3 Integrated Units

- Grade K and 1 Integrated Units
  - Grade K
    - Five Sense
    - Spiders
    - Dinosaurs
  - Grade 1
    - Plants and Seeds
    - The Human Body
    - Good Health
- Grade 2 and 3 Integrated Units
  - Grade 2
    - Oceans
    - Weather
    - Sun and Stars
  - Grade 3
    - Matter
    - Sound
    - Simple Machines

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Traducciones en Español

Unidad 2: Los Océanos

Unidad 2: El Tiempo

Unidad 2: El Sol y las Estrellas

Unidad 3: La Materia

Unidad 3: El Sonido

Unidad 3: Las Máquinas Sencillas

unidad

2 Los Océanos

Información de Fondo para la Maestra

El agua del mar contiene sal, que se quedará como un residuo de color claro an el fondo de la olla después de evaporarse toda el agua. Para los que no viven cerca del océano, un poco de sal en el agua de la llave también servirá de sustituto.

La mayoría de los seres vivientes están adaptados para vivir en cierto ambiente. Es improbable que las plantas y animales que se encuentran en un ambiente de agua salada también se hallen en el agua dulce.

Muchas diferentes plantas y animales viven en el ambiente de agua salada del océano. Pero aún en el ambiente del océano, hay diferencias entre el agua baja y la profunda. Las plantas y animales que viven en el océano de agua baja normalmente no se encuentran en las partes más profundas del océano.

Al calentarse el agua, el calor causa que las moléculas del agua se muevan con mayor rapidez y a una mayor distancia. Al separarse más las moléculas, el agua se pone menos densa. Lo densa de una sustancia indica cuánta masa hay en una sustancia particular. Entonces, el agua caliente es menos densa que el agua fría y por eso flota en ella.

Los océanos son ambientes de agua salada. Los lagos, arroyos, estanques, y ríos tienen poco o nada de sal disuelta en el agua. Esas aguas son ambientes de agua dulce. ¿Esperarían encontar las mismas plantas y animales viviendo en los dos ambientes?

Preparación Anterior: Traiga dos plantas al principio de la unidad. Se necesitarán las plantas para **la Lección seis.** Se les pide a los estudiantes que coloquen una de las plantas en la ventana. Deben poner la segunda planta en un clóset, u otro lugar donde no reciba luz. En tiempos apropiados, los estudiantes regarán las dos plantas a la misma vez y con la misma cantidad de agua.

LECCION 1

El Mundo Subacuático

Captando la Idea

Varios de los grupos estudiantiles demostrarán a la clase las rutas que encontraron para **circunnavegar** el mundo sin tocar tierra. Los estudiantes estiman qué rutas eran más largas y cuáles parecían más cortas.

La clase discute la cantidad de superficie cubierta por los océanos usando el concepto de porciento.

1. ¡Qué significado tiene cuando decimos que "más del 70% de la superficie de la tierra es agua"? Sí, más de 70 partes de cada 100 partes de la tierra son agua. Miren su cuadrícula de porcentajes. Muestren lo que es el 70% en las cuadrículas.
2. ¿Es el 70% más de la mitad? ¿Cómo pueden mostrar eso es su cuadrícula de porcentajes?
3. ¿Qué océanos contienen el 97% del agua del mundo? ¿Qué significa el 97%? ¿En qué otra manera podemos decir lo mismo?
4. ¿Qué significa cuando decimos que **el 2% es hielo en las capas polares**? ¿Cuánto es el 2%? Muéstrelo en su cuadrícula de porcentajes.
5. ¿Qué significa cuándo decimos que solo 1% del agua de la Tierra es agua fresco? Dibuja esto en tu gráfica de los porcentajes.

LECCION 2 *Montañas y Valles Oceánicos*

Captando la Idea

1 En su actividad con un acuario oceánico, diseñaron varios acuarios usando diferentes combinaciones de animales marinos, plantas y fondos oceánicos. ¿Pudieron formular una estrategia que les ayudara a encontrar todos los diferentes diseños? Al hacer juegos seleccionando diferentes miembros de varios grupos, estos nuevos juegos se denominan **combinaciones.** Cuando tenemos 2 animales (pulpo y delfín), 2 plantas (algas marinas y coral), y 2 fondos (rocas y arena), hacemos ocho **diferentes combinaciones.** Un grupo hizo este cuadro de todas las combinaciones. El líder del grupo dio esta explicación.

Hay tres cosas que se tienen que seleccionar: los animales, las plantas y el fondo. Así que primero se selecciona el animal, la planta y el fondo: O K R. Luego, cambias únicamente el fondo: O K S. Esos son dos diseños. Se vuelve a hacer lo mismo, pero con una planta diferente. Ahora son cuatro diseños. Se vuelve a hacer lo mismo, pero esta vez se cambia el animal. Ahora son ocho.

Éste es su diagrama. Otra manera de encontrar todas las posibles combinaciones cuando se puede seleccionar de entre dos juegos o más es de usar la multiplicación. Traten de averiguar cómo se multiplica para sacar la contestación correcta.

2. La idea de que el fondo del océano se mueve y cambia no era una idea fácil de aceptar para muchas personas, aún para los geólogos. Pero, por medio de la colección de datos, los científicos ahora aceptan el hecho de que el fondo del océano se mueve continuamente y se dispersa en diferentes direcciones. Esta dispersión causa que el fondo esté desnivelado, que tenga grandes montañas, valles y cuencas.

¿Cuánto tiempo creen que se ha requerido para que el fondo oceánico forme las montañas y valles que tiene? Los científicos nos dicen que los platos tectónicos en el fondo oceánico se mueven a un promedio de 6 centímetros, aproximadamente 2 pulgadas y 1/2, **por año.** Este es el promedio de crecimiento de las uñas de una persona. ¿Se pueden imaginar cuánto tiempo tomará para que esos platos se muevan para formar una cuenca o una zanja? Los científicos nos indican que ha estado cambiando el fondo oceánico durante más de **130 millones de años**.

Ahora que tenemos una idea de cómo se ve el fondo del océano, podemos agregar estos nuevos elementos a nuestros planos o a nuestro mural. También podemos empezar a diseñar un diorama oceánico.

LECCION 3

Las Olas, Mareas y Corrientes

Captando la Idea

De nuestras actividades, ¿qué idea sacaron de lo que es una ola? (Se hace una pausa para que los estudiantes den sus opiniones. Pídales a los estudiantes que describan el movimiento. ¿Es sólo hacia arriba y hacia abajo? ¿De un lado a otro? Pídales a los estudiantes que agiten las manos. Describan ese movimiento.) **Las olas** son el movimiento del agua al moverse hacia enfrente y hacia atrás, y también hacia arriba y hacia abajo. Cuando soplamos en el agua, hizo que el agua surgiera en olas. Las olas se encresparon y luego se menguaron o bajaron, y luego empezaron a encresparse de nuevo.

De nuestras actividades, ¿qué idea sacaron de las mareas? **Las mareas** son el ritmo regular del movimiento del océano. Este movimiento se debe a la presencia de la luna y del sol. La atracción de la gravedad de la tierra y de la luna es una de las causas de las mareas.

De nuestras actividades, ¿qué idea sacaron de lo que es una corriente? **Las corrientes** son ríos que corren por los océanos. Las dos causas principales de las corrientes son: 1. El calor del sol que calienta la superficie del mar y también genera vientos fuertes y continuos y 2. El agua fría y pesada se hunde y corre por el fondo del océano. (Se muestra el mapa de las corrientes.)

LECCION 4

Capas de Agua Salada

Captando la Idea

¿De dónde creen que viene la sal que se entra en el agua del mar?

- de la tierra
- de la tierra costeña que se desgasta por el viento y la lluvia
- es llevada por las aguas del mar
- de las conchas y esqueletos de los animales marinos

Han tenido que pasar millones de años para que los océanos lleguen a ser tan saladas.

Recuerden que el agua caliente es menos pesada y se ha expandido y el agua fría es más pesada y más densa (más unida). El calor hace que el agua sea menos pesada, así que flota encima del agua más pesada y densa. ¿Dónde cambiará la temperatura del agua, dependiendo del clima en la superficie y la estación?

Entre más hondo se penetre, mayor es la presión acuática. ¿Qué le sucede a un objeto al aplicársele mucha presión? Se hace referencia a la demostración del bote aplastado. (Después de haber tenido los estudiantes la oportunidad de expresar sus ideas sobre el bote aplastado, se les sugiere que al enfriarse el bote, la presión del aire de afuera, que es mayor que la presión dentro del bote por razón de que el aire es menos denso, hará presión de todos lados y lo aplastará.) Se les dice a los estudiantes que si se pusiera el objeto (bote) debajo del agua bajo gran presión, también se aplastaría. Tanto el agua como el aire pueden ejercer presión, así que es la presión, el peso, que aplasta el bote

¿Qué les sugirió el experimento con la linterna eléctrica y la gasa de algodón acerca de la intensidad de la luz a las diferentes profundidades del océano? ¿Cómo son iguales las dos nociones de las capas de gaza y las capas de agua del océano, y cómo son diferentes? ¿Dónde habrá la menor cantidad de luz en el océano? (fondo). ¿Por qué? Se filtra la luz del sol.

LECCION 5 *Los Océanos — un Mundo Distinto*

Captando la Idea

Se repasan **Las maravillas del mar**. ¿Quién puede recordar algunos de los nombres de las plantas? ¿de los animales? Se pregunta si es planta o animal. Se incluye en la lista bajo el encabezado apropiado.

En el ambiente subacuático el factor más importante es la luz y su ausencia, porque los organismos vivientes no pueden vivir en la auscencia de luz. La luz solar es la fuente de energía que hace posible el fotosíntesis. Controla la cadena alimenticia de la que dependen todos los animales.

El centro de esta cadena son las plantas en forma de plancton microscópico y alga. Estos convierten, como otras plantas, el agua y dióxido de carbono a carbohidratos por medio del fotosíntesis. Los carbohidratos son los ingredientes básicos que proporcionan el "alimento" a los organismos para crecer y reproducir. En esta cadena alimenticia, los animales herbívoros comen las plantas pequeñas, la dieta de estos animales depende de las plantas. Entonces los animales carnívoros, animales que comen a otros animales, se comen a estos animales.

La red alimenticia entera depende de la existencia de la energía solar que deja de penetrar más allá de los 650 pies de agua. Cuando no hay luz, no puede haber plantas ni ninguna producción de alimento. Todos los animales que viven en el mar tienen que alimentarse de la pequeña cantidad de alimento que se produce en una capa muy delgada de la superficie del agua iluminada por el sol — desde el plancton hasta los aguamares y hasta los tiburones y ballenas.

Aunque menos vida acuática puede existir en el abismo, en comparación con las grandes cantidades y el tamaño grande de los animales que viven cerca de la superficie del océano, sin embargo la variedad es grande. Ya que las condiciones en el fondo oceánico son dificultosas, los animales se adaptan en muchas maneras diferentes. Por ejemplo, un pez, el pez tripié, ha desarrollado órganos en forma de pies que le ayudan a caminar en el fondo oceánico. Otros usan sus cuerpos desarrollados en sacos gelatinados para soportar la presión acuática y flotan en las corrientes del océano, agarrando alimento mientras que pasa. Estos animales no ejercen más energía de la que necesitan para sobrevivir.

LECCION 6

Plantas y Animales del Abismo

Captando la Idea

Todos nuestros recursos alimenticios, tanto para las plantas como para los animales terrestres, provienen de las plantas. Las plantas utilizan la luz del sol y la clorofila para producir azúcares y fécula para usar como alimento. Los animales comen las plantas para alimento, y unos animales se comen a otros para alimento. Por lo tanto toda nuestra energía alimenticia, incluyendo la de los humanos, proviene de las plantas. ¿Dónde creen que se produce el alimento en el océano? Sí, las plantas también producen alimento para lo que vive en el océano. ¿En cuáles de las nueve zonas que hemos estudiado pueden crecer las plantas? Unicamente en las zonas en que se puede penetrar la luz del sol. Por lo tanto, las plantas sólo pueden existir en las aguas de la superficie o en los pantanos bajos y en el fondo oceánico que no tenga un profundidad mayor de varios cientos de pies, hasta donde pueda penetrar la luz.

Ya que se produce todo el alimento sobre, o muy cerca de las aguas de la superficie, la cantidad de alimento producido disminuye al llegar a mayores profundidades. Millones de toneladas de **plancton**, tanto animal como vegetal, vive sobre las aguas de la superficie y en las de poca profundidad. El plancton sirve de alimento para los peces y mamíferos de tamaño menor y mayor, como las ballenas. Las ballenas consumen toneladas del plancton para crecer a su tamaño inmenso y para ejercer la energía que utilizan al nadar y cazar. Los peces más grandes normalmente se comen a los peces de tamaño menor. Al comerse los peces más grandes a los menos grandes cerca de la superficie, pedacitos de alimento que sobran se hunden hacia las profundidades mayores. La vida animal de esas profundidades depende del alimento que sobra de los que nadan en la superficie. En el abismo el alimento no es abundante y las comidas son infrecuentes.

Sin embargo, la vida animal se ha adaptado a los distintos ambientes del océano. Por ejemplo, las ballenas y las morsas tienen grandes capas de gordura para aguantar las temperaturas frías, a menos de cero, del fondo oceánico. Otros que viven en el fondo oceánico tienen cuerpos especializados para soportar la presión acuática — sus cuerpos se asemejan a la gelatina. No tienen músculos fuertes para nadar y no gastan mucha energía buscando alimento. Estos moradores del abismo son llevados por la corriente oceánica esperando mientras que el alimento, que consiste en animales muertos, sobras, o pedacitos de alimento que los animales grandes no han comido, o también en el excremento de los moradores de la superficie que pasa. Por lo tanto, la mayoría de los peces que viven en las profundidades tienen bocas grandísimas, con dientes grandes y especializados para ingerir grandes cantidades de agua que luego se filtra para sacar el alimento. Unos alimales usan las temperaturas bajas de las profundidades y una digestión lenta para permitirles que se traguen a los peces que son más largos que su propio cuerpo. Otros ingieren lodo del fondo del océano para luego separar los pedacitos de alimento. La vida del abismo es, en verdad, áspera.

LECCION 7 *Los Océanos y las Industrias*

Captando la Idea

1. Cada estudiante nombra un deporte acuático en cual le gustaría participar, y discute y nombra las maneras de pasar su tiempo libre en el océano.
2. ¿Cuántos de ustedes coleccionan algo? Solicita respuestas. Bueno, hay muchas cosas divertidas y agradables que uno puede hacer en el océano; por ejemplo, podemos juntar conchitas marinas.

LECCION 8 *Los Océanos y la Contaminación*

Captando y Organizando la Idea

1. Los estudiantes hacen una lista de las cosas que están amenazando nuestros océanos bajo el encabezado — NUESTROS OCÉANOS SE ESTÁN MURIENDO POR CAUSA DE. Esto podría incluir: la eliminación de químicas y desechos tóxicos; sobrepescar; dragar; turismo (que tocan los arrecifes de coral), derrames y eliminación de petróleo (por ejemplo el aceite de los coches por la gente), eliminación de aguas residuales en los ríos y océanos, contaminación industrial.
2. Como los estudiantes pueden ver, los humanos se comportan en maneras que perjudican los océanos. Vamos a ver si podemos pensar en algunas soluciones. Por ejemplo: ¿Dónde se debería poner la basura? ¿Qúe haríamos con los desechos industriales?

   Recurso a usar: **50 Cosas Sencillas que los Niños Pueden Hacer para Salvar la Tierra**

- No tirar basura en la playa
- Cuando visitan la playa, se debe llevar una bolsa para juntar la basura
- Recircler los plásticos, vidrio, papel, y aluminio; no dejarlos en la playa
- Nunca tirar sedal al océano
- Cortar los anillos de plástico y tirarlos de una manera apropiada
- Llevar el aceite usado a un centro de reciclaje. No tirarlo en los tubos de desagüe o en la calle.

unidad

2 El Tiempo

Información de Fondo para la Maestra

El tiempo es tan importante que es un tema de conversación diaria en todas partes de la tierra. El tiempo afecta a toda persona las 24 horas del día. La cantidad disponible de alimento para que coman los humanos de todo el planeta depende del tiempo, como también los tipos de alimento que comemos, los tipos de casas que habitamos, el tipo de ropa que llevamos, los tipos de trabajos que tenemos, la manera de recreo que tenemos, y aún afecta nuestro temperamento, si nos sentimos bien, o tristes y así por el estilo. Sin embargo, el problema con el tiempo es que nadie puede controlarlo. La ciencia y la tecnología nos ayudan a **pronosticar** el tiempo, pero no es lo mismo que hacer algo sobre eso.

En esta unidad los estudiantes averiguarán en términos específicos de los fenómenos del tiempo que todos hemos experimentado. Se les puede ayudar a aprovecharse de esas experiencias realizando las actividades que les ayuden a comprender lo que causa las nubes, la lluvia, el viento y la nieve, y, en general, las estaciones. Comprenden el papel que desempeñan el sol y la tierra al causar el tiempo. Al ir desarrollando esta comprensión, podrán discutir, usando términos apropiados como cuantificadores, entre sí mismos y con otros, las causas de fenómenos particulares del tiempo.

Las actividades sugeridas requieren que los estudiantes participen en actividades íntegras o de grupos pequeños que enfoquen en simulaciones de ciertas condiciones (fenómenos físicos). Aunque son complejas, se pueden hacer comprensibles estas condiciones atmosféricas por el uso de análogos apropiados. Los estudiantes harán cuadros para describir condiciones actuales del tiempo y luego intentarán un pronóstico del tiempo a base de lo que han aprendido.

Se recomienda enfáticamente que a los estudiantes se les dé la oportunidad de ver segmentos grabados del **Weather Channel** en cablevisión. Ellos hacen un registro de los pronósticos durante una o dos semanas, hacen juicios sobre la precisión de esos reportes, y los usan como base de sus propios pronósticos.

LECCION

1 El Tiempo de Hoy

Captando la Idea

Los estudiantes hacen contribuciones al cuadro intitulado: Fenómenos del Tiempo, Ropa etc. para utilizar al escribir en sus diarios de cómo el tiempo afecta nuestra vida.

Los estudiantes describen lo que pueden ver desde la sala de clase, escribiendo las palabras nuevas que necesiten en un cuadro. Discuten diferentes experiencias que han tenido en relación con el tiempo. Al volver de su paseo, la clase discute lo que han visto, olido y sentido, usando términos descriptivos apropiados. Los estudiantes discuten cómo la manga de aire les proporcionó información sobre el viento y su dirección, y sobre el tipo de información que proporcionó el termómetro. ¿Hacía frío o calor afuera? ¿Cuánto calor (o frío) hacía? ¿Cómo podemos averiguar cuánto calor o frío hacía? ¿Qué usamos para averiguarlo? (termómetro) Los estudiantes comienzan a registrar los datos que se han juntado sobre el cuadro de pronósticos del tiempo. ¿Soplaba el viento? ¿Fuerte? ¿Estaba húmedo, o seco? Se contestan a esas últimas preguntas tomando las opiniones de los estudiantes. Los estudiantes describen las condiciones lo mejor que puedan. Se les dice que en otras discusiones, aprenderán a medir esas condiciones y tendrán maneras más precisas de describir el tiempo.

Aprendimos a usar un termómetro para saber cuánto calor o frío hacía afuera. No tenemos que usar palabras que sólo nos indican si hace calor, frío, mucho calor o mucho frío. Podemos dar una descripción más precisa. ¿Qué distancia caminamos? (Cuadras, yardas) ¿Cómo medimos la distancia?

LECCION 2 ¿Qué Causa el Tiempo?

Captando la Idea

Usando un globo del mundo, la maestra demuestra y discute las siguientes ideas:

1. La tierra tiene una capa profunda de aire que la rodea. Esta capa de aire se llama **la atmósfera.** Normalmente el tiempo es causado por el sol que calienta la tierra del planeta y la atmósfera terrestre, al girar la tierra en su eje. Al ir girando la tierra, gira en esa capa de aire y causa que el aire se mueva. Estos movimientos se denominan **corrientes de aire.** Las corrientes hacen el viento. Entretanto, el sol está calentando la superficie terrestre y también los océanos en la tierra. Al ir calentando el sol a la tierra, ésta refleja algo del calor que recibe del sol a la atmósfera que la calienta aún más. Este proceso causa más corrientes de aire.
2. Mientras que el sol calienta el agua de los océanos, causa **evaporación** del agua. La evaporación entonces forma **nubes.** Las nubes son una forma de vapor de agua que se ha **condensado.** El agua en las nubes se convierte en lluvia, nieve, escarcha, y otras formas de agua y vapor de agua, dependiendo de la temperatura del aire. Veremos que esto sucede cuando hagamos lluvia en la sala de clase.
3. Normalmente se perciben las condiciones del tiempo como movimientos de aire, o de viento, lo seco del viento, o su humedad y temperatura. Cada una de esas condiciones se pueden medir. Eso es lo que hace posible pronósticos precisos del tiempo.
4. Podemos estudiar el uso de la manga de aire. ¿Cuál es su propósito? La manga de aire nos indica en qué dirección está soplando el viento. Pero la manga de

aire no nos indica cuán rápido está soplando el viento. Aprenderemos a medir la velocidad del viento en otra lección.

5. ¿Cuál es el propósito del termómetro? ¿Tiene la temperatura algo que ver con el movimiento de la manga de aire? (No, sólo la dirección y la velocidad del viento.) ¿Cómo se usan los dos instrumentos juntos?

LECCION 3 *Las Cuatro Estaciones*

Captando la Idea

Se les pide a los grupos de estudiantes que justifiquen, en sus propias palabras, las contestaciones de las preguntas sobre las actividades de **Las Matemáticas de las Estaciones.** Después de la discusión, se les dice a los estudiantes las siguientes ideas, usando un globo del mundo para demostrar cómo ocurren las estaciones.

Las estaciones son divisiones del año que ocurren en ciclos y nos indican, por lo general, qué tiempo se puede esperar. En el pasado, se asociaban las estaciones con los ciclos de sembrar y cosechar las plantas cultivadas. El invierno es el período inactivo de la mayoría de las plantas, mientras que se asocia la primavera con la germinación y la siembra. El verano es el período de crecimiento y el otoño es el tiempo de la cosecha.

Fuera del **trópico,** se notan cambios extremos del tiempo en las estaciones, desde un mínimo de calor en el invierno hasta un máximo en el verano. Las otras dos estaciones, la primavera y el otoño, son períodos de transición. Sólo las estaciones más extremas tienen características muy diferentes. Aunque por lo general no se pueden hacer declaraciones absolutas sobre el tiempo de una sola estación, es conveniente dividir el año en cuatro partes separadas para describir el tiempo en general.

Las estaciones son causadas por cambios en el ángulo de los rayos del sol que llegan a la tierra y en la duración de los días. La cantidad de radiación solar (calor) absorbida por la superficie terrestre y por la atmósfera, cambia al ir haciendo su revolución la tierra alrededor del sol. Al ir moviéndose la tierra en su órbita, su eje mantiene una orientación casi constante en el espacio, inclinado aproximadamente 66° al plano de la órbita.

LECCION 4 El Viento: Aire en Movimiento

Captando la Idea y Organizando la Idea

El aire que está en movimiento rápido causa muchos cambios en el tiempo. Podemos experimentar el viento como una brisa refrescante que enfría o calienta, pero cuando su velocidad es grande, la experimentamos como **un tornado** (un viento giratorio que se ve como una nube en la forma de un embudo que se desplaza por un área angosta por la tierra) o como **un ciclón** (un viento fuerte que se mueve en un círculo extendido alrededor de un centro y que con frecuencia trae mucha lluvia). En cada uno de estos fenómenos naturales, la presión del aire es un componente importante de las tormentas, por ejemplo, lo tranquilo en el "ojo" de una tormenta.

1. Los estudiantes discuten las condiciones actuales del viento que han medido. Los estudiantes usan su ventómetro para hacer medidas de las condiciones actuales del viento. Hablan sobre la velocidad del viento, y su dirección.
2. Los estudiantes discuten las maneras de determinar la dirección del viento con más precisión que sólo por una de las direcciones de la brújula. Si los estudiantes no lo sugieren, la maestra sugiere la idea de una veleta, y cómo se podría construir.
3. Los estudiantes también discuten el experimento sobre la presión del aire. La maestra les pide a los estudiantes que piensen en maneras en que se podría usar la presión del aire.
4. Cuando han estado corriendo y se calientan, ¿qué hacen? (tomar agua, etc.) Quieren enfriarse usando EL AIRE de un abanico. ¿Por qué?

Si tienen el pelo mojado y lo quieren secar pronto, ¿qué hacen? Lo secan con una secadora. ¿Tiene que estar caliente el aire para que se seque el pelo? No, pero es más rápido. Pongan una toallita mojada en el brazo de un estudiante. Con la secadora en una velocidad baja, sin nada de calor, se dirige el aire hacia la toallita. Ahora, se pone la secadora en una velocidad alta, se dirige el aire hacia la toallita. Los estudiantes describen la diferencia. (Si no hay secadora, se puede abanicar con un cartón primero despacio y luego rápido.)

Los estudiantes **hacen una regla** sobre el aire y el enfriamiento, por ejemplo: Entre más fuerte sople el viento, más fría es la temperatura.

5. Después de usar el ventómetro, los estudientes discuten la velocidad del viento demostrada por los datos que juntaron y si la escala de Beaufort describe con precisión las condiciones actuales. Escriben en sus diarios sobre las condiciones actuales del tiempo incluyendo sus experiencias con la presión del aire, la manga de aire, la veleta, y el ventómetro.
6. En el **Writing Center**, los estudiantes escriben sobre la presión del aire, cómo se mide, y cómo se mide la velocidad del viento.
7. ¿Qué información nos da un barómetro para ayudarnos a pronosticar el tiempo? (Un barómetro mide la presión que ejerce el aire sobre un lugar particular en un tiempo específico. También nos indica si la presión está aumentando o disminuyendo.)

LECCION 5 Las Nubes, la Lluvia y la Nieve

Captando la Idea

Después que los estudiantes hayan tenido la oportunidad de completar la actividad, se pregunta:

1. ¿Por qué una toallita se siente mojada en su brazo?
2. ¿Qué causa la lluvia? ¿De dónde proviene el agua que causa la lluvia? (El agua en forma de vapor de agua, siempre está en el aire. Al subirse el aire caliente, se condensa en forma de gotitas de agua que bajan como lluvia.) Se repasa el experimento en que se hicieron lluvia y nubes en la sala de clase. Tal vez los estudiantes quieran repetir el experimento. ¿Cuándo se convierte en nieve la lluvia?
3. ¿Descubrieron lo que hace que las nubes tengan colores diferentes? Pueden tratar de adivinarlo.
4. ¿Qué hace que las nubes tengan diferentes formas y tamaños?
5. ¿Qué es la nieve? ¿Cómo son diferentes la lluvia, la nieve y las nubes? ¿Son iguales la lluvia, la nieve, las nubes y el vapor de agua en alguna manera? Si es así, ¿Cómo?
6. De los experimentos que completamos, ¿qué creen que es lo principal, o los factores que hacen la lluvia, la nieve y las nubes? (La humedad y la temperatura del aire.) Se les da a los estudiantes los nombres de las nubes y una descripción general de su apariencia.
7. ¿Qué palabra se emplea para referirse a las nubes, la lluvia, llovizna, neblina, nieve, granizo, escarcha, hielo etc. (Precipitación)
8. ¿Qué le pasó al agua que se congeló por la noche? ¿Qué hizo que el volumen (el espacio que ocupaba en la botella) del agua aumentara? ¿Pusimos más agua en la botella? ¿Cómo saben que nadie puso más agua en la botella? (El agua expande al congelarse. A los 40° el agua tiene su densidad menor.)

LECCION 6 El Show de Luces de la Naturaleza

Captando la Idea

Los relámpagos son una forma de energía eléctrica. Cuando las nubes se acercan unas a otras, una de las nubes recibe cargas eléctricas de la otra nube. La nube con las cargas extras ahora está en un nivel de energía diferente que la otra nube y/o la tierra. Esta diferencia en el número de cargas eléctricas se conoce como electricidad estática. La electricidad estática aumenta en una nube de truenos y se despide como un brillante destello de luz hacia la tierra, o hacia otra nube, para obtener un balance en las cargas eléctricas.

El ruido es causado por las ondas sónicas que se mueven por los aires. Al calentarse el aire, expande, y al expandirse rápidamente, causa ondas sónicas en el aire circundante. El calentamiento de aire, por razón de que se está expandiendo, como el aire que se escapa del globo, causa el ruido. Los truenos son causados por los relámpagos al calentar el aire en su trayectoria hasta 30,000° C (54,000° F), que es cinco veces más caliente que la superficie del sol. Al ir expandiendo el aire muy rápidamente, la velocidad del aire en movimiento causa el ruido retumbante llamado truenos.

Las tormentas con truenos normalmente ocurren cuando el aire está húmedo y caliente. Las nubes cumulonimbus se forman y al ir formándose esas nubes, el aire comienza a moverse rápidamente causando vientos borrascosos. Los relámpagos pueden ocurrir entre la tierra y una nube, o entre una nube y otra.

LECCION 7 *Pronosticar el Tiempo*

Captando la Idea

1. Discusión sobre el hacer decisiones basadas en los datos, dados en las actividades.
2. Tal vez la clase quiera invitar a un meteorólogo local a repasar el trabajo de la clase y dar mayores explicaciones. El meteorólogo tal vez quiera discutir el pronosticar el tiempo como una carrera.
3. Los estudiantes diseñan, organizan, escriben y dibujan mapas meteorológicos para un programa diario de televisión para pronosticar el tiempo del día próximo.

unidad

2 El Sol y las Estrellas

● ● ● Información de Fondo para la Maestra

Antes del siglo 16 la mayoría de la gente del Mundo Occidental, es decir Europa, creía que la tierra era el centro del universo y que el sol, la luna y las estrellas y todos los otros cuerpos "celestiales" giraban alrededor de ella. La trayectoria que seguía la tierra se llamaba **una órbita.** Copérnico, un astrónomo griego, fue la primera persona para decir que el sol era el centro de un sistema que se componía de la tierra y algunos otros planetas que giraban alrededor del sol. También creía que la trayectoria de la tierra alrededor del sol era circular, y que unas pocas estrellas, que él llamaba **planetas,** también se movían por el cielo en círculos alrededor del sol y que eran parecidas a la tierra.

Un poco después de Copérnico, un matemático llamado Johannes Kepler observó que el verdadero movimiento de la tierra y los otros planetas no era el que había creído Copérnico. Usando su conocimiento de matemáticas, Kepler cambió la trayectoria circular u órbita a un círculo alargado llamado **una elipse.**

La teoría de Copérnico, modificada por Kepler, fue modificada de nuevo por Galileo, quien era uno de los primeros astrónomos para estudiar el cielo utilizando un telescopio. La gente no quería creer que **la tierra no era el centro** del universo. Galileo puso un telescopio en el centro de la ciudad y pidió a los científicos del día que observaran el cielo, o en otras palabras, que realizaran una investigación científica. Los científicos se negaron y más tarde Galileo fue condenado de herejía, en parte por causa de su apoyo al modelo de Copérnico del sistema solar.

Desde la época de Galileo, muchos avances científicos han posibilitado que se diseñen y construyan nuevos telescopios que nos proporcionan información sobre el espacio. Aunque Galileo y otros astónomos tenían razón sobre el hecho de que el sol era el centro de nuestro sistema solar, nadie ha reclamado haber encontrado el centro del universo.

El pensamiento actual describe las estrellas como objetos autoiluminados que brillan por radiación producida por procesos nucleares continuos y otros que se efectúan dentro de las estrellas mismas. Por contraste, los planetas brillan únicamente porque reflejan la luz. Hasta donde se pueden comparar sus propiedades con las de otras estrellas, el sol es una estrella típica. Consta de una masa mayor de 300,000 veces más que la de la tierra y de un radio de 696,000 km. (432,200 millas). Las temperaturas de las estrellas tienen límites aproximadas de 5,000 a 20,000 C. La temperatura de nuestro sol son aproximadamente 6,000 C la cual lo coloca dentro de una escala media.

La información sobre las estrellas depende de que los científicos sepan las distancias de las estrellas de la tierra. Una manera importante de calcular esas distancias es la de observar su luminosidad. Ya que la luminosidad de los objetos brillantes varía con la distancia del objeto del observador, se utiliza esa idea para calcular la distancia de las estrellas. Por lo tanto, se conocen con precisión las distancias estelares con respecto a los objetos cercanos, pero para las estrellas en las partes más remotas de la galaxia sus distancias sólo son aproximaciones.

Cómo se formaron el universo y las estrellas es un asunto que continuamente se investiga en la astromonía. Un sistema solar como el que habitamos llegó a existir hace millones de años. Tal vez hay otros sistemas solares en la galaxia de esta tierra; tal vez 100 millones de estrellas tienen planetas orbitantes, y por eso son sistemas solares. Es posible que haya aproximadamente 2 o 3 millones sistemas solares que tienen planetas capaces de mantener formas más desarrolladas de vida, similares a las que hay sobre la tierra. Sin embargo, hay pocas posibilidades de que lleguemos a conocer o estudiar ninguna de las planetas que tengan formas de vida avanzada.

LECCION 1 *Nuestro Sistema Solar No Está Solo en el Más Allá*

Captando la Idea

Se muestran fotos de estrellas y/o planetas sacados de libros, carteles o revistas. Se muestra la etiqueta de palabras que tiene la esfera de "cuerpo estelar". Se define un cuerpo estelar como cualquier objeto en el espacio que sea una estrella, como el sol; un planeta como la tierra; un satélite como nuestra luna; una cometa; o un meteoro (una estrella fugaz). Las estrellas tienen la forma de una esfera, o de un balón. Se discute la idea de que hay muchísimos más objetos estelares en el espacio además de nuestro sol, la tierra y su luna. Se habla del hecho de que el universo comprende más que los cuerpos estelares que podemos ver.

Se pregunta: ¿Cuántas estrellas hay? ¿Qué tan lejos están? ¿Qué es una estrella fugaz (o un meteoro)? ¿Les gustaría viajar a la luna? ¿Por qué hay día y noche?

Cuando miramos el cielo crepuscular, normalmente sólo vemos tres cosas que se ven diferentes — tal vez veamos el sol poniente de un color anaranjado brillante, o tal vez de un color violeto; vemos la luna que puede aparecer muy grande al subir, y luego algunos puntos brillantes de luz, algunos más grandes y brillantes que los otros, pero de apariencia muy parecida. No todos estos puntos pequeños y brillantes de luz son el mismo tipo de cuerpos estelares — son muy diferentes. En las lecciones siguientes descubriremos lo que hace que esos cuerpos estelares sean diferentes.

Diariamente los estudiantes describen nuevas observaciones que han hecho y hacen un registro de ellas en sus cuadros sobre Observación de **la Luna** y **las Estrellas.** Al ir aprendiendo conceptos nuevos, éstos se incluyen en las discusiones diarias.

LECCION 2 Cuerpos Estelares Más Allá de Nuestro Sistema Solar

Captando la Idea

Después de que los grupos estudiantiles hayan tenido tiempo para buscar la información y hayan reportado a la clase, se discuten las siguientes ideas principales.

La Fuerza Mayor en el Espacio — la fuerza mayor en el espacio que son la base de muchos de los procesos que se realizan en el universo son la gravedad. Sabemos que todos los cuerpos se atraen de un modo que depende de sus masas y la distancia entre ellos. El gas de hidrógeno y partículas de polvos forman enormes nubes interestelares que comienzan a atraerse a causa de estas dos fuerzas y paulatinamente se acercan. Con el tiempo (después de millones de años), estas enormes nubes se vuelven tan grandes que los bordes se desploman hacia adentro y separan esta gigantesca nube de las otras partículas en el espacio. Si la estrella en desarrollo consta de suficiente materia o masa, el núcleo, el centro, comienza a calentarse lo suficiente para causar reacciones nucleares.

Comienza una Estrella — Los científicos creen que las estrellas se forman cuando masas grandes de polvo cósmico y gas de hidrógeno se juntan en un lugar del universo. Al calentarse lo suficiente y el gas de hidrógeno comienza a encenderse en una reacción nuclear, comienza una nueva estrella — es una nova. Los científicos creen que nuevas estrellas están comenzando a existir continuamente. El tiempo que una estrella continúe como estrella depende de la cantidad de masa o materia con que haya comenzado.

Estrellas Gigantes Rojas —Al gastarse el hidrógeno que estaba alimentando los procesos nucleares de la estrella, el núcleo o centro comienza a desplomarse. Al ir creciendo la estrella, el proceso de convertir el hidrógeno en helio se aleja del núcleo y suelta grandes cantidades de energía radiante (luz). El calor intenso de las reacciones nucleares causa que el color de la superficie de la estrella cambie de blanco a rojo. Cuando esto sucede, la estrella crece para formar una esfera roja y vasta. Crece hasta ser tan enorme que se le denomina una estrella gigante roja. Algún día, nuestro propio sol gastará su energía y comenzará a crecer hasta el punto de rodear a Mercurio, Venus y posiblemente la Tierra y Marte, al llegar a ser una gigante roja el sol también.

Estrellas Enanas Blancas — Al no quedar nada de energía nuclear en la estrella gigante roja, se desploma para formar una estrella pequeña y densa denominada una estrella enana blanca. Sus átomos están tan intensamente apretados que en comparación un cubito de azúcar, cuyas moléculas estuvieran tan intensamente apretados, pesaría miles de kilogramos. A través de muchos millones de años, la estrella enana blanca se enfría y paulatinamente se vuelve carbonilla negra. Este es el destino de no sólo la mayoría de las estrellas, sino de nuestro sol también.

Agujeros Negros — Cuando una estrella con una masa grande, más de tres veces mayor que la masa de nuestro sol, comienza a llegar al final de su ciclo nuclear de encenderse, se encoge hasta ponerse extremadamente densa, más pequeña que una Enana Blanca. Entonces su gravedad aumenta hasta el punto en que ni la luz puede escaparse de su atracción. Cualquier materia que se acerque a un agujero negro, es sorbida hacia su interior por su gravedad tan potente.

Cometas — Las cometas son los integrantes "diferentes" de la comunidad espacial. Son cuerpos estelares luminosos que tal vez sí o tal vez no lleguen a estar bajo la influencia del campo gravitacional del sol. Al acercarse su órbita a la de la tierra, es atraída hacia ésta y la podemos ver a causa de su luminosidad. Las cometas son los cuerpos estelares más grandes del universo. Una cometa consiste en la cabeza, mayormente materia condensada, y luego al acercarse al sol, forma una coma, estructuras peliformes que luego forman la cola, que puede verse desde la tierra con el ojo desnudo. Una cometa tenía una cola que se extendía hasta aproximadamente 28 millones de millas. Las cometas, como **la Cometa de Haley** se mueven en órbitas elípticas y tienen ciclos en los que se acercan a la tierra y pueden verse. La Cometa de Haley se acerca aproximadamente cada 75 años. Otras cometas tienen órbitas parabólicas y por lo tanto sólo se les ve una vez.

Asteroides — Los cuerpos pequeños que no son autoluminosos se llaman planetas menores o asteroides. Estos son pequeños cuerpos interestelares que tienen una escala de tamaños desde unos pocos kilómetros de diámetro hasta 620 millas o 1000 kilómetros de diámetro. Muchos millares de asteroides están en órbita por el sol entre Marte y Júpiter. Algunos científicos creen que se han desarrollado estos asteroides al explotarse un planeta. **Una zona de asteroides** se encuentra en cualquier lugar del espacio en el que se mueven en grupos muchos asteroides.

Meteoros — Un meteoro es una pequeña partícula de materia que se mueve por el espacio y que al encontrarse con la resistencia de la atmósfera de la tierra se enciende y produce una luz y un destello. Si hay materia suficiente en el meteoro para sobrevivir su entrada a la atmósfera, choca con la tierra, y se entierra en ella creando **un cráter,** entonces se le denomina **un meteorito.**

LECCION 3 *Las Estrellas Producen su Propia Energía*

Captando la Idea

Después que los estudiantes hayan completado la actividad con los objetos que emiten, o reflejan energía en la forma de luz, podemos ver que hay muy pocas cosas en el universo que producen su propia energía — las estrellas generan su propio calor y luz, pero otros objetos, incluyendo los cuerpos estelares, sólo reflejan la luz.

1. ¿Reflejan luz los seres humanos? ¿Cómo lo saben? (Si no reflejáramos luz, no nos podríamos ver)
2. ¿Puede absorber luz un ser humano? ¿Como lo saben? (Cuando nos sentamos en el sol nos ponemos muy calurosos.)
3. ¿Qué apariencia tienen Venus, Marte y Mercurio desde el espacio? (Estas planetas parecen brillantes a nuestros ojos porque reflejan la luz. Ya que los

planetas sólo reflejan la luz, sólo podemos ver la parte del planeta en que está brillando el sol. Decimos que la luna tiene un "lado oscuro" porque nunca podemos ver ese lado de la luna cuando no le está brillando el sol.)

4. ¿Tiene el sol un "lado oscuro"? (No, brilla en todas direcciones porque el sol está quemando hidrógeno por toda su superficie.)

ACTIVIDAD
La Energía Estelar

Demostración de la maestra

Captando la Idea

Nuestro propio sol brilla sobre la tierra durante varias horas del día dándonos grandes cantidades de luz y calor. Las estrellas más grandes que nuestro sol emiten más energía porque son muchas veces más grandes que el sol. No vemos la luz ni sentimos el calor de aquellas estrellas porque están a una distancia de millones y millones de millas. Sólo podemos ver pequeños puntos de luz que han atravesado esas distancias inmensas.

1. ¿Cómo suponen que se sentiría en la tierra si Alfa Centauri tomara el lugar de nuestro sol en el sistema solar?
2. ¿Creen que sentiríamos el calor?
3. ¿Cuántas veces más caluroso creen que se sentiría aquí en la tierra?
4. ¿Cuáles son las dos cosas que tenemos que ver en el cuadro para contestar a esas preguntas?

LECCION 4 *Nuestro Sol es una Estrella Pequeña*

Captando la Idea

En estas actividades, descubrimos que no todas las luces que brillan en el cielo son lo que llamamos estrellas. Como aprendimos en la primera lección, algunos cuerpos estelares emiten su propia luz, como nuestro sol, pero otros cuerpos estelares sólo reflejan la luz, como nuestra luna. Pero aún entre las estrellas mismas hay diferencias que hacen que nos parezcan diferentes en el cielo nocturno.

Por ejemplo, algunas estrellas están muy cerca de la tierra y otras están muy lejos. Los científicos han podido estimar la distancia de las estrellas por la cantidad de luz que llega a la tierra y por el color de la luz que llega a la tierra y por razón de que los científicos han podido calcular la velocidad de la luz.

Podemos comparar las estrellas por su tamaño, usando números grandes y la multiplicación. Usamos una de las estrellas como la unidad o como la referencia. Como aprendimos, algunas estrellas son enanas y otras son gigantes y otras todavía más grandes son supergigantes, cuando se comparan con otras estrellas.

Las estrellas también difieren en cuanto a color y luminosidad. Las diferencias que percibimos se relacionan con la distancia que estén las estrellas de la tierra y con sus temperaturas. ¿Qué experimento nos ayudó a comprender que la luminosidad que vemos depende de la distancia de la estrella?

Se pueden ver las estrellas por un telescopio porque producen y emiten energía en forma de luz. Esa es la característica principal de una estrella — **produce su propia energía por un proceso de cambiar la materia misma en energía.** La cantidad de energía producida en este proceso de cambiar la materia en energía hace que las estrellas sean diferentes con respecto a luminosidad, temperatura y color.

Nuestro sol es solamente uno de millones de otros soles. Es de tamaño reducido — en comparación con los gigantes y supergigantes. Por causa de que nuestro sol es de temperatura mediana, se clasifica como una Estrella Amarilla. Como aprendieron, otras estrellas se llaman Estrellas Blancas y otras se llaman Estrellas Azules, pero **todas ellas** producen y emiten su propia energía.

ACTIVIDAD
Tipos de Estrellas

Captando la Idea

Los estudiantes leen en libros de referencia para contestar a lo siguiente:

1. Usando un retrato similar al de arriba, los estudiantes escriben un párrafo que describe el núcleo, la cromoesfera y la corona del sol, o
2. Se compara el sol con otras estrellas con respecto a color, tamaño, luminosidad, distancia de la tierra, escribiendo un párrafo o haciendo un dibujo y poniéndole una etiqueta, o
3. Se describe el sol en cuantas maneras les sean posibles.

LECCION 5 *La Familia de Nuestro Sol — Los Planetas y sus Satélites*

Captando la Idea

Si la clase ha construido un modelo de los planetas suspendidos, se les habla a los estudiantes con respecto a que los modelos son estáticos — no se mueven. Un modelo que se moviera se llamaría un modelo dinámico.

Al moverse los planetas, se desplazan, como lo sabemos, alrededor del sol. La tierra toma un poco más de 365 días para completar su jornada alrededor del sol. Este es un período sideral. Pero, ¿cuál es la trayectoria de la tierra? ¿Es un círculo?

En el año 1500 Copérnico afirmó que la tierra se desplazaba alrededor del sol en un cículo. Otro astrónomo y matemático, Kepler, sostuvo que la óbita era una elipse. Los científicos de la actualidad creen que las órbitas son elípticas para la mayoría de los cuerpos estelares. Como lo dijimos, algunas cometas se desplazan en órbitas elípticas, pero otras se mueven en trayectorias parabólicas, y vemos esas cometas sólo una vez. ¿Por qué? (No son trayectorias cerradas.)

Recuerden que hemos dicho que la fuerza principal que domina los movimientos de los cuerpos estelares son las fuerzas gravitacionales que ejercen unos sobre otros. Al hacer girar la pelota de ténis, experimentaron dos fuerzas a la misma vez — una es la velocidad de la pelota de ténis al hacerla girar a su alrededor, y la otra fuerza es el cordón que hace que la pelota no se vuele. Estas dos fuerzas mantienen los cuerpos estelares en su lugar.

La próxima vez que asistan a una presentación sobre el hielo, o que vean una en la televisión, fíjense en lo que hacen los patinadores **para detenerse** después de estar dando vueltas rápidamente. Al ver eso, traten de adivinar qué fuerzas están actuando en el patinador.

LECCION 6 *La Luna es Nuestra Vecina Más Cercana*

Captando la Idea

1. Los estudiantes hacen un modelo de la luna de papel maché. Después de investigar las características de la superficie lunar, se dan forma a sus características y se colorea la superficie como la han descrito los astronautas. Los estudiantes discuten cuantas veces más grande es la tierra que la luna!!
2. La gravedad de un cuerpo estelar depende de la masa del cuerpo — cuanto más sea la masa, más será la gravedad del cuerpo estelar; nuestro peso terrestre es diferente de nuestro peso lunar porque la luna tiene 1/6 de la masa de la luna.
3. Las estudiantes discuten la causa de un eclipse lunar.

ACTIVIDAD
Mi Peso en la Luna

Captando la Idea

Los cuerpos estelares tienen masas distintas que afectan la fuerza de su gravedad. Pero su masa no siempre está distribuida igualmente por todo el cuerpo, por lo tanto, la fuerza de la gravedad no es la misma en todas partes. Lo que significa esto es que su peso no será siempre el mismo dondequiera que se pesen. Sin embargo, su **masa** queda igual.

Se utiliza la tierra como la unidad estándar en el cuadro. Con la excepción de la tierra, por razón de que se utiliza la gravedad de su superficie como la unidad estándar, todos esos otros factores sólo son aproximaciones. Sin embargo, todavía se puede desarrollar la noción de que el peso es una propiedad de la materia que depende de la localización, el lugar donde se mide el peso. La masa es constante — la cantidad de material en un pedazo de materia no cambia.

LECCION 7

Las Constelaciones

Captando la Idea

Pregúnteles a los estudiantes si saben lo que quiere decir la palabra "constelación". Si la dividen en sílabas, tal vez podrán adivinar. En español, "con" significa "with" o "together with". ¿Qué sugiere la palabra "stella"? Es verdad, estrella. ¿Qué significado tendrá la palabra entonces? — con otras estrellas o una agrupación de estrellas. En las actividades que han completado, han aprendido que hay unos patrones constantes en el cielo nocturno que se pueden identificar porque sugieren objetos familiares.

Las constelaciones visibles en cualquier parte del cielo parecen moverse hacia el este cada hora debido a la rotación de la tierra. Las constelaciones visibles en cualquier parte del cielo parecen moverse hacia el oeste cada mes, pero esto se debe a la revolución de la tierra alrededor del sol. Así que a través del periódo de un año, cada constelación es visible durante seis meses cuando se observa a la misma hora, y se mueve desde el este hacia el oeste. Estas son constelaciones **de temporada.**

Por otra parte, las constelaciones **circumpolares** son las que no salen ni se ponen, o en otras palabras no parecen moverse como las otras. Estas constelaciones parecen moverse en una serie de círculos alrededor de **Polaris, La Estrella Polar,** por lo tanto se les denomina circumpolares.

Hemos aprendido que los griegos dieron nombres a las constelaciones por razón de que si las constelaciones surgerían la forma de un objeto familiar, sería más fácil localizarlas en el cielo nocturno. Pero, ¿tiene un nombre **cada estrella** en una constelación particular?

En la actualidad los astrónomos através del mundo necesitan un sistema de comunicación en común para hablar de las estrellas y las constelaciones. Hay tantas estrellas que tiene que haber una manera de identificarlas sin equivocarse. Una característica que tienen las estrellas en común es su luminosidad. Así que los griegos clasificaban las estrellas según su luminosidad aparente y les daban el prefijo de una letra griega y luego el nombre de una constelación donde se podía localizar la estrella. Por ejemplo, B, beta, significaba la segunda estrella más luminosa de una constelación. Vean su Cuadro de **Datos sobre Estrellas.** Encontrarán que algunas estrellas clasificadas de alfa (la primera letra del alfabeto griego, como la A) y otras clasificadas de beta (la segunda letra del alfabeto griego, como la B) y así sucesivamente.

Los griegos no solamente daban nombres a las constelaciones por las formas que ellos imaginaban que podían ver en sus posiciones, sino que también les daban nombres para conmemorar acontecimientos importantes. También usaban letras del alfabeto griego para nombrar las estrellas individuales dentro de las constelaciones.

Los griegos también idearon otro sistema de codificación estelar llamado **el Zodíaco.** Véase **la Actividad** — La Fecha del Zodíaco. El sistema fue desarrollado a base de la posición del sol, en vez de las estrellas. Los griegos creían que los planetas ejercían gran influencia en la vida de la gente. Los griegos usaron la palabra Zodíaco para nombrar a ese sistema, por razón de que ellos también buscaban formas familiares en el cielo nocturno y les recordaba de un **zoológico** — un lugar donde encontramos muchos animales.

Después de discutir las ideas presentadas en las actividades, tal vez los estudiantes querrán considerar las siguientes preguntas interesantes.

1. ¿Qué piensan del juego de encontrar una estrella usando un par ordenado de números? (Por supuesto, en el espacio se tendrían que usar números adicionales para realmente encontrar una estrella por razón de que el espacio es tridimensional.
2. ¿Hay otros calendarios que han sido desarrollados por otras personas? Por ejemplo, los chinos tienen su calendario, así como los mayas y los hebreos también. Busquen en sus libros de referencia uno o más de esos sistemas y reporten a la clase.

ACTIVIDAD

Localizando las Estrellas

Captando la Idea

1. ¿Cambiará Polaris de posición durante el año a medida que otras estrellas se mueven del este al oeste? (No, porque es una estrella **circumpolar.** Gira "alrededor del polo" y permanece en el mismo lugar a través del año. Por eso la Estrella Polar es nuestro punto de referencia, o el punto inicial para localizar las estrellas.)
2. Si fueran marineros en un barco en medio del océano, sin poder divisar tierra, ¿necesitarían una brújula para encontrar el Norte? Si no, ¿cómo encontrarían el Norte?
3. Si estuvieran en una nave espacial en el espacio, ¿creen que podrían encontrar la dirección en que se movía la nave sin una brújula? ¿Cómo? ¿Todavían buscarían a Polaris para ayudarles a encontrar la dirección? ¿Por qué, o por qué no?
4. Supónganse que están a millones y millones de millas de la tierra en el espacio en una estrella muy distante. ¿Cómo se les vería la tierra? ¿Dónde estaría el Norte? ¿Les importaría el Norte allá? (La tierra, si se pudiera ver desde esa distancia, sería un puntito. Norte es una noción que sólo es de valor en la tierra, y no tiene significado en el espacio. Los navegadores de las naves espaciales usan métodos diferentes para dirigirse, pero **todavía usan las estrellas.**)
5. Supónganse que viven en Sud América, Australia, o Sud Africa, (por los menos 1000 millas debajo del ecuador). ¿Podrían encontrar a Polaris. Usen un globo de la tierra para explicar por qué. ¿Si fueran exploradores, buscarían el Norte o el Sur? ¿Cómo encontrarían el Sur? ¿Tratarían de usar las estrellas? **¡Primero, tendrían que localizar un punto en el cielo nocturno del sur!**

unidad

3 La Materia

● ● ● Información de Fondo para la Maestra

Todo del universo se compone de materia o energía. Antes de que los estudiantes puedan estudiar la materia, se presenta la noción básica de lo que significa la materia. La materia existe en su forma elemental, como carbono, mercurio, hierro, cobre, oro, plata etc. La materia también puede existir en la forma de mezclas como el aire, que es una mezcla de gases en su forma elemental (nitrógeno, oxígeno) y en forma molecular (dióxido de carbono, vapor del agua). Las unidades más fundamentales de la materia se denominan **átomos.** Un átomo es la partícula más pequeña de la materia que por sí solo puede combinarse con otros átomos diferentes o iguales. **Los elementos** son agrupaciones o combinaciones de átomos iguales, mientras que **las moléculas** son combinaciones de otros átomos iguales o diferentes.

La materia consta de dos propiedades esenciales — tiene **masa** y tiene **volumen,** ocupa espacio. La masa es la cantidad de material de que está compuesto algo. La masa tiene **inercia,** que es la resistencia de la materia al cambio de su estado de reposo o de movimiento.

A veces se refiere a las masa como peso. El peso es una propiedad de la materia que cambia, dependiendo de dónde se pese la materia. Los cuerpos grandes, como la tierra, el sol, los planetas y la luna, tienen su propia gravedad que atrae todo lo que esté cerca de ellos. Cuando nos pesamos en la tierra, medimos la atracción de la tierra a nuestro cuerpo. Nuestro peso sí depende de cuanta materia tenemos, pero cambia dependiendo de dónde nos pesemos — de lo que atrae a nuestro cuerpo. Por ejemplo, nuestro peso será menos si nos pesamos en la luna y más si nos pesamos en el sol. Sin embargo la masa de nuestro cuerpo, el material del que estamos compuestos, no cambia.

Toda materia es o un sólido, un líquido o un gas. Los elementos existen en cualquiera de esas tres formas —el oro, mercurio (forma líquida del elemento) y oxígeno. La materia puede cambiar su forma, pero bajo procesos normales, la materia, en su forma elemental, no puede ser destruida. Bajo un cambio físico, el carbón (elemento, carbono) permanece como sólido aún cuando se convierte en polvo. El agua (en forma molecular), tiene la propiedad excepcional de poder cambiarse fácilmente a cualquiera de los tres estados de la materia. Los estudiantes pueden ver que cuando el agua se convierte en gas, es invisible.

Las sustancias también pueden existir como **mezclas,** en que cada uno de los compuestos individuales mantiene sus propiedades. La leche es una mezcla de sustancias que pueden ser separadas a su forma original. Los cereales, com Fruit Loops o "trail mix", son buenos ejemplos de mezclas, ya que cada uno de los componentes individuales puede verse y se puede separar con facilidad. Sin embargo al quebrarse un huevo, o cuando se bate, es muy difícil ver los componentes originales y son imposibles de separarse. Pero, no obstante, es una mezcla por razón de que **sólo** se cambió **físicamente**. Quebrar un objeto es un ejemplo de un cambio físico.

Los elementos se combinan para formar varias sustancias en un proceso que no solamente es físico, sino también químico . Cuando los elementos como el carbono y el hidrógeno, y otros, se combinan con el oxígeno, por ejemplo, se queman y forman **compuestos.** Los co:npuestos son combinaciones de elementos que han sido unidos por cambios químicos. Por ejemplo, cuando se cocina un huevo, la naturaleza del huevo cambia. Cocinar es un ejemplo de un cambio químico.

La noción de operaciones inversas es una noción matemática también. Por ejemplo, sumar y restar son operaciones inversas por razón de que la una "deshace" a la otra. Por otra parte, hay algunas operaciones que no tienen operación inversa, y hay otras operaciones que son sus propias inversas.

LECCION 1 *La Materia Está en Todas Partes*

Captando la Idea

Se les dice a los estudiantes que todo lo que vemos y tocamos es materia. Nuestros cuerpos están hechos de materia, el agua que tomamos está hecha de materia, como lo está el aire que nos rodea. (Hay muy poco de lo que podamos ver y sentir que no sea materia.) A veces podemos ver la materia y sentirla, pero a veces no. Aún si no podemos verla, o sentirla, como el aire, todavía es materia. La materia existe como sólido, líquido o gas.

¿Cómo se puede describir un sólido? (es duro; está pesado; no se puede ver a través de ello; no se puede pasar a través de ello; se le puede ver y sentir; tiene una forma específica) Nota: Si un estudiante nombra a la luz como materia, puede responder que el mundo sí recibe luz del sol y esa luz es energía, pero no se estudiará la energía en esta unidad sino en otra.

¿Como se puede describir un líquido? (Se le tiene que poner en algo; no tiene forma específica; toma la forma de su receptáculo).

¿Cómo podemos describir un gas? (va por todas partes: no tiene forma; no se queda en un receptáculo descubierto; toma la forma de su receptáculo; a veces no se le puede ver; va por todas partes del cuarto).

ACTIVIDAD
Sólidos, Líquidos, Gases

Captando la Idea

En esta actividad vimos que la materia existe como sólido, líquido o gas. Pero vimos otra cosa también — la materia puede cambiar su forma de sólido a líquido a gas, y luego al revés. La materia no puede ser destruida — sólo se puede cambiar de forma.

LECCION 2 Cómo Detectar la Materia

Captando la Idea

Completen las frases siguientes para el experimento sobre el peso de un líquido.

El peso del ________ menos ________ del ________ son ________.

El peso del ________ más ________ del ________ son ________.

Se contesta a la siguiente pregunta: ¿Se puede encontrar el peso de todos los líquidos en esta manera? (Casi siempre sí, pero tal vez haya líquidos que no se puedan manejar con tanta facilidad como el agua, o el alcohol, la leche etc.)

Una propiedad de la materia es **la masa.** La masa es el material de que está compuesto todo. En estos experimentos pudimos ver que **toda materia tiene masa** cuando levantamos objetos como esta canica o un pisapapeles. No es tan fácil sentir que algo está pesado cuando levantamos esta pelota de ping pong o esta bolita de algodón. Necesitamos una balanza para ayudarnos a ver que estas cosas tienen peso.

Describimos la masa de la materia diciendo que tiene peso. El peso nos indica cuánto la gravedad de la tierra está jalando sobre algo. Si no hubiera gravedad, entonces no pesaríamos nada, **pero todavía tendríamos la misma cantidad de masa.** El peso sólo describe cuánto jala la gravedad sobre la materia y es una manera de describir la materia.

¿Toda materia tiene peso? ¿Cómo lo sabemos? ¿Tienen peso los sólidos? ¿Los líquidos? ¿Qué podemos decir del aire? (El aire tiene peso porque es materia.) Aunque no podemos ver el aire, sabemos que está allí porque podemos amasarlo, o podemos pesarlo. Los gases tienen masa y pueden pesarse también.

¿Cuál es la contestación a nuestra pregunta? Si no podemos ver la materia, olerla, ni sentirla, **¿cómo sabemos que está allí?** Escriban e ilustren la contestación en sus diarios.

LECCION 3 Otra Manera de Detectar la Materia

Captando la Idea

Para que un científico pueda descubrir las contestaciones a las preguntas sobre la materia, es muy importante tener las herramientas correctas y apropiadas para ayudarles a hacer sus observaciones. Una herramienta de ésas es el cilindro graduado. En su forma es un cilindro — es redondo y tridimensional. También es angosto y largo. ¿Por qué creen que es alto? (Se hace una pausa para esperar las respuestas de los estudiantes) Es alto para hacer que el líquido suba alto dando así una medida más precisa. Entre más angosto sea el tubo, más se parecerá a una "línea" que se puede medir con una cinta de medir. También se marca el tubo en "grados" o pasos para leerlo con mayor facilidad. Es una herramienta importante para los científicos.

Se les pregunta a los estudiantes lo que tienen en común los sólidos líquidos y gases. Se hace una pausa otra vez para esperar las respuestas de los estudiantes. Es verdad, todas estas cosas ocupan espacio; ocupan lugar; tienen **capacidad** o **volumen.** Decimos que la caja tiene **capacidad.** Podemos medir su **volumen,** o el espacio que ocupa, usando esta pulgada cúbica estándar, o este milímetro estándar.

¿Cuál es otra manera de detectar la materia? Otra manera de detectar la materia es que ocupa lugar. ¿Cuál es la otra manera? Tiene masa y puede pesarse.

Los gases se conforman a la forma de su receptáculo pero lo llenan completamente. Esa es una diferencia entre los líquidos y los gases. Se tiene que poner los líquidos en un receptáculo, y se conforman a la forma de su receptáculo, o en otras palabras toman su forma. Por otra parte, los gases también se conforman a la forma de su receptáculo, pero **el receptáculo** tiene que estar **cerrado,** de otra manera se escapa el gas. El gas toma la forma del receptáculo **entero.**

LECCION 4 ¿Qué es la Materia?

Captando la Idea

Conocemos algunas sustancias en su forma pura como el carbono, carbón, carbón de leña o grafita. Otras sustancias que generalmente vemos en su forma pura como **elementos** son los diamantes, que son carbono también, pero en forma de cristales. El oro es otro elemento. Normalmente, cuando se usa el oro en joyas, no está en su forma más pura porque el oro es muy blando. Tiene que mezclarse con otros metales para que sea duro. También se puede ver la plata en su forma pura, generalmente como joyas. Otros metales, como láminas delgadas de aluminio, cobre y zinc existen como elementos. Estos son ejemplos de materia en su elemento y en su forma sólida.

La materia también existe en una forma líquida como elemento, pero esto no es lo normal. Un metal, el mercurio, existe en su forma pura como líquido. También se convierte en su estado de vapor muy fácilmente y es muy venenoso como gas. Eso no se lo demostraremos excepto en este termómetro de mercurio. El mercurio está sellado en este tubo y no se puede escapar.

La materia en forma de gas existe como elemento también. Esos gases son difíciles de ver porque normalmente no tienen color. El oxígeno en el aire está en su forma de elemento, como lo es el nitrógeno. Sin embargo, el dióxido de carbono, que está incluido en el aire que exhalamos, también es un gas sin color ni olor, pero no es un elemento. Existe en la forma de **un compuesto.** Los compuestos son **sustancias** que se componen de dos elementos o más que se han unido a consecuencia de un cambio químico. El agua, por ejemplo, es un compuesto compuesta de dos gases — oxígeno e hidrógeno.

En uno de nuestros experimentos dijimos que las moléculas del agua caliente se estaban moviendo más rápidamente que las moléculas del agua fría. ¿Cómo llegamos a esa conclusión? (Pausa: Se permite que los estudiantes den sus opiniones.) Una gota de colorizante de comida se mezclará mucho más rápidamente en agua caliente que en agua fría por razón de que al calentarse los líquidos, las moléculas en ellos se mueven con mayor rapidez. El movimiento de las moléculas "menea" el agua y causa que el colorizante se mezcle a mayor velocidad. El agua no se comprime, pero se expandirá y se contraerá debido a cambios en temperatura.

ACTIVIDAD
Moléculas Dulces

Captando la Idea

1. Han hecho unas representaciones de moléculas en esta actividad; ¿Qué representan las diferentes piezas de dulce? (Cada pastillita de goma representa un átomo. Los diferentes colores de las pastillitas de goma nos ayudan a ver cuántos **diferentes elementos** se hallan en cada molécula.)
2. ¿Qué representan los palillos de dientes? Dijimos que las moléculas son agrupaciones de átomos que están unidas como pequeños imanes que se pegan. Los palillos representan las fuerzas magnéticas que mantienen unidos a los átomos, y así se forma la molécula. Sin esas fuerzas magnéticas, las moléculas se separarían.)
3. ¿Cuántos tipos diferentes de átomos forman una molécula de hidrógeno? (Sólo un tipo — los dos átomos que componen esa molécula son átomos de hidrógeno.)
4. Describan la molécula del agua. (Se compone de tres átomos, y dos tipos de elementos — sólo el hidrógeno y el oxígeno.)
5. ¿Cuál es la diferencia entre las moléculas del dióxido de carbono y las del monóxido de carbono? ¿Cuál es la diferencia entre esos dos gases en la vida real? Los humanos exhalan el dióxido de carbono, y también se inhala el dióxido de carbono en el aire que respiramos. El dióxido de carbono existe en el aire normal sólo en un porcentaje mínimo. Pero, el monóxido de carbono, por otra parte, es un gas muy mortífero. Los humanos no lo pueden respirar por más de unos pocos minutos y sobrevivir.)

ACTIVIDAD
Las Moléculas Pueden Moverse a través de los Sólidos

Captando la Idea

Después de tres días, se les pregunta a los estudiantes cuáles han sido sus observaciones y cuál es su interpretación de los datos.

Nota: Tal vez debe asegurarse de que el globo está bien amarrado para que el aire no se pueda escapar de la abertura. Se puede hacer esto sumergiendo el globo en el agua para ver si hay burbujas de aire. Al quedar inflado el globo, las moléculas del aire penetran el material del globo y perderá aire lentamente aunque el aire no se está escapando por ningún medio observable. Para la duración de este experimento, la temperatura del aire deberá permanecer lo más constante posible. Si cambia la temperatura del aire, el globo se expandirá o contraerá (en el aire más caliente y menos caliente respectivamente), y anulará los resultados.

LECCION 5 La Materia Cambia de Apariencia

Captando la Idea

La materia puede pasar por cambios. La materia puede cambiar su forma. Eso significa que la materia puede cambiar su **apariencia.** Esto se denomina **un cambio físico.** Por ejemplo, podemos romper un pedazo de vidrio, pero cada pedazo es todavía un pedazo más pequeño de vidrio. Podemos cortar una manzana, pero cada rebanada es todavía un pedazo más pequeño de manzana. Sólo su tamaño o forma cambia.

¿Son permanentes los cambios físicos? Explique esto a la clase. (Cuando el hielo se convierte en agua y luego se vuelve a congelar, el cambio del hielo al agua y al revés no son cambios permanentes. Sin embargo, si se rompe un pedazo de vidrio, es un cambio físico, pero a menos que tengan una fábrica de vidrio, no podrán volver a juntar los pedazos de vidrio, exactamente como estaban antes. Esto significa que no podemos decir si un cambio es un cambio físico sólo por observar si un cambio es permanente o no.)

Usamos la masa y el volumen para demostrar que los cambios físicos sólo cambian **la apariencia de** la materia pero su masa no. Pudimos ver que que la masa, descrita por el peso de las piedras, después de quebrarse quedó igual.

La idea de **las operaciones inversas** en matemáticas puede usarse para pensar en eventos que se siguen de tal manera que el realizar una operación tras otra nos regresa al lugar en que principiamos. Dos operaciones inversas de mucha importancia son sumar y restar, como aprendimos en **la Lección Dos.**

Podemos mostrar los resultados de realizar operaciones inversas — "Vete a la Cárcel/Vete al Comienzo" — una tras otra pensando en ellas como un mapa. Una seguida de la otra nos lleva al lugar donde principiamos.

LECCION 6 Una Sustancia Puede Cambiar su Masa

Captando la idea

Un fósforo ardiendo es un ejemplo de la materia que se está cambiando de un pedazo sólido de madera a un gas — al humo, y a cenizas — otros sólidos y un gas que son diferentes del fósforo con el que comenzamos. Si observamos de cerca al ir quemándose el fósforo, podemos ver algo de líquido cerca de la llama. Este líquido es parte del fósforo que se vaporizado po razón de que se puso tan caliente que se convirtió en líquido antes de convertirse en humo. Este cambio de un fósforo ardiendo a vapor y luego a cenizas se llama un cambio químico. Al pasar la materia por **un cambio químico**, no hay manera, usando procesos normales, de volver a cambiarlo en lo que era antes del cambio. En este ejemplo, no hay manera que podamos atrapar el vapor y volverlo a poner en las cenizas para hacer un fósforo de madera otra vez.

Hemos estudiado otros ejemplos de cambios químicos. ¿Qué le pasó al estropajo de acero seco? Nada — ningún cambio. ¿Por qué cambió el estropajo de acero mojado? ¿Cuál era la única diferencia entre los dos estropajos? Uno tenía agua, estaba mojado y tenía aire. El hierro se oxidó. La oxidación es una sustancia compuesta de hierro y oxígeno. Las moléculas de oxidación contienen átomos de hierro y oxígeno, con moléculas de agua pegadas. Cuando estos elementos — el hierro, oxígeno y agua — se unen, se lleva a cabo un cambio químico — el hierro se convierte en oxidación.

Todos ustedes han tenido la oportunidad de observar los cambios en la papa, la manzana y el estropajo de acero, el globo y el agua. ¿Por qué creen que algunos de esos cambios son físicos, mientras que otros son químicos? (la papa y la manzana se pudrieron; se pusieron verdes o cambiaron de color; ya no son iguales; el estropajo se oxidó y se puso escamoso; el agua sólo se evaporó; el globo no cambió, todavía es un globo; sólo se puso lacio).

La descomposición y la oxidación son otros ejemplos de cambios químicos. La evaporación es un cambio físico. Sin embargo, la materia **puede cambiar** su forma y sus atributos en maneras que son permanentes. Vemos que sucede constantemente. La evidencia que ha ocurrido un cambio químico son uno o una combinación de lo siguiente: Un cambio de masa se muestra en un cambio de peso; se genera calor (el fósforo ardiendo); cambia el color de la sustancia (la manzana y la papa); se genera un gas (las burbujas cuando se combinaron el polvo misterioso (bicarbonato de sodio) y el líquido misterioso (vinagre)); la sustancia cambia su naturaleza (la clara del huevo se hizo elástico, y el pegamento Elmer's y el almidón líquido se hicieron Silly Putty).

LECCION 7 *Los Compuestos y Mezclas*

Captando la Idea

Se repasan las nociones de la composición de la materia. Las unidades más pequeñas en las que existe la materia se denominan **átomos**. Cuando la materia existe en una combinación de dos o más elementos, se le denominan **un compuesto** o **una mezcla**.

Todo objeto del universo se compone de materia, o como un elemento puro o como un compuesto o mezcla. Los elementos se combinan para formar compuestos o mezclas. Al formarse una mezcla, es el resultado de un cambio físico — los componentes o partes individuales que se incluían en la mezcla son visibles

— las partes individuales mantienen todas sus propiedades y se pueden separar en su forma original con relativamente poco esfuerzo, por ejemplo, el "Trail Mix". Miren esta bolsa del cereal **Lucky Charms.** Es una mezcla. En una mezcla a veces se pueden ver las distintas partes. Contiene bombones, estrellas, cereal y nueces. Sin embargo, si se le derrama en una mesa, se le pueden separar todas las partes distintas. Esto no es verdad del agua, por ejemplo. No se pueden separar con facilidad los gases del oxígeno e hidrógeno de que está compuesta.

Por otra parte, cuando se combinan dos elementos o más para formar un compuesto, ocurre un intercambio de energía. A veces, se emite calor. La luz y el gas también son productos de la unión de elementos para formar compuestos. Por ejemplo, una explosión es el efecto secundario de la formación de nuevas sustancias, como cuando se detona la dinamita.

LECCION 8 *La Ciencia: Contar y Medir*

Captando la Idea

¿Qué creen que hacen los científicos cuando realmente no pueden contar o medir algo para juntar datos para contestar a una pregunta? Es verdad, estiman. Nosotros hacemos lo mismo; si en realidad no podemos contar algo, intentamos estimar el número. **Estimar** quiere decir que hacemos un cálculo aproximado usando algunos indicios que nos ayudan a acercarnos lo más posible al verdadero número que buscamos. Cuando estimaron el número de frijoles en el frasco, ¿qué indicios buscaron para ayudarles a calcular aproximadamente el número?

¿Qué hicieron la primera vez que conjeturaron? (sólo conjeturaron; intentaron contar algunos; vieron el tamaño del frasco, etc.)

¿Qué hicieron la segunda vez que conjeturaron? (volvieron a conjeturar; si el frasco era más grande, calculé más frijoles; tenía más experiencia estimando frijoles en un frasco y mi cálculo aproximado era mejor)

¿La tercera vez?

A veces los científicos tienen que estimar también. Por ejemplo, los astrónomos nos dicen que la distancia de la tierra al sol son 93 millones de millas. ¿Cómo lo saben? No lo saben; los científicos la han estimado usando diferentes indicios — así como hicieron ustedes. Ahora que los astronautas han viajado a la luna, han podido medir la distancia de la tierra a la luna. Ahora saben que los indicios que usaban para estimar la distancia en el espacio eran válidos — que los indicios que usaban en verdad les estaban ayudando a medir la distancia en el espacio.

Vamos a pensar en algunos de los datos que hemos juntado en el experimento sobre los cambios químicos. Miren el cuadro de datos. En el cuadro indicamos que la papa y la manzana se arrugaron, se hicieron cafés, olieron mal y se pudrieron o se secaron. ¿Hay alguna manera de medir **cuánto** se pudrió la papa? ¿Podemos medir qué tan mal olía? ¿Por qué no podemos medir eso? No tenemos ningún instrumento, ni una unidad estándar sobre cuánto se pudre o huele la comida. Sólo podemos estimar que cada día la papa se veía más podrida y olía peor que el día anterior.

¿Qué tal el agua? ¿Pudimos medir la cantidad de cambio? ¿Pudimos determinar cuánta agua se evaporaba cada día? Sí, por razón de que metimos el agua en una taza de medir y podíamos leer la escala para ver cuánta quedaba. ¿Qué más pudimos medir en ese experimento? Después de que los estudiantes hayan pensado un poco sobre la pregunta: ¿Pudimos medir cuánto aire se había escapado del globo? Sí, porque medimos la circunferencia del globo todos los días.

¿Qué tal la piedra? ¿Cambió de apariencia? ¿Cambió su masa? ¿Cómo lo saben?

unidad

3 El Sonido

● ● ● Información de Fondo para la Maestra

Mucho de lo que aprendemos de nuestro mundo nos llega a través de nuestro sentido del oído. El oír es importante no solamente para aprender del mundo, sino también para comunicarse con otros humanos, y con los animales. La voz humana es única en su habilidad de expresar ideas abstractas.

Los sonidos les proporcionan a los animales mucha información que les advierte del peligro e informa que está cerca una presa posible. Los sonidos les informan a los animales y los humanos del tiempo en la forma de truenos, y por la cualidad del sonido, (por ejemplo, los sonidos en una noche fría y clara son diferentes de los sonidos en una noche calurosa y húmeda) o por el soplar del viento. Nos informamos con respecto a la hora — el silbato a la hora de comer; el peligro, con el alarma de incendio, o el silbido del policía; la felicidad o tristeza con la música, etc.

Los doctores pueden escuchar el latido del corazón, los pulmones y el estómago de sus pacientes para ayudarles a diagnosticar la enfermedad. Podemos escuchar los motores para tener una indicación si necesitan reparación. Podemos identificar a personas por el sonido único de su voz o por el sonido de sus pisadas. Podemos identificar a los animales por sus sonidos: El canto de los pájaros, el rugido de los leones, el zumbido de los insectos etc. Todos podemos aprender del mundo por medio del los sonidos que oímos. De esta manera, nuestro sentido del oído nos ayuda a aprender del mundo que nos rodea.

Los estudiantes pueden aprender muchos conceptos técnicos relacionados con el sonido haciendo los experimentos y actividades de la unidad. Los estudiantes pueden aprender los conceptos del tono y volumen jugando con objetos que vibran y luego haciéndolos vibrar de diferentes maneras. A medida que aprenden los estudiantes a cambiar las variantes en un experimento y observar las consecuencias de los cambios, comenzarán a desarrollar un acercamiento a la capacidad de solucionar problemas que los llevará a apreciar el método científico.

Se pueden sentir las vibraciones, o energía acústica, en forma de una pulsación. Entonces se interpretan estas vibraciones como ondas acústicas y se visualizan en forma de gráficas por los científicos que las estudian. Los estudiantes pueden usar estos nuevos conceptos de energía que se propagan en forma de ondas a través de un medio para comprender las nociones esenciales del sonido. Se pueden explicar el tono, volumen, ritmo, música y ruido mirando una gráfica de ondas acústicas. Aunque la producción del sonido y la capacidad de los humanos de detectar, analizar e identificar sonidos son conceptos complejos, los estudiantes pueden comprender las nociones fundamentales si pueden hacer experimentos con objetos para familiarizarse con las ideas.

El sonido se propaga mejor a través de objetos sólidos porque están más compactas las moléculas y no tienen que moverse una gran distancia para chocarse la una con la otra y transmitir las vibraciones. El sonido se propaga a mayores distancias por la misma razón. Por supuesto, la excepción son los materiales acústicos especialmente diseñados que parecen ser sólidos pero están diseñados con espacios para "atrapar" vibraciones.

Se deberían oír con mayor claridad los golpecitos que se dan en el escritorio y el tictac del reloj cuando la oreja se pone en contacto con el objeto sólido. Los medidores de un metro y un pie deberían sostenerse sueltos para que la mano no amortigüe las vibraciones. Los indios americanos usaban este principio al mantener la oreja en contacto con el suelo para oír sonidos a grandes distancias. Se podían oír las manadas de búfalos y el sonido de las patas de los caballos antes que se pudieran ver. "Mantener la oreja pegada al suelo" significa (en inglés) escuchar atentamente.

El sonido es una parte importante de nuestra vida. Es uno de los primeros estímulos a que reaccionan los recién nacidos, y su presencia o ausencia nos forma y afecta durante nuestra vida. Esta sección presenta el sonido, sus causas y usos. Un estudio del sonido se presta muy bien a las actividades concretas, con muchas posibilidades para descubrimiento/investigación. No se hace ningún intento de presentar la fisiología del oído, aunque pueda optar por enseñarla en relación con este campo de estudios.

Se puede expandir grandemente un estudio del sonido en el área de "Language Arts" para desarrollar y enriquecer las capacidades de escuchar. Se puede integrar la música por una discusión de los términos musicales que se encuentran en esta sección. Las actividades finales sobre el inventar y tocar instrumentos musicales podrían conducirse a estudios adicionales de métodos antiguos y métodos electrónicos modernos de producir música.

A través del estudio, se les debe animar a los estudiantes a que traigan y demuestren sus propios instrumentos musicales. Si hay una escuela secundaria o universidad cerca, el director musical tal vez esté dispuesto a cooperar proporcionando músicos e instrumentos. La mayoría de las comunidades tienen grupos corales que tal vez estén dispuestos a hacer una presentación. Se podrían sacar resultados interesantes y divertidos enviando una nota a los padres pidiendo los nombres de personas que tocan instrumentos musicales poco comunes.

Al hablar sobre el tono, o la frecuencia de vibraciones por segundo, los niños deben estar conscientes de que el oído humano no puede detectar las frecuencias de vibraciones muy altas (rápidas) ni muy bajas (lentas). Los silbatos para perros, por sus frecuencias demasiado altas, no los pueden oír los humanos, pero sí los pueden oír los perros y algunos otros animales.

Al hablar sobre la importancia del sonido, se debería poner énfasis en el valor de poder oír y hablar claramente. Los niños deberían saber que personas de todas edades padecen de una reducción en su capacidad auditiva y que casi todos llegan a sufrir de algún tipo de deterioro físico al envejecerse.

Se puede incluir con frecuencia en este estudio a personas con recursos especiales. Estos podrían ser individuos de todas edades que tengan impedimentos auditivos; una enfermera, un médico, y audiólogo, un especialista en sonido (arquitecto), un dueño de una tienda de música, un músico, o alguien que fabrique o toque instrumentos musicales poco comunes.

Este es un campo repleto de actividades que puedan llevarse a casa para fomentar discusión. El llevar a casa objetos concretos para mostrar y discutir con la familia les ayudará a los niños a que desarrollen su capacidad lingüística y que lleguen a ser una fuente de motivación en las ciencias.

Se ha puesto poca atención al campo de la electrónica en el sonido. El estudio de la tierra y del espacio introduce campos como el radar, el sonar, y radiotelescopios. El estudio de electricidad estática y electricidad de corriente considera el papel del electrón, de una manera sencilla, a través de la televisión, radio, y aparato estereofónico.

La clase debería discutir, y tal vez hacer una lista de, las maneras en que el sonido nos puede ayudar; por ejemplo, en comunicaciones, señales de aviso, entretenimiento, estética, y protección. El sonido puede ser perjudicial también. Los ruidos fuertes pueden dañar los oídos. El sonido puede ser agradable y tranquilizador a una persona, pero también puede molestar e irritar. La intensidad del sonido se mide en decibeles. Para la protección del público muchas comunidades tienen leyes que limitan los niveles de decibeles que pudiera producir una variedad de medios. Al llegar a ser más común el equipo electrónico de sonido, los niños deberían comprender los efectos negativos que tienen los sonidos fuertes continuos en la audición.

LECCION 1 *¿Qué es el Sonido?*

Captando la Idea

Pregúnteles a los estudiantes qué creen ellos que es el sonido. Se produce el sonido cuando algo está **vibrando** — cuando se mueve rápidamente en sentidos contrarios. Se sostiene una liga suelta entre los dientes y se le pulsa suavemente. Pregúnteles a los estudiantes; ¿está produciendo un sonido? ¿Por qué no? Tienen razón — tiene que hacer movimientos rápidos — vibrar velozmente — para que oigamos el sonido. Ahora, estire la liga muy fuerte y punteála. ¿Qué pasa?

Muéstreles a los estudiantes el pito en forma de animal y se lo sopla. ¿Lo pueden oír? Se les permite a los estudiantes que intenten solpar el pito para determinar si el pito está vibrando. ¿Por qué no lo podemos oír? Hay unas vibraciones que son tan lentas que el oído humano no los puede oír.

Todos los sonidos son producidos por el movimiento de materia. El sonido es muy importante en nuestra vida. El sonido nos puede poner felices con la música, el baile, o al tocar un instrumento musical. Sin embargo, el sonido puede ser perjudicial cuando está demasiado fuerte. Los sonidos también nos pueden advertir del peligro, como en el caso de una sirena de incendio. A veces cuando estamos solos en casa, el sonido de la radio o televisión nos puede tranquilizar.

Se habla sobre cada actividad con los estudiantes poniendo énfasis en que se producen los sonidos en muchas maneras diferentes como vibraciones en la materia.

LECCION 2 El Sonido se Propaga en Ondas

Captando la Idea

Pregúnteles a los estudiantes cómo creen que se propaga el sonido. ¿En qué se parecían el movimiento del agua y las ondas en la arena producidas por el diapasón o el "slinky"? Al hacer sonar el diapasón vibrante, se produjeron olas en el agua, o en la arena y las olas se movían hacia los lados de la olla. Al pegarse en los lados, rebotaban y chocaban con las nuevas olas que llegaban. Si hubiéramos esperado unos minutos, habríamos visto que el agua finalmente dejó de moverse y se puso serena — ya no había más olas. El diapasón también produjo ondas en el aire — por eso podíamos oír el zumbido del diapasón. El sonido necesita un medio, como el aire, para propagarse. Se podía ver el movimiento de las ondas en el "slinky" porque el "slinky" servía de medio para la onda.

Presente las palabras **reflejado** y **absorbido.** Dígales a los estudiantes que hagan sonar el diapasón y que luego lo toquen con la mano. ¿Pueden sentir las vibraciones? Dígales a los estudiantes que pongan la mano arriba de un radio cuando está tocando. ¿Qué pueden sentir? ¿Qué está vibrando? ¿Qué está produciendo el sonido?

Dígales a los estudiantes que expliquen lo que es un eco. ¿Se propaga el sonido a través de las ondas? Un eco es sonido reflejado. Choca con materia que es dura y lisa y refleja el sonido — lo hace rebotar.

¿Qué sucede en un cuarto alfombrado? ¿Qué sucede en un cuarto a prueba de sonido? Las paredes contienen materiales que no son duros y lisos — son suaves y ásperos — como la alfombra, o el terciopelo, o la lana. Estos materiales absorben las ondas acústicas.

ACTIVIDAD
Botellas Musicales

Captando la Idea

1. ¿Qué estaba vibrando para producir el sonido — las botellas, el aire en las botellas, o el agua? Explique su respuesta.
2. ¿Qué botella tenía el sonido más alto? ¿El más bajo?
3. ¿Qué sucedió cuando tomó la primera botella y echó el agua a una botella más pequeña? Cuando la sopló, ¿se produjo el mismo sonido o un sonido distinto? ¿Era correcta su predicción? Explique su respuesta.
4. ¿Qué sucedió cuando echó el agua a una botella más alta y angosta llena hasta el mismo nivel que la botella de referencia? Cuando la sopló, ¿se produjo el mismo sonido o un sonido distinto? Explique su respuesta.

ACTIVIDAD ALTERNA
La Velocidad del Sonido y de la Luz

Captando la Idea

La luz se propaga muy rápidamente, a más de 186,000 millas por segundo. En comparación, el sonido es un "rezagado" que sólo se desplaza a más o menos 770 millas por hora al nivel del mar. (La velocidad del sonido es afectada por la temperatura y la densidad del aire. Los límites de velocidad son aproximadamente de 740 a 770 al variarse la temperatura entre los 32 grados a los 75 grados Fahrenheit.) Aún a la distancia reducida de 100 metros, será posible verle al niño golpear el tambor antes que se oiga el sonido. Los niños que han asistido a eventos deportivos en un estadio grande, tal vez se hayan fijado en que los sonidos producidos en el campo de juego por los atletas o las bandas se ven antes de oírse. A veces es difícil localizar en el cielo a los aviones por su sonido, particularmente los jets rápidos, por razón de que el sonido se está moviendo tan despacio que para cuando llega, el avión se ha desplazado a otro lugar.

Los niños deberían tener la capacidad de contestar a las preguntas en el paso 6 si recuerdan que el sonido se propaga mejor en el aire cuando hay más moléculas. Las elevaciones más altas tienen aire **más enrarecido,** con menos moléculas por centímetro cúbico. El aire frío contiene más moléculas y es **más denso.** Por lo tanto, el sonido se propagaría mejor de noche o en un día frío.

LECCION 3 *Las Vibraciones Altas/ Bajas o Rápidas/Lentas*

Captando la Idea

Se lee el libro de Conklin **If I Were a Bird.** Enséñeles a los estudiantes los cuadros musicales indicándoles los sonidos altos y bajos. Los cuadros musicales son como gráficas. Demuestran el tono o la frecuencia. Podemos cambiar el tono variando la frecuencia y el volumen. Pero el cambio del volumen no cambia el tono.

Dígales a los estudiantes que han estado explorando maneras para cambiar el tono, o la altura de un sonido. La altura nos indica cuan alto o bajo es un tono. Se cambia la intensidad pulsando con mayor fuerza la nota. Las ondas acústicas varían con la altura — las vibraciones son más rápidas para los sonidos altos, y más lentos para los sonidos bajos. Además, las ondas acústicas varían cuando se hace vibrar a un objeto con ondas acústicas más altas. Hemos aprendido a distinguir entre estas variaciones en el **Mathematics Center.**

1. Al poner en secuencia las ligas en el experimento con la caja de zapatos, ¿ha notado un patrón en las ligas? ¿Cuál era? ¿Puede formular una regla que conecte el tamaño de las ligas al sonido que producen?
2. Al enseñarle a su compañero la melodía que aprendió a tocar en su guitarra de

caja de zapatos, ¿usaron las ligas coloreadas para ayudarse? ¿Qué les ayudan a ver en la guitarra las ligas de diferentes colores? (Los colores demuestran que la altura es diferente de una liga a otra.) ¿En qué manera?

3. ¿Qué hicieron para producir un sonido de mayor o menor volumen en la guitarra? ¿Por qué?

ACTIVIDAD

Popotes Musicales

Captando la Idea

Con la práctica los estudiantes podrán hacer que el extremo cortado del popote vibre para producir sonido. Esto es similar al clarinete o al oboe. Sirven mejor los popotes de papel que los de plástico porque los de plástico no se comprimen tan fácilmente para formar una lengüeta.

Cuando un grupo usa la manguera, un niño que toque la trompeta, el trombón o el clarín quizás podrá demostrar y ayudarles a otros a aprender a tocar. Cambiar la forma de la manguera no variará el tono; sin embargo, el cortar un pedazo o de la manguera o del popote acortará la columna vibrante de aire y subirá el tono.

LECCION 4 *Radiadores y Resonancia*

Captando la Idea

Los objetos que vibran y emiten ondas acústicas se llaman **radiadores.** ¿Puede pensar en algo más que se llame radiador? Sí, un calentador. ¿Qué irradia? El calor, sí. Pero como han descubierto en sus experimentos, estos radiadores afectan a otros objetos y los hacen vibrar al mismo tono que el de ellos. Se llaman **resonadores** a los objetos que los radiadores hacen vibrar. Vieron que todos los instrumentos musicales que investigamos constaban de una parte que era radiador (las cuerdas o el parche de los tambores etc.) y otras partes que eran resonadores. También llamamos a estos resonadores "tablas de armonía". Decimos que estas "tablas de armonía" **amplifican** el sonido — lo hacen más fuerte. ¿Han oído la palabra "amplificador" antes? ¿En qué contexto? Con las bandas de "rock" y otros tipos de bandas. Cuando se quiere un sonido más fuerte, se puede usar un amplificador — uno hecho de madera, de metal, o uno que es eléctrico. También se puede usar un amplificador para reducir la intensidad del sonido - un amplificador varía el volumen - o más alto o más bajo.

ACTIVIDAD
Amplificadores

Captando la Idea

1. ¿Qué materiales amplificaban el sonido? ¿Cuáles reducían el sonido?
2. Se debe formular una regla sobre materiales que amplifican el sonido. Se le debe comunicar al grupo y a la clase para que se pueda discutir.
3. ¿Cómo cambió el sonido al agregar más arena a la cubeta? ¿Lo amplificó?
4. ¿Qué cambió el tono de la cuerda?

ACTIVIDAD
Resonadores Musicales

Captando la Idea

1. ¿Qué tambor tenía el tono más bajo? ¿Por qué?
2. Encuentre la cuerda en cada violín que tiene el tono más alto. Intente subir el tono aún más alto. Pídale al maestro de música que le enseñe a cambiar el tono del violín.
3. ¿Qué tecla del piano tiene el tono más alto? ¿El más bajo? ¿Qué cuerda es la más larga?

LECCION 5 *La Voz Humana*

Captando la Idea

Muéstreles a los estudiantes un diagrama del aparato vocal del cuerpo: la laringe, llamada la "caja vocal" que contiene las cuerdas vocales, los pulmones que hacen que el aire pase hacia adentro y hacia afuera a través de las cuerdas vocales, y la boca, la nariz y dientes.

Se les pide a los estudiantes que hagan una lista y describan las partes del cuerpo necesarias para producir la voz humana. ¿Hay otros animales que puedan producir sonidos humanos? ¿Por qué no se consideran esos sonidos "habla"?

Se discute con los estudiantes la razón por qué las voces de los niños son más altas que las de los adultos. (Sus cuerdas vocales son más cortas, más delgadas, y más breves, como las cuerdas de un piano.)

En el **Listening Center,** los estudiantes

1. escuchan la música vocal de una ópera o de un musical popular. Deben hacer una lista de las distintas voces que oyen y el sonido particular que hacen.
2. leen en una enciclopedia acerca de los diferentes tipos de voces que hay para el canto, para el drama, etc.
3. invitan a la maestra de música para darles información acerca del canto y de la práctica necesaria para aprender correctamente cómo formar los sonidos y las palabras.

ACTIVIDAD
Humanos, Sonido y Palabras

Captando la Idea

1. Cuando estaban recitando la poesía infantil, ¿cuándo podían hablar con mayor facilidad?
2. ¿Es fácil hablar? ¿Pueden hacer que las palabras se oigan como quieren cuando no pueden mover la lengua? ¿Cuándo dice la gente, "Has the cat got your tongue"?
3. Al tratar de imitar a alguien que conozcan, ¿qué partes del cuerpo procuran controlar? (cuerdas vocales, lengua, dientes, forma de la boca, garganta)
4. ¿Es fácil aprender a hablar claramente?
5. ¿En realidad pueden hablar los pericos? Explique su contestación.

LECCION 6 ¿Qué es la música? ¿Qué es el ruido?

Captando la Idea

Se les dice a los estudiantes que la música tiene ciertas características — algunas de ellas ya han investigado, como el tono y el volumen. La música de todas las culturas tiene características parecidas. Sin embargo, no han hablado del **ritmo.** Otras palabras para ritmo son compás, cadencia y tiempo. En los sonidos agradables y en los sonidos musicales normalmente hay patrones que se pueden detectar. Un patrón es el del ritmo o compás. ¿Se puede escuchar la música y determinar si es música "rock"? ¿Cómo? ¿Cómo es diferente el "rock" del compás de "Mickey Mouse" o de "Puff the Magic Dragon"?

En el **Rhythm Center** los estudiantes escuchan la música que ellos escojan e identifican el compás de sus canciones favoritas. Reportan a la clase cuando creen que pueden repetir el compás dando palmadas al ritmo de la música. Los otros estudiantes lo verifican.

LECCION 7 El Sonido es Importante en la Comunicación

Captando la Idea

1. Ahora voy a leer un cuento con que posiblemente se podrán identificar. **The Terrible Thing That Happened at Our House.** La maestra lee el cuento. Al final los estudiantes hablan sobre el por qué es importante la comunicación entre los seres humanos. El sonido nos ayuda a comunicar.

2. Al jugar el juego de adivinanzas, ¿pudo comunicar todas las ideas secretas a la clase? ¿Por qué fue difícil? ¿Son el hablar y escuchar partes importantes de la comunicación? Si hubiera habido un verdadero incendio en su casa, ¿cómo hubiera comunicado ese hecho a su familia?

¿Cuánto éxito tuvo comunicando a la clase que tenía un millón de dólares? ¿Cuál hubiera sido la manera más efectiva de comunicar eso?

¿Qúe hizo para comunicarle a la clase la idea de la belleza del arco iris? ¿Siempre son las palabras el mejor método de comunicación? ¿Hubiera sido mejor mostrarle a la clase un cuadro de un arco iris, o el arco iris mismo?

En el **Art Center** los estudiantes hacen dibujos del cerebro del mismo modo que los han visto en sus libros de referencia y localizan los lugares que controlan las funciones del habla y del oído.

unidad

3 Las Máquinas Sencillas

Información de Fondo para la Maestra

El mundo en que vivimos constantemente está ejerciendo diferentes **fuerzas** sobre sí mismo y sobre los seres que lo habitan. Las fuerzas hacen que los objetos se muevan; las fuerzas hacen que los objetos cambien de dirección; y las fuerzas hacen que los objetos se paren. Estas fuerzan parecen ser de mayor importancia cuando están actuando sobre nosotros como individuos o cuando queremos usar esas fuerzas para modificar nuestro ambiente para agradar nuestros gustos. A través de largos períodos de tiempo, los humanos han aprendido cómo funcionan estas fuerzas, y hasta cierto grado hemos colocado estas fuerzas bajo nuestro control. Claro que somos novatos en el uso de estas fuerzas, pero hemos podido usarlas para lograr muchas cosas.

Por ejemplo, los humanos han cambiado su ambiente en muchas maneras, construyendo estructuras para albergue, abriendo tierras y obteniendo y conservando agua para producir alimento en un ciclo de relativa confiabilidad. Esto se ha logrado cortando y levantando grandes árboles, metiendo clavos en madera dura, sacando grandes piedras y tocones. Se han venido realizando estos cambios a medida que los humanos han aprendido a controlar estas **fuerzas como empujón o tirón.** Al lograrse un cambio, como levantar una piedra pesada o cortar un árbol, se ha hecho trabajo. **El trabajo produce cambio** — y — el cambio es el resultado del trabajo.

Los humanos no pudieran haber logrado muchos de estos cambios usando sólo la energía que nuestros cuerpos relativamente débiles pueden ejercer. Sin embargo, los humanos han utilizado su cerebro para diseñar aparatos que han ayudado a realizar estos cambios. Una máquina no es sino un ejemplo de cómo la inteligencia humana ha ayudado a facilitar nuestra vida sobre la tierra.

En un sentido muy general, una máquina es una combinación de partes que se usan para superar **una resistencia** (que también es fuerza, como una piedra grande que necesita ser removida), **transfiriendo o transformando energía,** normalmente ejercida por un ser humano. Fundamentalmente hay tres máquinas básicas — la palanca, el plano inclinado y la rueda y eje. A veces nos referimos a otras combinaciones como máquinas sencillas que parecen algo más complicadas, pero en realidad son combinaciones basadas en las tres primeras.

En esta unidad, observaremos dos fuerzas mayores que las máquinas nos ayudan a superar — **la fricción y la gravedad.** Por otra parte, **la inercia** es una característica de la materia — es la resistencia de la masa a ser puesta en movimiento o quitada de movimiento, o parada. A consecuencia, si queremos mover materia, o una masa, que se expresa como peso, necesitamos ejercer fuerza sobre esa materia para superar la inercia así como también **la fricción** y/o **la gravedad.** Normalmente las fuerzas que queremos superar se llaman la resistencia. Las fuerzas utilizadas para superar **la resistencia** se llaman **el esfuerzo.**

Cuando se hace trabajo, se ha usado **energía**. La energía cambia de forma, pero no desaparece. Usando máquinas sencillas por medio del trabajo humano, se transfiere la energía de un objeto a otro, o se cambia de forma en sonido, calor o energía de luz.

La comprensión de cómo funcionan las máquinas sencillas es un paso grande hacia la comprensión de cuánto del mundo que nos rodea funciona, aún en los tiempos modernos, por la razón de que la naturaleza de la materia y la energía no ha cambiado — sólo nuestra comprensión de ella.

El énfasis actual sobre la importancia de que los estudiantes de escuelas elementarias aprendan y apliquen conceptos básicos de probabilidad y estadísticas, sugiere que se presente un concepto fundamental como **el promedio** en una oportunidad temprana utilizando acercamientos intuitivos. Se ha diseñado e implementado en un nivel de tercer año el siguiente juego de actividades con los niños bilingües cuya instrucción pone énfasis en el desarrollo lingüístico como una estrategia mayor para desarrollar los conceptos de matemáticas y ciencia.

La noción intuitiva en esta estrategia es que el hallar **el promedio** es parecido a tomar conjuntos individuales, cuyos números cardinales sabemos, y hacer **iguales** los conjuntos (por ejemplo, hacer los grupos parejos). Quizás la maestra quiera comenzar la lección discutiendo la idea de **hacer los montones o conjuntos.** Se muestran dos o tres montones que tienen el mismo número de fichas y la maestra indica con la mano que los montones son diferentes con respecto a altura. Estos montones son **desiguales** (por ejemplo, no parejos). La idea de la actividad es la de hacer iguales los montones. Los montones deben tener la misma altura. Los estudiantes, en un acercamiento a la solución de problemas, descubren cómo hacer de cualquier número de montones **desiguales** montones **iguales.** Se presentan las siguientes actividades con estas nociones en mente.

La noción de estudiar una máquina creada para ayudarles a los humanos a trabajar, es un acercamiento importante para presentarles a los estudiantes las ideas relativamente sofisticadas de la inercia, una propiedad de la materia, y algunas de las fuerzas que actúan sobre la materia. Estos conceptos de fricción y gravedad conducen a las ideas más complejas que los estudiantes podrán comprender con antecedentes apoyados en experiencias a temprana edad que relacionen "la ciencia" con el "mundo real".

LECCION 1 *Máquinas Sencillas*

Captando la Idea

Muéstreles a los estudiantes el retrato de la persona que está moviendo una piedra grande. Dígales que observen que una persona chica puede mover una piedra grande si usa un palo largo y fuerte. Pregúntele a Sandra si cree que podría levantar la piedra si tuviera un palo largo. De nuevo, pida sugerencias.

Cuando la chica en el retrato empuja hacia abajo en el palo para mover la piedra, está usando energía. También está haciendo trabajo. ¿Por qué? Está cambiando el lugar donde se encontraba la piedra grande, a un lugar más alto en el aire con la ayuda del palo. ¿Qué hace la piedra grande al palo? (Está empujando hacia abajo con su masa.)

Sí, la piedra está empujando hacia abajo en el palo.

Cuando la chica empuja hacia abajo en el palo debajo de la piedra grande, el palo gira sobre el eje de una piedra pequeña o algún otro objeto, transfiriendo así la energía de la chica a través del palo hasta la piedra grande, haciendo que se mueva habia arriba la piedra grande.

¿Qué pasa si la chica suelta el palo? La piedra se caerá y transformará su energía estrellándose con un ruido. La piedra transfiere su energía haciendo un hoyo en el suelo, haciendo un ruido fuerte a estrellarse, y calentando el suelo a su alrededor. La energía se transfiere desde la chica hasta la piedra y luego si la piedra se cae, la energía regresa desde la piedra en forma de sonido, calor o energía de movimiento.

Ahora, vamos a mirar estas fotos de las revistas. Estas personas están haciendo algo. Vamos a nombrar las actividades. Cada foto muestra que se está aplicando una fuerza a algo. Vamos a nombrar las fuerzas que se están aplicando y en qué manera.

Los aparatos que usa la gente para ayudarse a trabajar se llaman máquinas. En este cartel se muestra un palo fuerte junto con una piedra chica como ejemplo de una máquina sencilla, llamada **una palanca.** Se hace trabajo ejerciendo una fuerza sobre algo. Las máquinas transforman o transfieren la energía para hacer trabajo. Las chicas empujan hacia abajo y se levanta la piedra grande. Vamos todos a hacer lo mismo usando un lápiz para levantar un libro. ¿Qué han usado como punta?

En el **Mathematics Center** los estudiantes completan **la Actividad** — Un abanico de papel es una máquina sencilla.

ACTIVIDAD
Compartamos el Trabajo

Captando la Idea

1. Pregúnteles a los estudiantes: sin tener en cuenta la manera en que se resolviera el problema, ¿era igual la cantidad de trabajo que se hizo? Sí. Sin tener en cuenta cómo se hiciera, se levantó hasta la mesa la caja grande junto con su contenido.
2. ¿Pesaba igual la caja al ser levantada por dos, tres o cuatro personas? Sí, pesaba igual, pero las personas compartieron el trabajo.
3. Cuando dos personas levantaron la caja, ¿cuánto trabajo hizo cada una? 1/2 cada una.
4. Cuando tres personas levantaron la caja, ¿cuánto trabajo hizo cada una? 1/3 cada una.
5. Cuando Sandra hizo el trabajo sola, ¿Cuánto trabajo hizo ella? Todo.
6. Cuando levantaban la caja hasta la mesa, ¿en contra de qué fuerzas estaban trabajando? (Gravedad)

   Otra cosa que tenemos que recordar: Al hacer trabajo, se usa energía.

7. ¿Quién usó energía al hacer el trabajo de levantar la caja? Sí, cada persona que ayudaba tuvo que usar energía para completar el trabajo.
   Entonces, se define el trabajo como el mover una masa a través de una distancia
8. ¿Qué trabajo se hizo aquí? Fue levantada (movida) esta caja, esta masa, 38 pulgadas.

LECCION 2 *Fuerzas y Trabajo*

Captando la Idea

Hemos estudiado dos fuerzas hoy. ¿Cuales son? La gravedad y la fricción. Cuando superamos una fuerza, como la gravedad o la fricción, estamos haciendo trabajo. Cuando trabajamos, normalmente estamos moviendo en contra de una fuerza a través de una distancia. Vamos a dar unos ejemplos del trabajo que hicimos en los experimentos.

1. ¿Qué trabajo hizo Berta caminando de un lado del cuarto al otro? Sí, ella movió su peso trabajando en contra de la fricción, pero también trabajó en contra de su propia inercia. La inercia es una propiedad de la materia que resiste el cambio de estar en descanso o de estar en movimiento. Por ejemplo, si se coloca un pedazo de madera sobre una mesa, se quedará allí hasta que alguna fuerza, como una persona que tira de la liga, o un soplo fuerte de viento, lo mueva. (Se demuestra con un secador de pelo si es posible.) Así que cuando movemos nuestro cuerpo, estamos trabajando en contra de la inercia del cuerpo. Al llevar una carga, tenemos que mover la carga en contra de su propia inercia.
2. ¿Qué trabajo hicieron cuando jalaron la silla por el piso? Sí, movieron en contra de la inercia de la silla y también en contra de la fricción del piso.
3. ¿Qué trabajo hicieron cuando jalaron la silla por la alfombra? Sí, usaron energía para mover en contra de la inercia de la silla, pero también en contra de la fricción mayor de la alfombra.
4. ¿Qué trabajo hicieron cuando jalaron el bloque de madera?

Dígales a los estudiantes que a veces la fuerza que tiene que superarse haciendo trabajo se llama **la resistencia**. Recuerden — **una resistencia es siempre una fuerza** que se opone al **esfuerzo** que ejercemos cuando trabajamos. Por ejemplo, cuando yo saco tierra del fondo de un hoyo con una pala hasta la parte de arriba del hoyo, ¿cuál es la resistencia? Sí, la tierra es la resistencia, pero también la pala, porque tengo que mover las dos en contra de su propia inercia y al subir la tierra tengo que superar la gravedad también.

ACTIVIDAD
Balompié

Captando la Idea

Después del juego:

1. Dígales a los estudiantes que **una fuerza es un empujón o un tirón.** ¿Cuál es el empujón al jugar cuando patean el balón? El pie es un empujón contra el balón. ¿Cuál es la fueza que siente el pie al patearlo? Están pateando en contra de la **masa,** la **materia** del balón. La resistencia que sienten al patear el balón es **la inercia del balón.**
2. Pregúnteles a los estudiantes qué pasó cuando patearon el balón al aire. ¿Había otra fuerza actuando sobre el balón? Sí, la gravedad lo jaló hacia abajo. **La gravedad es un tirón,** así que la gravedad es también una fuerza. Cuando paran con la cabeza o con el pie a un balón que cae, ¿cómo pueden saber que la gravedad es una fuerza? (Les pega fuerte y por eso saben que es una fuerza; porque les empuja.) Al caer un balón, decimos que la gravedad lo jaló y causó que cayera.
3. ¿Qué pasa cuando ruedan un balón en el zacate alto? ¿Se mueve rápido o despacio? ¿Qué causa que se mueva despacio? (La fricción) **¿Es la fricción una fuerza**? ¿Cómo lo saben? (Empujó en contra del balón y hizo que se parara.)

   Se necesita energía para ejercer una fuerza.

Muestre fotos de personas que están participando en diferentes actividades como jugar, pasear en bicicletas, sacar punta en los lápices etc. Defina la energía, fuerza, gravedad y fricción señalando las fotos que ilustran cada una. Haga que los estudiantes identifiquen otros ejemplos de estas fuerzas encontradas en las fotos.

ACTIVIDAD
Midiendo el Trabajo

Captando la Idea

Es un poco complicado determinar la cantidad de trabajo que se hace al subir escalones. Para determinar el trabajo que hicieron, ¿multiplicaron su peso por la distancia a través de la línea en los escalones? NO!

Hay un pequeño problema calculando el trabajo en esta situación porque si suben unos escalones no se se puede calcular la distancia a lo largo de los escalones, sino del piso a la parte de arriba de los escalones (la línea oscura), por ejemplo el dibujo mostrado arriba. Si no pueden subir por el lado de los escalones para medir la altura, entonces necesitan determinar la distancia vertical de otra manera. Los estudiantes trabajan en sus grupos para encontrar una solución.

Si no lo han resuelto todavía, prueben esto. Midan lo alto de cada escalón y sumen para determinar la distancia vertical total. O, si todos los escalones son de la misma altura, midan uno de ellos y multipliquen por el número de escalones.

Recuérdese: La fuerza necesaria para levantar alguna cosa que pesa una libra un pie hacia arriba se denomina un pie-libra. En subir los escalones, usaste __________ pie-libras de fuerza.

LECCION 4 *Una Bicicleta*

Captando la Idea

Lea a la clase: Wheels por Hughes. Después de leer y discutir el libro, dígales a los estudiantes de otra máquina sencilla. Una rueda y eje es otro tipo de máquina sencilla. Esta máquina se compone de dos partes, como el nombre lo indica. Una parte de la máquina es la rueda y tiene la forma de un círculo. La otra parte es el eje que tiene la forma de un cilindro. Las ruedas de una carretilla son un ejemplo de una rueda y eje. Muchas veces se combinan dos ruedas con un eje en común para hacer rodar objetos de un lugar a otro. Un ejemplo es una carreta que jalan los burros.

(Se muestra un retrato de una bicicleta.) Una bicicleta es un ejemplo de una máquina que tiene dos ruedas y dos ejes; sin embargo, no es una máquina sencilla. Pida que los estudiantes describan la bicicleta. (Tiene dos ruedas; las ruedas giran en un eje; la cadena es como una banda en una polea; etc.) ¿Qué formas geométricas se ven en una bicicleta? ¿En un monociclo?

LECCION 5 *Un Resbaladero*

Captando la Idea

Sección 1

El plano inclinado es una de las máquinas más sencillas conocidas por el hombre. Se utiliza para ayudar a la gente a levantar cosas pesadas o a bajarlas con más facilidad. Cualquier tabla o superficie plana hecha para recostarse contra algo puede ser un plano inclinado. Un plano inclinado, al inclinarse sobre una base forma un triángulo.

En el dibujo abajo, se levanta una piedra desde el nivel de la tierra hasta la parte de arriba de la tabla como tal vez pudiera haberse hecho cuando se estaban construyendo las pirámides. Muchas personas, tirando de cuerdas gruesas, podían levantar piedras que hubieran sido demasiado pesadas para levantar sin el plano inclinado. ¡También los trabajadores usaban troncos como rodillos (ruedas)!

Discusión:

1. Cuando bajan por el resbaladero y van muy rápido, o tienen puesta ropa muy delgada, ¿qué sienten? (Se pone caliente) ¿Qué causa el calor? (fricción, porque la superficie del resbaladero resiste el cuerpo que baja por el resbal-abero.) ¿Qué se puede poner en el resbaladero para bajar más rápido? (algunos niños le echan tierra al resbaladero; ¿qué pasa?)
2. ¿Qué trabajo se hizo en el resbaladero? (Está moviendo el peso del cuerpo hacia abajo - moviendo una masa por una distancia).

Sección 2
Otra máquina sencilla se llama una cuña. Una cuña es la combinación de dos planos inclinados puestos de espalda para tener la forma de un triángulo también.

Las cuñas hacen muchas cosas que se requieren para levantar un objeto, cortar o trozar algo, o sujetar algo en un lugar. Ejemplos de cuñas comunes son: una pala para escarbar la tierra, una tachuela para sujetar papel en el tablero de boletines, un clavo para sujetar una tabla en su lugar, un retenedor de puerta para mantener la puerta abierta, un hacha para trozar leña, o un diente para masticar comida.

Sección 3
Los estudiantes dan y dibujan ejemplos del tornillo como: una escalera de caracol, caminos que dan vueltas por una colina muy inclinada, un tornillo de banco para sujetar cosas, bancas de piano ajustables, piezas de llaves ajustables, hélices para aviones y barcos, etc. En los dibujos ellos colorean la parte que muestra el tornillo.

LECCION 6 *Las Poleas*

Captando la Idea

Una polea es una máquina hecha de una banda, cuerda o cadena que se enreda en algo como la rama de un árbol, una barra, o una rueda. Una polea fija ayuda a cambiar la dirección de una carga, como se ha visto en la demostración. Sin embargo, una polea movible le ayuda a la persona a trabajar moviendo la carga.

Vamos a ver si han podido resolver el problema con que se empezó la lección. ¿Cómo puede Betty levantar esa tina de objetos pesados hasta la mesa? ¿Creen que podríamos usar la polea que está colgada del techo? ¿Cómo podemos hacer eso? Se cuelga la cubeta y Betty se sienta en la mesa en vez de acostarse en ella en el estómago. Luego Betty jala hacia abajo. ¿En qué dirección se está moviendo la cubeta? Sí, se está subiendo — **¡pero Betty está jalando hacia abajo**! Es verdad, una polea es una máquina muy sencilla, puede hacer cosas muy importantes — cambiar la dirección en que tenemos que aplicar la fuerza, por una.

¿Qué descubrieron al completar **la Actividad** — Poleas? A la polea se le jala. Es una máquina a la que, en su forma más sencilla, no se le aplica menos fuerza, pero sí se puede hacer otro trabajo muy importante - cambiar la dirección de la carga. En una polea fija, se le jala hacia abajo y la carga se sube. Al usar varias poleas, se ejerce menos fuerza, pero se pierde distancia.

También se requiere menos esfuerzo para mover la carga.

En el **Writing Center** los estudiantes leen y luego discuten sobre cómo funciona un ascensor. Los estudiantes escriben un poema sobre los ascensores.

Actividades científicas - Lea la definición en **Science Horizons**, Silver Burdett and Ginn, p. 198-199. Los estudiantes resuelven los problemas en la página 199. Escribirán un plan de cómo se debe solucionar. Se juntarán en grupos de tres o cuatro para encontrar soluciones.

unit

2 Oceans

Prior Knowledge

The student has

1. read and written numerals from one to 100
2. added and subtracted single- and double-digit numbers using manipulatives
3. classified objects according to various attributes
4. ordered by size and by length
5. worked with fractions such as 1/2, 1/5, 1/10.

Mathematics, Science and Language Objectives

Mathematics

The student will

1. explore the concept of percentage
2. measure length
3. multiply single-digit numbers as repeated addition, using arrays
4. record and graph data
5. classify objects
6. recognize and create patterns and similarities
7. read temperature on Fahrenheit and Celsius scales
8. explore symmetry
9. explore multiplication as a cross-product
10. explore division as repeated subtraction, separating into arrays
11. use denominate numbers (hours and minutes) to calculate time
12. compare numbers using subtraction or fractions.

Science

The student will

1. identify at least three main oceans
2. describe zones of salt water that vary in temperature, pressure and light intensity
3. identify and describe different environmental conditions in the oceans
4. identify and describe different types of ocean life
5. demonstrate and explain or draw the effects of salt water
6. illustrate and explain the tides
7. classify ocean life as plants and animals
8. have an understanding of the ocean floor, an assimilation of the different layers of the ocean
9. name and describe various resources and careers provided by oceans
10. discuss how oceans are being polluted and list ways that will decrease future pollution
11. list and discuss at least three water recreation activities.

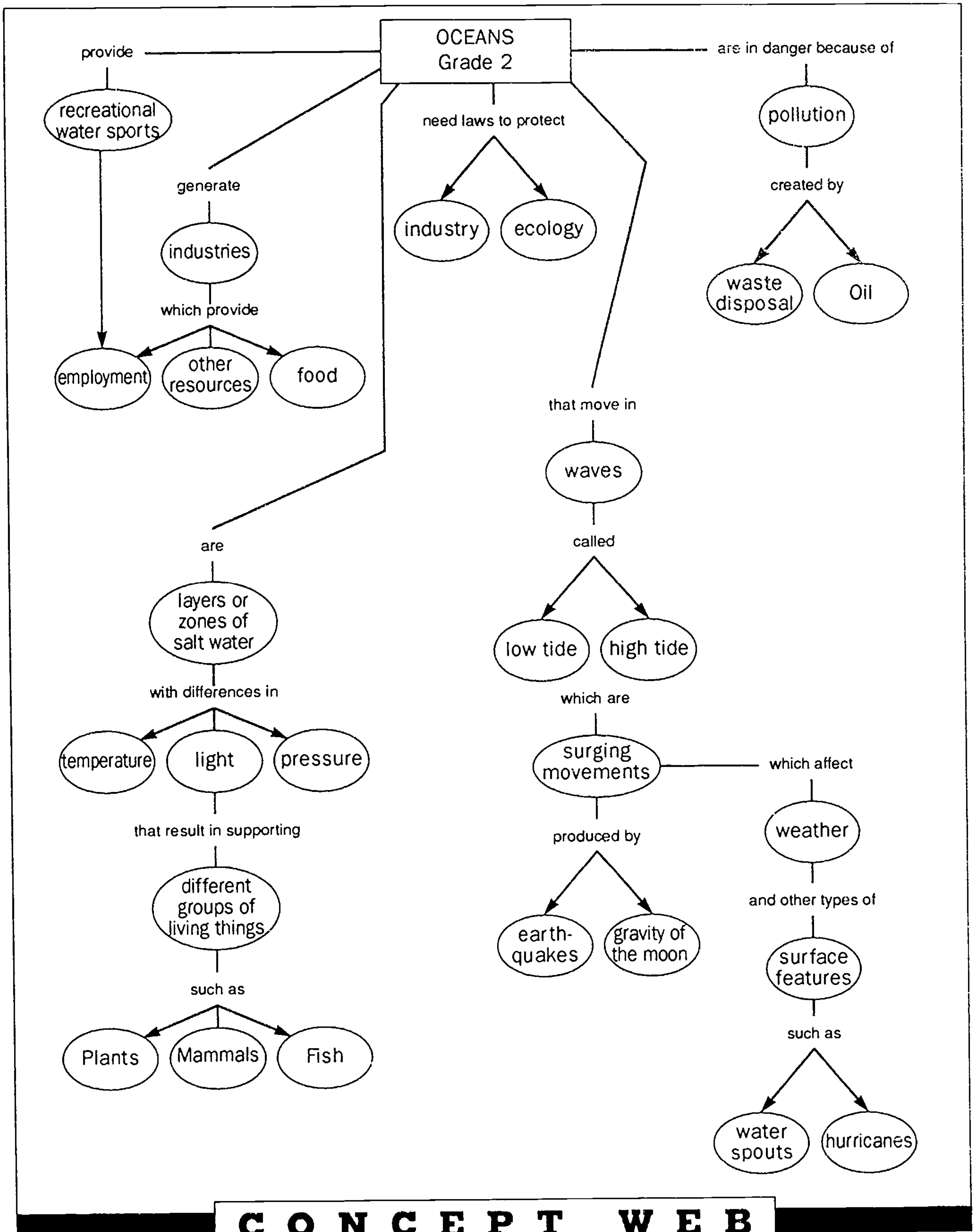
Language

The student will

1. respond to storytelling or oral language in verbal and/or nonverbal ways
2. listen to literature selections daily for personal enjoyment and language acquisition
3. employ active listening in a variety of situations
4. engage in pre-writing activities
5. write complete sentences
6. predict outcomes
7. explain observations.

VOCABULARY

recreation recreación	current corriente	river río	volcano volcán	beach playa
reef arrecife	depth profundidad	formation formación	canyon cañón	coastline costa litoral
estuary estuario	tide marea	energy energía	temperature temperatura	weather tiempo
gyre rotación	pollution contaminación	animal animal	plant planta	hurricane huracán
earthquake terremoto	gravity gravedad	salty salado	surf rompientes	boating pasear en barco
swim nadar	fish pescar	career carrera	instruments instrumento	migration migración
basin cuenca	waves olas	erosion eroción	light luz	
food source recurso alimenticio		food chain cadena alimenticia		continental margin margen continental
North Atlantic Atlántico del Norte		South Atlantic Atlántico del Sur		South Indian Indico del Sur
North Pacific Pacifíco del Norte		South Pacific Pacífico del Sur		ocean océano
history of oceans historia de los océanos				


OCEANS
Grade 2
provide
recreational water sports
are in danger because of
pollution
created by
waste disposal
Oil
need laws to protect
industry
ecology
generate
industries
which provide
employment
other resources
food
that move in
waves
called
low tide
high tide
which are
surging movements
which affect
weather
and other types of
surface features
such as
water spouts
hurricanes
produced by
earth-quakes
gravity of the moon
are
layers or zones of salt water
with differences in
temperature
light
pressure
that result in supporting
different groups of living things
such as
Plants
Mammals
Fish

CONCEPT WEB

Teacher Background Information

Sea water contains salt, which will be left as a light-colored residue in the bottom of the pan after the water has evaporated. For those who do not live near the ocean, a sprinkling of salt in tap water will make a good substitute.

Most living things are fitted or adapted to live in a certain environment. Plants and animals found in a salt-water environment are unlikely to appear in fresh water.

Many different plants and animals live in the salt-water environment of the ocean. Yet even in an ocean environment there are differences between the shallow parts and the deep. Plants and animals that live in the shallow ocean are not usually found in the ocean's deeper parts.

When water is warmed, the heat causes the water molecules to move faster and farther apart. As the molecules move farther apart, the water becomes less dense. How dense a substance is tells how much mass is in a particular volume. Warm water, then, is less dense than cold water and so floats on it.

The oceans are salt-water environments. Lakes, streams, ponds and rivers have little or no salt in the water. These bodies of water are fresh-water environments. Would you expect to find the same plants and animals living in both fresh-water and salt-water environments?

Prior Preparation: Bring in two like plants at the beginning of the unit. The plants will serve in **Lesson 6.** Ask the students to place one of the plants in a window. They place the second plant in a closet or other place where it will get no light. At appropriate times, the students water both plants at the same time and with the same amount of water.

LESSON FOCUS

■ LESSON 1

The Underwater World

BIG IDEAS The oceans and seas on earth cover 7/10, or 70%, of its surface with salt water, creating an underwater world that is still largely unknown.

■ LESSON 2

Ocean Mountains and Valleys

BIG IDEAS The ocean floor is not smooth and it is not flat; great mountains and valleys cover it. Different combinations can be made using only a small number of things.

■ LESSON 3

Waves, Tides and Currents

BIG IDEAS The oceans' water surges as it travels in waves creating great currents; the rotation of the earth and the position of the moon cause low and high tides.

■ LESSON 4

Layers of Salt Water

BIG IDEAS The oceans exist as layers of salt water that vary in temperature, light intensity, pressure and currents. We can measure all these characteristics.

■ LESSON 5

Oceans — A Different World

BIG IDEAS Conditions in the ocean environment produce many different types of shore and underwater life.

■ LESSON 6

Plants and Animals of the Abyss

BIG IDEAS Life abounds in the ocean on the surface, in the thermocline and in the abyss. The largest mammals and the smallest one-celled protozoa and one-celled algae — all live in the ocean.

■ LESSON 7

Oceans and Industries

BIG IDEAS The oceans are important sources of food, employment and recreation.

■ LESSON 8

Oceans and Pollution

BIG IDEAS The oceans are in danger of increased pollution; we can protect them through awareness and laws.

OBJECTIVE GRID

Lessons	1	2	3	4	5	6	7	8
Mathematics Objectives								
1. explore the concept of percentage	•							
2. measure length	•			•				
3. multiply single-digit numbers as repeated addition, using arrays		•	•		•			
4. record and graph data	•	•				•	•	
5. classify objects	•	•			•	•	•	
6. recognize and create patterns and similarities	•	•			•		•	
7. read temperature on Fahrenheit and Celsius scales				•				
8. explore symmetry	•				•			
9. explore multiplication								•
10. explore division as repeated subtraction, separating into arrays			•		•			
11. use denominate numbers (hours and minutes) to calculate time			•					
12. compare numbers using subtraction or fractions	•							
Science Objectives								
1. identify at least 3 main oceans	•							
2. describe zones of salt water that vary in temperature, pressure and light intensity		•	•	•	•	•		
3. identify and describe different environmental conditions in the oceans			•	•	•	•	•	•
4. identify and describe different types of ocean life	•			•	•	•	•	•
5. demonstrate and explain or draw the effects of salt water	•				•			
6. illustrate and explain the tides			•					
7. classify ocean life as plants and animals	•				•	•	•	•
8. understand that the ocean floor is not flat, but has mountains and valleys		•		•		•	•	•

Lessons	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
9. name and describe various resources and careers provided by oceans						•	•	•
10. discuss how oceans are being polluted and list ways that will decrease future pollution								•
11. list and discuss at least 3 water recreation activities.							•	
Language Objectives								
1. respond to storytelling or oral languge in verbal and/or nonverbal ways	•	•	•	•	•	•	•	•
2. listen to literature selections daily for personal enjoyment and language acquisition	•	•	•	•	•	•	•	•
3. employ active listening in a variety of situations	•	•	•	•	•	•	•	•
4. engage in pre-writing activites	•	•	•	•	•	•	•	•
5. write complete sentences	•	•	•	•	•	•	•	•
6. predict outcomes	•	•	•	•	•	•	•	•
7. explain observations	•	•	•	•	•	•	•	•

LESSON 1 The Underwater World

BIG IDEAS The oceans and seas on earth cover 7/10 of its surface, or 70%, with salt water, creating an underwater world that is still largely unknown.

Whole Group Work

Materials

Book: **I Am the Ocean** by S. Marshak

World globe; books and encyclopedia; large bowl of salt water; a hot plate; blank world maps for students; four cups of salt water (two T. salt per cup); laminated pictures of seashells; metric and English rulers

Word tags: ocean, sea, underwater, Pacific, Atlantic, Indian, circumnavigate

Encountering the Idea

Today, we begin an adventure to discover what the largest part on our earth is! Ask those students who have been to the ocean to tell about their experiences of the ocean. What did they see? How did the water taste? What sea life did they see? (As the students tell their experiences, write relevant words on the chalkboard to use later in sentences for a class book on oceans.) Today, we will discover what an ocean is, where the ocean is located, the different names of oceans and interesting characteristics of oceans.

Read **I Am the Ocean**. After reading the book, students locate the oceans on a world globe and on their individual blank world maps.

Exploring the Idea

Pointing to the world globe tell students that the globe represents the earth. Show the parts of the globe that are land and those that are water. Tell the students that the earth can be seen from outer space as a **big blue marble** because there is so much water on the earth's surface that the blue color is visible from space. Water covers more than half of the earth's surface. There are three main bodies of water — **The Pacific Ocean, the Atlantic Ocean** and the **Indian Ocean.** Did you know that although we name different oceans — **Atlantic, Pacific, Indian, Arctic,** and **Antarctic** — these are actually all part of one ocean? We could travel around the world without touching land.

After looking at books on the oceans and world maps, the students work in small groups to plan and design a mural to show the three main oceans and the main continents surrounding them. After negotiating the plan and design, the students separate into specific task groups.

At the **Art Center,** students begin **Activity** — Ocean Mural.

At the **Social Science Center** (or where the large world globe is located), the students work in pairs to trace routes from Los Angeles around the world and back, without touching land.

At the **Science Center,** the students complete

1. **Activity** — Salt Water
2. **Activity** — Floating in Salt Water.

At the **Mathematics Center,** the students complete **Activity** — Looking at % (Percent).

Getting the Idea

Several of the student groups demonstrate to the class the routes they found to **circumnavigate** the earth without touching land. Students estimate which routes were longer and which routes appeared to be shorter.

The class discusses the amount of surface area covered by the oceans using the concept of percent.

1. What do we mean when we say "over 70% of the earth's surface is water? Yes, over 70 parts of every 100 parts of earth is water. Look at your percent grid. Show what 70% is on the grid.
2. Is 70% more that 1/2? How can you show this on your % (percent) grid?
3. What does it mean that the ocean holds 97% of the world's water? 97% means what? In what other way can you say the same thing?
4. What does it mean when we say that 2% **of the earth]s water is ice in the polar caps?** How much is 2%? Show it on your % (percent) grid. Is it a lot or is it little?
5. What does it mean when we say that **only** 1% **of the earth's water is fresh** water? Draw this on your % (percent) grid.

Organizing the Idea

At the **Writing Center,** the students begin work on an illustrated class Big Book on oceans by listing interesting things they want to include in the book.

At the **Mathematics Center,** the students complete **Activity** — Ocean Mathematics.

Students work on their blank world maps. Working in groups, they color land brown and the ocean blue. Using the world globe and/or other reference materials as guides, they label the oceans and continents.

Applying the Idea

Predict what would happen if a ship traveled in fresh water and another one traveled in salt water. Would it make a difference in how much cargo (weight) each ship could carry?

Closure and Assessment

1. When you ordered the seashells by size (length) was the order of the seashell the same when you used centimeters as when you used inches? Explain to your partner why the order was the same.
2. Why does a seashell **measure** more in centimeters than in inches? Is the length of the sea shell the same whether you use inches or centimeters? What changes?
3. Pick a picture of a particular seashell, one of the longer pictures, and ask students to compare the length of the seashell to a particular student.

Oral Assessment

1. Name two oceans of the world.
2. In the experiment on ocean water, what did you see at the bottom of the pan after the water had evaporated?
3. What did the residue taste like?
4. Where did the residue come from?
5. What did this experiment tell you about ocean water?

Performance Assessment

The student traces two routes to circumnavigate the globe and gives reasons why one might or might not be shorter or longer.

Assess participation (frequency and quality of ideas) in the completion of a colored, labeled map of the world.

Written Assessment

Students list things contained in the ocean or that describe the ocean (**Writing Center**).

Students begin work on an illustrated class book on oceans: "I AM THE OCEAN." Students write a sentence describing the ocean or something living in the ocean.

List of Activities for this Lesson

- ▲ Ocean Mural
- ▲ Salt Water
- ▲ Floating in Salt Water
- ▲ Looking at % (Percent)
- ▲ Ocean Mathematics

ACTIVITY
Ocean Mural

Objective

The students create a mural of the ocean.

Note: The development of the mural is an ongoing project that the students complete in stages as they learn about the ocean. The planning and design phase may have to be completed after the students have gone through Lesson 3.

Materials

Book: **Swimmy** by L. Lionni

White butcher paper; scissors; colors; glue; magazines picture of ocean life; library books on oceans; films depicting ocean life; sponges

Procedures

1. The students, working in small groups, plan and design an ocean mural for their group.
2. The mural includes surface and undersea features containing life forms (plants as well as animals) found in each zone.
3. The mural includes, as a surface feature, illustrations of industries and employment opportunities that the oceans and their products have generated.
4. The study of the ocean is an important area of science — oceanography. The researchers are called **oceanographers.** People who study the life that exists in the ocean are **marine biologists.** Students can read about these careers and report to the class what they think is interesting about these careers. They may include ocean science activities in the mural.
5. As an optional activity, the students can create an individual ocean mural, using the same artistic style as L. Lionni or another style they find interesting.

ACTIVITY
Salt Water

Objective
The students say that sea water contains salt; fresh water does not contain salt.

Materials
Hot Plate; pan; small piece of wood; bowl with fresh water; sea water (or salt water)

Procedures
Put some of the sea water aside to use in the second part of the demonstration.

Tell students that you have put some sea water (or some water that is like sea water) on the pan that is on the hot plate. After the water has evaporated and the pan has cooled, ask the students to look at the bottom of the pan. What is it? Taste it and see. What do you think is in sea or ocean water? Have any of you tasted sea water?

Discussion
1. What is left at the bottom of the pan?
2. What do you think is in sea water? Does all water have salt in it?
3. Where do you suppose the salt comes from?
    - the land
    - coastal soil and rocks worn away by wind and rain
    - carried by rivers
    - shells and skeletons from sea animals
4. How long do you think it took to get so much salt into the ocean? (Hundreds of millions of years.)
5. Have any of you gone swimming in the ocean? Pause for student responses.
6. Put the piece of wood in the pan with fresh water in it. Mark the piece of wood on the water line. Now, put the same piece of wood in the pan with salt water. What do you see? Why is the wood floating higher in the sea water than it floated in fresh water?
7. If you have gone swimming in the ocean, you know that you can float more easily in salt water than in fresh or regular water. The salt in the water makes the water more **buoyant**. Salt water exerts more upward force than regular or fresh water to make something float.

ACTIVITY
Floating in Salt Water

Objective

The student says that things float higher in salt water than in water without salt.

Materials

Large bowl filled 3/4 with tap water; salt; unpainted block of wood

Procedures

1. Float a block of wood in the bowl of water.
2. Remove the block and mark it where the wood is wet.
3. Dry the block.
4. Add five spoonfuls of salt to the water. Stir until most of the salt disappears.
5. Float the block again and mark where the wood is wet.
7. Compare the two marks. In which type of water did the block float higher?

Discussion

What can you say happens when salt is added to the water?

Make and test a prediction:

1. Do you think you can put more weight on a ship if it is going to float in salt water than you can if the ship is going to float in fresh water?
2. Students develop and test a hypothesis to answer this question.
3. After the students work on the problem, they report to the class. The class develops a concensus regarding the answer to the question.

ACTIVITY
Looking at % (Percent)

Objective

The student writes a given % (percent) as a fraction with 100 as the denominator.

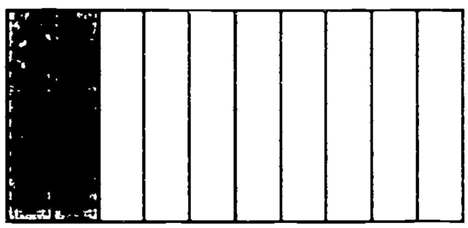
Materials

10 x 10 grids and areas separated into 10 equivalent areas (laminated); erasable markers

Procedures

1. Review meaning of a fraction as a part of a set and as part of an area.
2. Students show 3/10, 5/10, 1/10, 2/10 as shaded areas on the review grid.
3. Working in small groups, students show 70/100, 4/100, 25/100, 95/100 as shaded areas. They check each other's work.
4. Tell students that % (percent) shows a fraction with 100 as a denominator. Then 70% means 70/100 with 70 parts out of 100.
5. What do we mean when we say that 70% of the earth is water?

Review Grid



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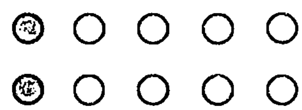

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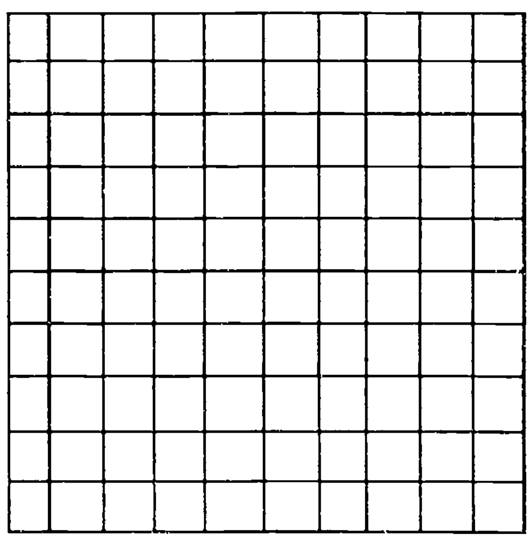


% grid

100

ACTIVITY
Ocean Mathematics

Objective

The students

1. categorize an object by size and shape and identify its line of symmetry, if it has one
2. use a nonstandard measure (a paper cutout drawing of a seashell) to measure his/her height
3. use a standard measure such as inches and/or centimeters and compare the measures.

Materials

Collection of various types of seashells or seashell pictures

Word tags: ellipse, cone, spiral, hexagon, cylinder, circular or circle, symmetry, symmetrical and other words students use to categorize the seashells

Procedures

1. The students describe each shell (at least seven of them) by size (measured in centimeters and/or inches), shape (using as many words to describe the shape as possible) and by symmetry.
2. The students select the categories they want for the seashells.
3. The students separate the seashells into the selected categories.
4. The students use a paper cutout of a shell to measure his/her own height.
5. The students measure their heights in inches and/or centimeters.
6. The students write word problems comparing the sizes and shapes of the various seashells. For example: How many centimeters longer is the elliptical shell than the cone shell?

   A spiral shell measures 12 centimeters but a cone measures four inches. Which is longer? How do you know? Can you compare two centimeters and four inches by putting the seashells side by side?
7. The students order the pictures by size, using centimeters and then using inches. They consider if the order is the same regardless of the unit used.

Discussion

1. Why are the measures in centimeters and inches different?
2. What is a standard unit of measure? A nonstandard unit?
3. What is an example of a nonstandard unit of measure?

LESSON 2 Ocean Mountains and Valleys

BIG IDEAS The ocean floor is not smooth and it is not flat; great mountains and valleys cover it. Different combinations can be made using only a small number of things.

Whole Group Work

Materials
Listed with activities

Encountering the Idea

We have been talking about the oceans on earth, the area they cover, and that they have salt water that is different from fresh water. Before we can begin to draw our mural, however, we need to know something about the bottom of the ocean, its floor. What do you think it looks like — the floor of the ocean? Is it smooth? Is it flat? What would you predict? Pause for student suggestions. Write the more plausible ones on a chart to use later.

Let's ask a different question. What does the surface on earth look like? Is it flat and smooth? No, it has valleys and mountains. Some of the mountains are very high. Some of the valleys are very deep. How were the mountains and valleys made? What caused some of the surface to rise and other parts to sink? We can look at some activities that will help us discover the answers to some of these questions.

Exploring the Idea

At the **Science Center**, students
1. complete **Activity** — Seaquakes
2. complete **Activity** — An Ocean Volcano
3. complete **Activity** — The Ocean Floor.

At the **Mathematics Center**, the students complete **Activity** — An Aquarium.

Getting the Idea

1. In your activity on an ocean aquarium, you designed several aquariums using different combinations of sea creatures, plants and ocean floors. Were you able to develop a strategy to help you find all the different designs? When we make sets by selecting different members out of several groups, these new sets are called **combinations**. When we have two creatures (octopus, dolphin), two plants (kelp, coral) and two floors (rocks, sand), we made eight **different combinations**. One group made this picture of all the combinations. The group leader gave this explanation:

There are three things that have to be chosen: the creatures, the plants and the floor, so first you select the creature, the plant and the floor: **O K R**. Next, you change only the floor: **O K S**. That's two designs. You do it again, but with a different plant. That makes four designs. You do it again, but this time change the creature. That makes eight.

This is their diagram:

O(ctopus)	K(elp)	R(ocks)
O	K	S(and)
O	C(oral)	R
O	C	S
D(olphin)	K	R
D	K	S
D	C	R
D	C	S

Another way to find all possible combinations where you can select from two or more sets is to use multiplication. Try to find out how you multiply to get the correct answer.

2. The idea that the ocean floor moves and changes was not an easy idea for many people, even geologists, to accept. But through the collection of data, scientists now accept the fact that the ocean floor is continuously moving and spreading in different directions. This spread causes the floor to be uneven, to have large mountains, valleys and basins.

How long do you think that it has taken for the ocean floor to develop the mountains and valleys it has? Scientists tell us that the earth plates on the ocean floor are moving at the average rate of six centimeters, about 2 1/2 inches, **per year.** This is the average growth rate of a person's fingernail. Can you imagine how long it will take for these plates to move to make a basin, or a trench? Scientists tell us that the ocean floor has been changing for over **130 million years.**

Now that we have some idea of what the ocean floor looks like, we can add these new features to our plans for our mural. We can also begin to design an ocean diorama.

Organizing the Idea

Students complete **Activity** — Ocean Diorama.

Applying the Idea

Many people like to look for and have found large treasures of gold, silver and precious gems in the Gulf of Mexico. Find the Gulf of Mexico on the world globe or on your world map. In your reference books read about the Gulf and hypothesize why people would have found gold in sunken ships on the Gulf floor.

Closure and Assessment

Oral Assessment

1. What does the ocean floor look like?
2. What do you like the best (or least) about what you have learned about the ocean floor?

Performance Assessment

1. Draw a picture illustrating the ocean floor. Label as many different things about the ocean floor as you can.
2. Show, with objects if you need to, as many different scenes as you can make in an aquarium if you put into it two types of fish, two kinds of plants and two types of seashells.

Written Assessment

The student selects one of the following activities:

1. Describe and illustrate the ocean floor as thoroughly as you can.
2. Describe and illustrate how the ocean floor has developed over time.
3. Write a paragraph about the ocean floor following the pattern:
   The most important thing about the ocean floor is __________, because __________.

List of Activities for this Lesson

- ▲ Seaquakes
- ▲ An Ocean Volcano
- ▲ The Ocean Floor
- ▲ An Ocean Aquarium
- ▲ Ocean Diorama

▲ ACTIVITY
Seaquakes

Objective

The student understands that the ocean floor changes by describing the effects of **plates** of earth moving to cause cracks and hills, or valleys and mountains.

Materials

Playdough or clay molded into two flat surfaces, about 1/2 inch thick

Procedures

1. Place the two clay surfaces end to end and push together. Students make observations.
2. Remold the clay into two flat surfaces to simulate plates of earth.
3. Place the two surfaces one on top of the other. With the heel of your hand, press against the clay and observe.

Discussion

1. The two pieces of clay represent plates of earth. What happens when we push the two plates. Does it take a lot of force to push them together?
2. What makes the plates move together?
3. What happens to the earth's surface during an earthquake?
4. What happens to the ocean's floor during a seaquake?

Application

1. At the **Art Center**, draw what you imagine can happen on the ocean floor as the earth moves two plates together during an earthquake.
2. After you have drawn your ocean floor scene, share it with members of your group and design a scene of an earthquake on the ocean floor to include in your ocean mural.

ACTIVITY
An Ocean Volcano

Objective

Students say that volcanoes exist underwater and erupt in the same way as on the earth's surface.

Materials

Cardboard on which to place the clay volcano; clay to mold into a volcano shape; 20 inches of plastic or rubber tubing; puffed rice; pen or pencil

Procedures

1. Form the clay into a volcano shape and place on the cardboard.
2. Color the clay and cardboard to simulate the ocean floor around a volcano.
3. At the top of the volcano make a cone-shaped opening from the top to the bottom of the volcano.
4. Make a small tunnel the size of the tubing through the base of the cardboard and the volcano. This tunnel should connect with the cone-shaped opening at the top of the volcano.
5. Insert the tubing through the tunnel at the base of the volcano.
6. Pour the puffed rice into the cone-shaped opening at the top.
7. Blow air gently through the tubing to show a simulation of the magma that is getting ready to erupt, and then blow hard to show the effect of pressure from under the ocean floor on the pieces of rice.

Discussion

1. What did we learn about volcanoes from this demonstration?
2. What do the rice and the air that we blow through the tubing represent?
4. What do you think happens on the ocean floor when an ocean volcano erupts?
   - the water is very hot
   - magma erupts instead of the rice
   - the magma cools faster because it erupts into water instead of into air
   - other suggestions

ACTIVITY
The Ocean Floor

Objective

The students simulate and describe different layers of the ocean by using sand and pebbles in a jar of water.

Materials

Large glass jar for each student group; students bring the jars with lids
Different types of sand
Water
Seashells, different kinds, shapes, sizes

Procedures

Students work in small groups.

1. The students fill 1/3 of the jar with sand.
2. They place a few pebbles and seashells in the jar.
3. Fill the jar with water, and close the lid tightly.
4. The students shake the jars gently and thoroughly.
5. The containers sit on a shelf overnight.
6. On the following two days, the students observe the "ocean floor." They note the characteristics of the "ocean floor."
7. The students shake the jar every day and let it settle overnight for four to five days. Students describe the layers after the water has settled every day.
8. Is there a visible pattern to the way the layers settle?
9. If there is a pattern to the way the layers settle, make a rule about how the different layers settle.
10. The students shake the jar one more time to see if the rule they made applies to the results they get.

Assessment

1. Students describe their observations of the "ocean floor" in their journals.
2. The teacher asks:
   a. What does the floor look like?
   b. Are there different layers?
   c. Draw a picture of what you see.
3. Why do the layers settle in similar ways every time you shake the jar? (The heavier objects will drop faster to the bottom, while the lighter objects will settle on top.)
4. Students describe a volcano eruption and explain how it changes the ocean's floor.

ACTIVITY
An Ocean Aquarium

Objective

Students explore multiplication as a cross-product.

Materials

Set of five shapes of sea creatures (swordfish, shark, whale, dolphin and octopus)
Set of three types of ocean plants (kelp, seaweed and coral)
Three types of aquarium floors (rocks, clay and smooth sand)

Procedure

A decorator is designing an aquarium for a large building. The decorator can put only one type of sea animal, one type of sea plant and one type of floor in the aquarium. How many different aquariums can the decorator design? Tell your teacher or your friend how you know that number is correct.

1. Suppose the decorator has two types of sea creatures (octopus and dolphin), two types of plants (kelp and coral) and two types of floor (rough and smooth). How many **different** aquariums can the decorator design, using only one type of creature one type of plant and one type of floor for each acquarium? Draw at least four different ones. (eight possible combinations — (octopus, kelp, rough) is one; (octopus, kelp, smooth) is another; (octopus, coral, smooth) is another; (octopus, coral, rough), etc.
2. Suppose the decorator now has two types of sea creatures, three types of plants and three types of floor. How many different aquariums can be designed? Work with your group to see if you can develop a strategy to find all the possible designs without drawing them. (18 possible combinations: 3 x 3 x 2 = 18.)
3. What if the decorator now has four types of sea creatures, two types of plants and two types of floors? Use the strategy you used in Problem #2 above to see if it works on this problem. (4 x 2 x 2 = 16 combinations.)
4. In your journal, design, draw and color two or three different aquariums.
5. Write a story about one of the animals in your aquarium. Read it to your group, to your class or to your parents.

ACTIVITY

Ocean Diorama

Objective

The students create an ocean scene.

Materials

Shoe box; blue tempera paint; toothpicks; plastic wrap; pictures of sea animals; sand; small, colored rocks; weeds to resemble sea plants; dried flowers; small seashells

Procedures

1. Cut out one side of a shoe box (one of the long sides).
2. Color the bottom and three sides of the shoe box with blue tempera paint. Let it dry.
3. Draw or cut out pictures of sea animals.
4. Glue pictures of some of the sea animals on the inside of the shoe box.
5. Put the toothpicks through the top of the shoe box. Glue some sea animals on the inside of the box where the toothpicks are. These animals will appear to be swimming inside the box.
6. Glue sand, small pebbles and seashells on the bottom of the shoe box.
7. Glue dried weeds or flowers along the inside and bottom of the shoe box.
8. Glue small seashells and some rocks on the bottom of the inside of the shoe box.
9. Cover the cut-out side of the shoe box with plastic wrap.
10. The scene appears as three-dimensional with the fish or other sea animals glued to the toothpicks.

Each student briefly explains her/his ocean diorama to the class.

LESSON 3 Waves, Tides and Currents

BIG IDEAS The oceans' water surges as it travels in waves creating great currents; the rotation of the earth and the position of the moon cause low and high tides.

Materials

Book: **When the Tide Is Low** by S. Cole
Pie plate; Blow dryer; Pictures of ocean waves; World map showing currents
Word tags: wave, tide, current, ebb, crest, convection;

Encountering the Idea

Look at this picture of the ocean. What do you see? Waves — large ones, small ones, for many, many miles. The ocean is never still; it is always moving. When we began this unit we said that many of the earth's surface features, such as mountains and valleys, appear on the ocean floor also. On the earth's surface we have rivers — small and large. What would you guess? Are there rivers that run underwater? What do you think? What could make it possible? Today, we will discover what makes the ocean be in continuous motion.

Exploring the Idea

Waves: Let's start by making waves and observing their motion.
Activity — Making Waves, as below.

Materials

Pie plate filled with water

Procedures

1. Blow gently on the plate of water. Blow harder with the dryer, first on slow and then fast. Waves get bigger.
2. Students describe the effect the air has on the water.
3. Students hypothesize about the effect of wind on the ocean water.
4. Let the water in the plate become calm.
5. Place a small piece of wood (from the pencil sharpener) or some other small object that will float on the water.
6. Make waves by gently moving a hand back and forth in the water.
7. Students describe the action of the waves on the piece of wood.

Students complete **Activity** — Tides and the Moon, and **Activity** — Calculating High and Low Tides.

Now let's read **When the Tide Is Low.** Be thinking about what might cause the ocean to have tides — high and low.

Currents: At the **Science Center,** students complete **Activity** — Underwater Rivers.

Getting the Idea

From our activities, what idea did you get about what a wave is? (Pause for students to give their opinions. Ask the students to describe the motion. Is it only up and down? Back and forth? Ask students to wave their hands. Describe this motion.) **Waves** are the backward and forward **and** also up and down motion of water as it moves. When we blew on the water, it caused the water to surge in waves. The waves crested or peaked and then they died down, and ebbed and then began to crest again.

From our activities, what idea did you get about tides? **Tides** are the regular rhythm of the motion of the ocean. This motion is due to the presence of the moon and the sun. The attraction of the earth's and the moon's gravity is one of the causes of the tides.

From our activities, what idea did you get about what a current is? **Currents** are rivers flowing through the ocean. The two main causes of currents are the heat of the sun that warms the sea surface and generates strong, steady winds, and the cold heavy water that sinks and flows along the ocean floor. (Show map of currents.)

Organizing the Idea

At the **Art Center**, students
1. complete **Activity** — High and Low Tides
2. complete **Activity** — The Oceans Currents, as below.

Materials
Blank world maps outlining the continents.

Procedures
1. Students look in reference books that depict the oceans warm and cold currents to locate five of the world's major surface circular current systems: the North Atlantic, South Atlantic, South Indian, North Pacific, and South Pacific.
2. The students draw and color the currents to show the cold and the warm currents.
3. The students draw arrows on the currents to show the direction of their motion.

At the **Writing Center**, the students list at least three important ocean currents, locate them on a world map, and describe and illustrate their routes.

At the **Language Center**, students analyze the words: current, convection, crest and peak. They compare the English words to the Spanish words **corriente**, which means "running"; **convección**, which means "move together"; **cresta**, which means "top"; and **pico**, which means "spike". The students look for other words in English and Spanish that, but for some spelling differences, have the same meaning — cognates.

Closure and Assessment

Oral Assessment
Name and describe three types of movement of ocean water.
Name and locate on a world map one of the important ocean currents.

Performance Assessment

Illustrate the motion of water as waves. Show two types of movement of the waves (back and forth, and up and down.)

Illustrate and label an ocean current.

Assess the level and quality of completion of the activities involving high/low tide scenes.

Written Assessment

Locate a continent and an ocean current. Describe and illustrate where that current would take you if you floated on it in a canoe.

Write a brief explanation of how the moon's gravity affects the ocean's water.

Fold a paper in half. On one side, draw an ocean beach and what you might see at high tide. On the other half, draw the same ocean beach and what you might see at low tide.

List of Activities for this Lesson

- ▲ Tides and the Moon
- ▲ Calculating High and Low Tides
- ▲ High and Low Tides
- ▲ Underwater Rivers
- ▲ Sea Square and Rectangles

ACTIVITY

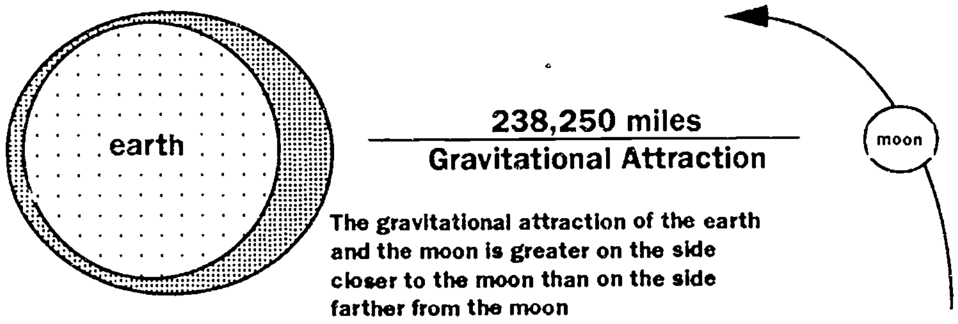
Tides and the Moon

Objective

The students explain verbally and/or with illustrations the action of the moon on the ocean to cause the tides.

Materials

Reference books for students to read about the tides
Sphere to simulate the earth
Sphere (smaller) to simulate the moon circling the earth
Large sphere to simulate the sun



Procedures

1. Students simulate the action of the moon around the earth, showing on which bodies of water the high and/or low tides would occur.
2. Then students simulate the action of the moon around the earth and the action of the earth around the sun to show where the highest of the high tides would occur. (When both the sun and the moon are in the same general direction, the pull of both will create the high tides.)
3. Students read about the tides in the reference books.
4. The students write and illustrate in their journals how the moon affects the tides.

ACTIVITY

Calculating High and Low Tides: Part 1

Objective

The student, given a table of times for high and low tides, uses the pattern to calculate future tides.

Materials

Tide chart, as below.

Procedures

1. Students look for patterns in the chart and develop strategies for predicting the time for the next high or low tide.
2. Students work in pairs or small groups to complete the chart shown below.

Schedule for Low and High Tides

	Sun.	Mon.	Tues.	Wed.	Thur.	Fri.	Sat.
Low Tide		2:37 1/2 a	3:27 1/2a				
High Tide	8:00 a	8:50 a	9:40 a				
Low Tide	2:12 1/2 p	3:02 1/2 p	3:52 1/2p				
High Tide	8:25 p	9:15 p	10:05 p				

3. Student groups compare the strategies they used and the times they calculated for the other days of the week.

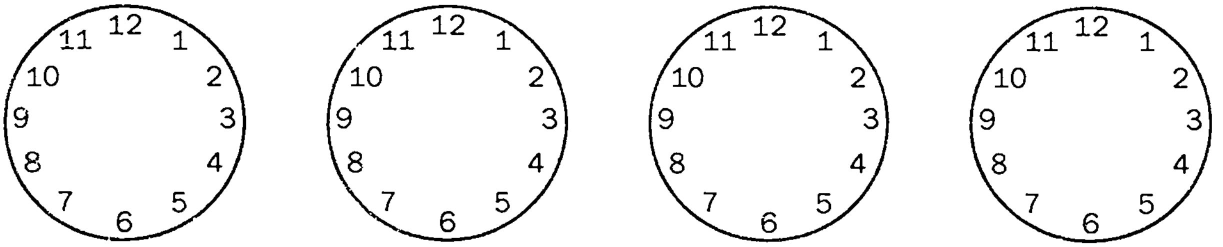
ACTIVITY

Calculating High and Low Tides: Part 2

Application

The students may want to use the clock faces to help them discover the patterns and calculate the times.

1. If you were the captain of a ship, would you leave the harbor when the tide is coming in or when the tide is going out? Explain why you chose one or the other. What time period would you choose to take your ship out on Wednesday?
2. Why would it be important for you to have an accurate schedule for the tides?



ACTIVITY
High and Low Tides

Activity 1

Objective
The students illustrate a high tide and a low tide.

Materials
White construction paper; pencil; crayons; markers

Procedure
1. Divide the paper into two sections, making both sides even.
2. Have children draw a nighttime picture showing a beach, the moon and water at a time of high tide.
3. On the second half of the paper, students draw a day picture showing the beach, the sun and water at a time of low tide.
4. Color pictures drawn.
5. Students display and explain a low tide picture and a high tide picture to their group or to the class.

Activity 2

Objective
The students illustrate a high tide and a low tide.

Materials
White construction paper; pencil; crayons; marker; blue or clear cellophane paper

Procedures
1. Using the construction paper, students draw a day beach scene, focusing on low tide characteristics.
2. Using the cellophane paper, draw or glue on a night beach scene, focusing on high tide characteristics.
3. Glue or staple, on the corresponding side of the paper, the moon and the sun.
4. Students do the illustration to resemble a book that shows both tides.
5. Students display and explain their drawing to their group or to the class.

ACTIVITY

Underwater Rivers

Objective

The student demonstrates and explains that cold water is heavier than warm water by constructing a model of the water currents that form underwater rivers in the ocean.

Materials

Two large transparent jars; two small bottles; ice water; water; red and blue food coloring

Procedures

1. Fill one large jar and one small bottle with ice water. Add enough blue coloring to the small bottle to color the water. Mix the color completely.
2. Fill the other large jar and small bottle with warm water. Add red food coloring to the small bottle to color it. Mix the color completely.
3. Hold the small bottle of blue ice water over the jar of warm water. Slowly pour the blue ice water into the jar of warm water. What happens to the cold water in the warm water?
4. Slowly pour the red warm water into the jar of ice water. What happens to the warm water in the cold water?

Discussion

After discussion, the students answer the questions in their journals. The students compare the density of ice water and warm water to explain ocean currents.

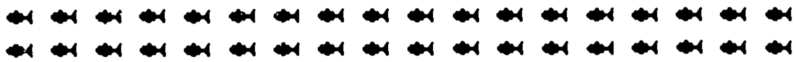
ACTIVITY
Sea Squares and Rectangles

Materials

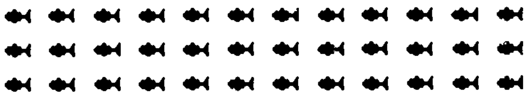
Sea Squares by J.N. Hulme, placed in the **Reading Center** for students to read
Boxes of fish-shaped cheese crackers
Containers for the crackers, one container per group
Paper towels

Procedures

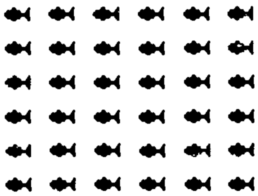
1. Each pair of students receives a container with the same number of crackers (36).
2. Thirty-six fish by in pairs. How many pairs are there? The students make arrays with the crackers.
3. After separating the crackers, the students take turns telling each other what they did: 36 divided into groups of two make 18 groups of two each.
4. The students find out how many groups with three, then only four, then six, and then nine fish in each group they can make.
5. After each separation, the students take turns telling each other what they did.



36 fish in pairs are 18 pairs.



36 fish in groups of three are 12 groups



36 fish in groups of six are six groups

LESSON 4 Layers of Salt Water

BIG IDEAS The oceans exist as layers of salt water that vary in temperature, light intensity, pressure and currents. We can measure all of these characteristics.

Whole Group Work

Materials

Book: **The Magic School Bus on the Ocean Floor** by J. Cole
Copy of the diagram of three ocean layers below
Glass bowls; plastic tubing; pitchers; rubber bands; food coloring; balloons; pan; buckets; hot plate; flashlights; pieces of cheese cloth; poster board

Encountering the Idea

Today we are going to take a field trip to the ocean! Let's join Ms. Frizzle and her class as they take a special journey. Read **The Magic School Bus.**

We too are going to explore the different layers of the ocean. These layers of water are different, just like the layers of air on earth are different in temperature, pressure and light intensity. We are going to explore these conditions at three different layers:

- the shore or beach (at sea level)
- the surface or continental drift (up to 600 ft. deep)
- the floor or abyss (up to 20,000 ft. deep)

Exploring the Idea

Look at the diagram shown here. Before going to the learning centers, we are going to study the diagram to see what it tells us about the ocean layers. We will also make and record predictions about the conditions in these different layers of water. We will check them later.

	Temperature	Water Pressure	Light Intensity
Beach (surface) (0 to 1650 feet)	Depends on shore conditions, varying from 90 degrees F to below freezing at the poles.	Same as air pressure at sea level. At 33 ft. depth, pressure is twice pressure at sea level.	Sunlight penetrates to 3300 feet into the ocean; supports life in upper 650 feet only. From 130 to 650 feet depth is a twilight zone; only blue light remains.
Thermocline (3300 to 5000 feet)	Area of rapid changes; separates warm surface water from cold of the deep ocean.	The pressure increases from about 50 to over 200 times the pres. ure at sea level.	
Abyss (6500 to 13,000 feet)	Always cold; very close to temperature of the water at the poles.	In the deepest part of the ocean the pressure is over 1000 times the pressure at sea level.	World of perpetual darkness where the only light is produced by organisms that generate **bioluminescence.**

Where do you predict the water will be the warmest? Why? Where do you predict the pressure will be the greatest? Why? Where do you predict there will be the least amount of light? Why?

At the **Science Center**, students

1. complete **Activity** — Ocean Temperatures
2. complete **Activity** — Water: Pressure and Temperature
3. complete **Activity** — Water Pressure is a Force, as shown below. This is a teacher demonstration.

Materials

Empty, clean and dry can of duplicating fluid with tight-sealing lid, or some other can that is lightweight; hot plate to heat the can

Procedures

- Heat the can carefully, so as to drive out some air from the can as the air becomes warm.
- Remove the can from the hot plate. Immediately seal the can tightly.
- Students make observations and propose hypotheses about why the can was crushed.
- Students complete **Activity** — Light Intensity, as shown below.

Materials

Flashlight; pieces of gauze

Procedures

Turn on flashlight. Place one piece of cheesecloth over the light. Can light still shine through? Place another. How about now? Students describe what is happening.

Getting the Idea

Where do you suppose the salt found in seawater comes from?

- the land
- coastal soil and rocks worn away by wind and rain
- carried by rivers
- shells and skeletons from sea animals

It took hundreds of millions of years for the oceans to become as salty as they are.

Remember that warm water is lighter and has expanded, and cold water is heavier and more dense (closer together). Warmth makes water lighter, so it floats on top of the heavier, denser cold water. At what ocean depth will the temperature of the water change depending on surface climate and the season? (Close to the surface of the water.)

The deeper we go, the greater the water pressure. What happens to an object when it is under a great deal of pressure? Refer to the demonstration of the crushed can. After students have had an opportunity to express their ideas about what crushed the can, suggest to them that as the can cools, the outside air pressure, which is greater than the less-dense air pressure inside the can, will press in on all sides of the can and crush it. Tell students that if the object (can) were underwater under great pressure it would also be crushed. Both water and air can exert pressure, so it is the pressure, the weight, that crushes the can.

What did the experiment with the flashlight and cotton gauze suggest to you about the light intensity at the different depths of ocean water? How are the two notions — the layers of gauze and the layers of ocean water — alike? How are they different? Where will the least amount of light be in the ocean? (The floor.) Why? The sunlight is filtered out.

Organizing the Idea

Students use the diagram from **Exploring the Idea**, above, to complete the writing assignment.

At the **Writing Center**, the students describe the environmental conditions at each of the three levels. They focus on:

If I went swimming (or diving) on the (shore, on the surface, or close to the floor)

I would wear _______________; I would see _____________. I could only stay

______ (hrs, min).

Students can add other ideas such as protective gear, radio contact with a ship, etc.

Applying the Idea

1. Look at the chart on the characteristics of ocean water. There are three general levels of water depth. There are also three things that affect ocean water that we studied — temperature, pressure and light intensity. How many boxes (classifications) will you have to make if you make combinations of three levels of depth and three characteristics? (nine.) (Refer to **Activity** — An Ocean Aquarium, Lesson 3.)
2. Suppose you are a marine biologist and want to build a laboratory on the ocean floor. Select an ocean (Atlantic, Pacific, other) and a floor depth to build your lab. How would you design it? What would it need? You may want to do research in some of your reference books before you answer the question. Make a drawing to illustrate your ideas.

Closure and Assessment

Oral Assessment

1. Describe the three layers of the sea.
2. Where is the coldest layer of water located in the ocean?
3. Is the coldest water in the ocean only at the North and South Poles? Explain your answer.
4. Are there underwater rivers in different ocean layers? Give your reasons for your answer.

Performance Assessment

Students draw and illustrate the layers of the ocean with a one-sentence description of temperature, pressure and light each.

Written Assessment

At the Writing Center, each student selects an ocean layer (or the ocean floor) he/she would most like to explore and explains why.

List of Activities for this Lesson

▲ Ocean Temperatures

▲ Water: Pressure and Temperature

ACTIVITY
Ocean Temperatures

Note: Since the lesson requires that students heat water on a hot plate, the teacher will need to supervise the activity at all times.

Objective
The student heats or cools water to the two extremes in temperature of the oceans' water, excluding the subfreezing temperatures of the polar regions.

Materials
Thermometer; rock salt; two glass jars; ice; test tube; dishwashing glove; hot plate; bowl with water; distilled water

Procedures
1. Using a hot plate and a water bath, heat the temperature of water in one jar to approximately 90° F. Students feel the water in the jar.
2. Using the ice to cool the water in the bowl, fill the other jar with ice and water and stir until the water reaches a temperature as close to freezing as possible. Again, the students feel the water in the jar to note the difference.
3. Have students put on a dishwashing glove (plastic, insulated) and again feel the hot and cold water.
4. Dissolve some of the rock salt into a bowl of water and ice. Put a test tube filled with distilled water (preferred) into the water bath. Take the temperature in seven to 10 minutes. The temperature should be at about 32° F or below. (Hold the test tube very still.) Students feel the water in the bath. Take the test tube out and tap it lightly. What happens?

Discussion
1. Since the water in the water bath was below 32° F, why didn't the water freeze? (The salt brings down the freezing temperature of water and supercools it. This freezing temperature is like an arctic temperatures.)
2. Students review the water temperature in the three layers of water in the ocean.
3. Tell the students that the water temperature in the **tropics** is normally warm, or average.
4. The temperature at the deepest parts of the ocean is approximately 30 to 34° F.
5. Tell students that the glove **insulates** the hands from cold or heat and is similar to what **scuba divers** wear when they go into the ocean.

ACTIVITY
Water: Pressure and Temperature

Objective
The students understand the effects of water pressure by stating a rule relating water depth and water pressure.

Materials
Large plastic container; masking tape; small balloon or rubber sheet

Procedure
1. Make three holes spaced evenly at the top, at the center and at the bottom of a large plastic container.
2. Place tape on the holes to prevent the water from draining out.
3. Fill the container to the top with water.
4. Remove the tape one piece at a time from the holes on the side of the container and let the flow run into the large pan.
5. Have students make observations about the streams flowing out of each hole by putting a hand in each stream to feel the pressure.
6. Cover the container top tightly with a balloon or rubber sheet. Press down into the container through the balloon. What happens?

Discussion
1. Where in the container is the water pressure strongest? How do you know at which level on the can the pressure is strongest?
2. Can students state a rule:
   The _______________ the water, the _______________ the water pressure.
3. Why do you suppose this rule is true? (Water has weight; the deeper the water the greater the weight, which is felt as pressure.)

Activity — Balloon Water Pressure

Materials
Balloons; rubber bands; plastic tubing; buckets

Procedures
1. Secure a balloon to plastic tubing with rubber bands. Blow up the balloon.
2. Deflate the balloon.
3. Now put the balloon that is still secured to the plastic tubing at the bottom of a bucket filled with water. Try to blow it up.

Discussion
1. Why could you not blow up the balloon when it was submerged in the water? (It is impossible because the water is pressing in on the balloon.)
2. What does this experiment tell us about water pressure in the different layers of ocean water?

Activity — Warm and Cold

Materials

Clear glass bowls; pitcher; food coloring; pan; hot plate

Procedures

Fill a glass bowl 3/4 full of cold water. Fill pitcher with hot (not boiling) water. Add a few drops of food coloring to the hot water. **Gently** pour the hot water down into the side of the bowl. Where does the hot water go?

Discussion

1. What happened to the hot water as we poured it into the bowl?
2. What happened to the cold water as we poured the hot water into the bowl?
3. What can we say about hot water and cold water when they come into contact, when they meet? (The cold, denser water goes to the bottom and the warm water, which is less dense, goes to the top.)
4. How does this experiment help us understand what happens in the ocean when a current of cold water meets a current of warm water?

LESSON 5 Oceans— *A Different World*

BIG IDEAS Conditions in the ocean environment produce many different types of shore and underwater life.

Whole Group Work

Materials

Book: **Monsters of the Deep** by N. Barrett, **Find Demi's Sea Creatures** by Demi and **Wonders of the Sea** by L. Sabin
Paper and crayons
A variety of pictures of plant and animal sea life
Word tags: adapt, bioluminescence

Encountering the Idea

We've talked about three different layers of water that make up the ocean. These layers differ in temperature, pressure, light and currents. You also know there are fish in the ocean. Name some of the sea creatures you know about. (Students name several: whales, sharks, etc.) Do you suppose there are plants that live in ocean water? Can you name some?

Exploring the Idea

Do you suppose that plants and animals can live in each of the zones of the ocean? We know that temperature, pressure and light are different in each of the layers. Does this matter to plants and animals? Yes. Let's discover how these different environments affect plants and animals. Study the nine different ocean environments described in the chart from **Lesson 4**, p. 33.

Read **Monsters of the Deep.** After discussing the characteristics of deep sea creatures and generating a word bank, students draw their own sea creatures and give them names.

Problem Solving Activity

Whole Group Activity

In **Lesson 4**, we learned that there are eight different environments in the ocean. In each category there is an environment that affects each of the living organisms — the animals and the plants — that live in it.

For each category, write descriptive words about the type of living organisms that could possibly live there. For example, in the abyss where there is no light, do you suppose there is animal life there? If so, what type? Where would you expect to find the most plant and animal life? Where would you expect to find the greatest **variety** of plant and animal life?

	Temperature	Water Pressure	Light Intensity
Beach (surface) (0 to 1650 feet)			
Thermocline (3300 to 5000 feet)			
Abyss (6500 to 13,000 feet)	No plant life because there is no light. Animal bodies float in currents. No eyes. Don't hunt food; grab what passes by. Food: pieces of dead animals falling to the ocean floor, food particles left by other animals.		

Getting the Idea

Read **Wonders of the Sea** by B. Sabin. Who can recall some of the names of the plants? Animals? Ask if the student is naming a plant or an animal. List under appropriate heading.

In the underwater environment, the most important factor is light and its absence, because living organisms cannot exist in the absence of light. Sunlight is the energy source that makes photosynthesis possible. It drives the food chain on which all animals depend.

Plants in the form of microscopic plankton and seaweed are at the center of this chain. They convert — like other plants — water and carbon dioxide into carbohydrates through photosynthesis. Carbohydrates are the basic ingredients that give organisms the "food" to grow and reproduce. In this food chain, the small plants are eaten by herbivorous animals, animals whose diets depends on plants. Then those animals are eaten by the carnivorous animals, animals that eat other animals.

The entire food web depends on the existence of solar energy that ceases to penetrate beyond 650 feet of water. When there is no light, there can be no plants and no production of food. All the creatures that live in the sea — from plankton to small jellyfish to sharks and whales — must be fed from the small amount of food that is produced in a very thin layer of sunlit water surface.

Although less aquatic life can exist in the abyss, as compared to the large numbers and the big size of some of the creatures living close to the surface of the ocean, the variety is nevertheless great. Since conditions on the ocean floor are very harsh, the creatures adapt in many different ways. For example, one fish, the tripod fish, has developed feet-like organs that help it walk on the ocean floor! Others have bodies that have developed into jelly-like sacks to withstand the water pressure and to float in the ocean currents, and these creatures grab food as it passes by. They do not exert more energy than they need to in order to survive.

Organizing the Idea

Do **Activity** — Salt on a Plant.
Do **Activity** — Fish Math.
Do **Activity** — Sea Creature Symmetry.

1. As students learn more about the ocean, they include the new ideas in the class mural. Before adding to the mural, they consult with their group members to ensure that everyone give suggests and participates.
2. At the **Writing Center**, students write and illustrate a paragraph about how they imagine life exists in the abyss. They are to think first about what the animals look like, if they need eyes, hearing or feeling organs, their outward coloring, what they eat, how they protect themselves from predators, and anything else the students may want to include. Before writing the students may want to look at pictures and do research on sea-bottom dwellers.

Applying the Idea

Fold a large piece of paper in half. Using various books and encyclopedias on ocean life, prepare a picture display of plants on one side and animals on the other side. Label the pictures with the names of the plants and animals. Use this information to add to your ocean mural.

Activity — Find Demi's Sea Creatures, as below.

Students read **Find Demi's Sea Creatures** by Demi. The students try to find the sea creatures in Demi's book. After the student-pairs find as many creatures as they can, they count them by twos, threes, or some other number they select. They compare with other student-pairs to see who has found the most creatures.

Closure and Assessment

Oral Assessment

Name one plant and one animal found in the ocean.

In the activity with the fish crackers,

1. how many groups of 10 did you have?
2. how many ones did you have?
3. what is the total number of fish crackers you had?

Performance Assessment

1. Illustrate and label the display of plants and animals.
2. Identify all sea creatures in **Find Demi's Sea Creature**
3. Draw favorite sea creature or plant in the sea creature's particular environment.

Written Assessment

1. If I could be any ocean plant or animal, I would be a(n) ______________ because ______________ (fill in). Illustrate.
2. If I lived in the abyss as an animal, I would (need, or not need) protective coloring because ________________.

List of Activities for this Lesson

▲ Salt on a Plant

▲ Fish Math

▲ Sea Creature Symmetry

ACTIVITY
Salt on a Plant

Objective

Students explain and/or draw the effect of salt water on a lettuce leaf and on a spinach leaf.

Materials

Book: **Wonders of the Sea** by L. Sabin

Crisp lettuce leaves; two jars with covers; tap water with salt added; labels; fresh water; pencil; clear plastic cups; salt; spinach leaves; teaspoons

Procedures

1. Mix two teaspoons of salt into two cups of water. Pour this water into a jar marked SALT WATER.
2. Fill the jar marked FRESH WATER with some tap water.
3. Choose lettuce leaves with stiff white centers. Place one leaf in the fresh water and another in the salt water. Cover each jar with its lid and let stand overnight.
4. The next day, remove each leaf and feel it.
5. Students describe the leaves and compare.

Fill three cups 3/4 full with water. Measure one tsp. salt and stir in one cup. Measure two tsp. salt and stir in second cup. Leave the third cup plain. Place a spinach leaf in each cup. In 20 minutes, observe the spinach.

Discuss results: What happened to the spinach after 20 minutes? (Stayed firm in fresh water, and mushy or mushier in salt water.) What does this suggest? (Some plants and animals live better in salty water; others do not.)

ACTIVITY
Fish Math

Materials
Sheet of paper and pencil for each student
Place value chart
Box of fish crackers

Part 1

Objective
Students separate a set into groups of 10s and ones.

1. Students guess how many fish they can draw in a minute with their right hand. The "drawing" of the fish can simply be an open "8" drawn horizontally.
2. Students draw as many fish as they can in one minute (by the clock).
3. Stop after a minute and count the fish drawn. How many groups of 10? How many ones left over?
4. Write the number of 10s and ones on a place value chart.
5. Students tell what the number is.
6. If someone draws more than 100 fish, the students suggest what needs to be done to the place value chart after they have 10 10s.
7. The students now draw the fish with their left hand. They repeat the activities as with the right hand. The students compare the difference in number of fish drawn by the two hands. They discuss why this might happen.

Part 2

Objective
Students explore the concept of division as continued subtraction by grouping by twos, threes, fives and 10s.

1. Give each student group a handful of fish crackers.
2. Student predict how many there are in a handful.
3. The students group them by twos, threes, fives and 10s. The students put the leftover fish in a container so they won't include them.
4. Tell students that this is one example of division — grouping the members of a set by a given number. When they were grouping by twos, they were dividing by twos; when they were grouping by threes, they were dividing by threes, and so on.
5. The students group the crackers by fours and make a statement. Ex. three groups of four fish is 12 fish.
6. The students decide why they had to put the leftover fish in a container. Why did they not count those fish? (There weren't enough of them to make a group of twos, or threes, fours, etc., depending on the number by which they are grouping the fish.)

ACTIVITY
Sea Creature Symmetry

Objective

In this activity the students explore the concept of symmetry and create sea creatures.

Materials

Sheet of paper folded along the longer side for each student
Soft lead pencil for each student group
Crayons

Procedures

1. Each student writes his/her name in large letters along the fold of the sheet of paper with the soft lead pencil
2. After writing the name, students darken the writing with the soft lead pencil.
3. Fold the paper again so the pencil marks are on the inside of the fold.
4. Press the paper on the reverse side so the name transfers to the other half of the paper.
5. Students color the resulting figure they like to show a sea creature.
6. Students discuss the concept of symmetry and sea creature characteristics.

Assessment

1. Why are there two eyes, two ears, two legs, two arms in humans?
2. Is the nose symmetrical?
3. How many lines of symmetry does a fish have? A human?
4. How many lines of symmetry does your sea creature have?

LESSON 6 *Plants and Animals of the Abyss*

BIG IDEAS Life abounds on the surface, in the thermocline and in the abyss. The largest mammals and the smallest one-celled protozoa and one-celled algae — all live in the ocean.

Whole Group Work

Materials

Reference books on ocean life — plants and animals
Microscope for each student group
Slides of pond water containing algae and amoebas

Encountering the Idea

Today, we will begin our lesson by looking at slides of very small plants and very small animals. These plants and animals are so small that we have to use a microscope to see them.

After the students have had an opportunity to look at the algae and other life forms on the slide, they make and record their observations in their journals. Discuss with them that although the animal and plant life they have been observing is from a fresh water pond, the life that we can see in a few drops of pond water is very similar to the microscopic life that exists in the ocean. We know that in order to survive, animals must have certain needs met. One need is food. All life needs food to survive. What do ocean plants and animals need to survive? Yes, they need food. Where do animals get their food? How do plants survive in the ocean? What do plants do on land to meet their food needs? (Pause for students to review needs — sunlight, carbon dioxide, water and minerals.) In today's activities we will discover how ocean plants and animal meet their survival needs.

Exploring the Idea

At the **Science Center**, students

1. complete **Activity** — Ocean Plants
2. complete **Activity** — Looking for Food in the Ocean
3. complete **Activity** — Ocean Life
4. complete **Activity** — Deep Sea Divers and Surface Swimmers
5. identify different living organisms found in the ocean and classify them as plants or animals, as shown below.

Materials

Magazines; scissors; glue; pencil; 11 x 14 construction paper

Procedures

1. Children look for pictures of ocean animals and plants in fishing magazines or reference books.

2. Cut out pictures or draw and illustrate if the pictures are in reference books.
3. Fold construction paper into two equal areas. Label the areas **animals** and **plants.**
4. The children glue pictures under the correct classification.
5. Children write the names of the animals or plants on the pictures.
6. The students look for ways the organisms have **adapted** to their environment.

Getting the Idea

All the food sources for both plants and animals on land come from plants. Plants use sunlight and chlorophyll to produce sugars and starch to use as foods. Animals eat plants for food, and some animals eat other animals as food. Thus, all our food energy, including that for humans, comes from plants. Where would you guess that the ocean produces food? Yes, plants also produce food for ocean life. In which of the eight zones we have studied, can plants grow? Only in those zones where sunlight can penetrate. Thus, plants can exist only on the surface waters or shallow marshes and ocean floors no deeper than several hundred feet, where light can penetrate.

Since all food develops on or very close to the surface waters, the amount of food produced by plants decreases with increasing water depth. Millions of animals as well as plant **plankton,** for example, inhabit the surface and mid-surface waters. The plankton serve as food for the smaller and larger fish and for mammals, such as the whales. Whales consume tons of the plankton to grow into their immense size and to exert the energy they do in swimming and hunting for prey. The larger fish are usually predators of the smaller ones. As the larger fish eat the smaller ones close to the surface, small leftover food particles drift downward into the lower depths. Animal life at these depths depends on the food that the surface swimmers leave over. In the abyss food is sparse and meals are infrequent.

Animal life, however, has adapted itself to the different environments in the ocean. For example, whales and walruses have large layers of fat to withstand the cold below-zero temperatures of the ocean depths. Others that live on the ocean floor have specialized bodies to withstand the water pressure — their bodies resemble jelly. They don't have strong swimming muscles and do not spend a lot of energy hunting their food. These dwellers of the abyss drift in the ocean currents waiting for the food to drift by. That food consists of dead animals and remnants or particles of food uneaten by the larger species and of feces of the surface dwellers. Thus, most deep-sea fishes have very large mouths, with large or specialized teeth, to take in large amounts of water that is they filter for food. Some animals use the low temperatures in the deep and a slow digestive rate to allow them to swallow fish that are longer than their own bodies. Others suck up mud from the ocean floor and sift it for particles of food. Life in the abyss is, indeed, harsh.

Applying the Idea

Do **Activity** — Seafood Math

At the **Writing Center**, each student group selects an ocean creature: octopus, jelly fish or sting ray. The students write a five to six sentence paragraph describing the creature and justifying why its body is gelatinous.

Closure and Assessment

Summarize the characteristics of the ocean mammals, fish and plants.

Oral Interviews

1. What is an ocean mammal? Name one ocean mammal.
2. What is a fish? Name one saltwater fish.
3. What is an ocean plant? Can an ocean plant make its own food through photosynthesis? Explain.
4. Can you name a plant that lives in sea water? (Sea weed, kelp)
5. Are there any plants in the ocean abyss? Why? Or why not?

Performance Assessment

Using pictures, students classify ocean mammals, fish and ocean plants.

Written

1. Write a brief description of a favorite living thing in the ocean.
2. List the characteristics of the ocean mammals.
3. At the **Writing Center**, the students describe and illustrate coral and say whether it is a plant or animal. They justify their answers.

List of Activities for this Lesson

- ▲ Ocean Life
- ▲ Deep Sea Divers and Surface Swimmers
- ▲ Ocean Plants
- ▲ Seafood Math
- ▲ Looking for Food in the Ocean

ACTIVITY
Ocean Life

Objective

The student describes and/or illustrates at least three different types of animals and at least two plants that live in the ocean.

Materials

Reference books on ocean life
Blank copy of the chart on ocean life for each student
Paper, markers and crayons for students to illustrate pictures

Procedures

1. Students use reference books and other books to locate examples of the various animals and plants listed in the chart below.
2. Students make illustrations in the various sections of a blank copy of the chart.

OCEAN LIFE

Migrating Fishes Migrate from fresh water to salt water or from salt water to fresh water to breed. Ex. carps, river eels, trouts	**Mollusks** Have soft one-segment bodies covered by a hard shell in one, 2, or 3 layers. Ex. oysters, clams, squids	**Other Aquatic Animals** Ex. frogs, turtles, coral
Marine Fishes Live in the ocean only. Ex. cods, haddocks, basses, sardines, tunas, sharks	**Aquatic Mammals** Mammals that live in the ocean. Ex. blue whales, porpoises, seals, walruses	**Aquatic Plants** Ex. brown seaweed, red seaweed
Crustaceans Have a hard shell. Ex. crabs, lobsters, krill, plankton crustaceans	**Sea Birds** In flight can snatch food, from surface; skip across the surface while snatching or catching prey; swim or dive to catch prey; dive into the water to pursue prey for some distance. Ex. skuas, petrels, penguins, pelicans, terns	

[1] Birds are included in the chart because they live off ocean food resources

ACTIVITY

Deep Sea Divers and Surface Swimmers

Objective

Students describe how sea animals have adapted to being either deep sea divers and dwellers, or surface swimmers.

Materials

Reference books on the ocean
Pictures of scuba divers and their equipment
Pictures of human deep sea divers, diving bells and other equipment used in deep sea diving
Pictures of sea creatures that live on or close to the surface
Pictures of sea creatures that live in mid-depths of the sea and in the abyss

Procedure

1. After studying pictures of the divers, students describe and make a list on one side of a sheet of paper of the conditions deep-sea divers must plan for before going on a dive. (No light; near or below freezing temperature; water pressure of many pounds per square inch pressing on the body, if not protected; possible attack by Mako sharks.)
2. The students make a list on the other side of the sheet of paper of how the divers prepare to go into the deep. (Lights on top of their headgear; thermal wet suits; pressurized suits to withstand the water pressure; oxygen tanks.)
3. If the divers are going to great depths where the human body cannot withstand the pressure, even with pressurized suits, the divers go in diving bells, similar to navy submarines, that are especially constructed to withstand the water pressure.
4. The students compare and contrast deep-sea diving with scuba diving. How are the conditions alik? How are they different? The students make observations about the scuba divers and their equipment. (Have light near the surface; temperature is close to that of the shore and in the tropics can even be warm; don't need special suits. If they go deeper, divers may need oxygen tanks to stay underwater for a long time.)
5. Student groups design (show how it has adapted to the conditions of the surface, thermocline or the abyss) and illustrate an animal of the group's choice — fish, mammal or amphibian (can live in the water and on land) — either a **deep-sea diver** or a **surface swimmer.**
6. Students display their Aquatic Animals on the bulletin board.

ACTIVITY
Ocean Plants

Prior Preparation: Bring in two like plants at the beginning of the unit. Ask the students to place one of the plants in a window. They place the second plant in a closet, or other place where it will get not light. At appropriate times, the students water both plants at the same time and with the same amount of water.

Objective
The students describe the conditions that must occur for plants to exist and produce their own food.

Materials
The two plants for students to observe and describe
Chart describing the conditions that exist in the various ocean environments.

Procedures
1. Students review plant needs. (1. carbon dioxide, 2. water, 3. chlorophyll that the plant itself produces, 4. and solar energy required for the process of photosynthesis to produce sugar and other carbohydrates.)
2. What conditions are met in each of the ocean zones with different temperature, pressure and light conditions?
3. Where can plants survive?
4. Name some ocean plants and describe what they look like and where they live.
5. Design and illustrate your own plant. Display it on the bulletin board.

Note: All plant needs are met on the surface or close to the surface of the ocean. For example, water conditions are met: carbon dioxide is available, dissolved in the ocean water; solar energy is available up to the depth of the thermocline, since there is no light past a few hundred feet in ocean depth. Thus, at the surface and close to it, there is abundant plant and animal life. At depths greater than 700 feet, where light does not penetrate, there is no plant life. Animal life does, however, exist because the animals have adapted to those conditions.

On the surface and close to the surface, water temperature varies as the surrounding air temperature varies. Thus, plant and animal life lives within the temperature range from slightly below freezing at the poles and in the abyss, up to the warm tropical waters of the equator.

Plant life cannot survive where there is no light; consequently, plants do not have to adapt to the great water pressures of the abyss.

ACTIVITY

Seafood Math

Objective

Students summarize on a bar graph information that they gather by counting; students compare numbers (cost) by using play money, place value charts or any other strategies they suggest.

Materials

Tuna in water; salmon; shrimp; crackers; paper plates; napkins

Procedure

1. Each student receives a small portion of three types of seafood on a cracker — tuna, salmon, shrimp.
2. After tasting a small sample of each, each student indicates a preference for one.
3. The students count the number of votes for each type and graph results on a bar graph.
4. The students read the graph and list everything they can read from the graph, for example: Which seafood do we like the most? Which do we like the least? What was the difference between the most- and the least-liked? Between the most-liked and the "medium"-liked? Between the least-liked and the "medium"-liked?
5. Students compare the cost of each of the cans of seafood.
6. Students work in groups to make this comparison. Students read the price or are told the price for each can. After they have begun to work, and if they have not yet noted it, they need to consider the weight of the contents of the cans in order to compare the prices.
7. Students discuss what they need in order to compare costs. We can't compare two numbers — the costs — if the cans are not the same size or if they don't have the same weight. (The students could also discuss that the two cans could have the same cost but different weight.)
8. The students discuss the strategy they used to find the cost of one ounce.
9. Students discuss what "unit pricing" means.

Cost of Seafood

Seafood	Cost	Weight	Cost per ounce Unit price
Tuna		8 ounces	

ACTIVITY
Looking for Food in the Ocean: Part 1

Objective

Students explain what a food web is and describe the ocean food web by making a whole group illustrated dictionary of important classes of aquatic life and their place in the food web.

Materials

Copy of a blank ocean food chart for each student

List of classes of aquatic life to begin the students' search: bacteria, plant plankton, animal plankton, sea cucumbers, crustaceans, mollusks, starfish; octopus; dolphins, whales, walruses, tuna, squid, glass sponge, tripod fish, turtles, any others they find and wish to include

Reference books for students to look at pictures of the various organisms that live in the sea and to read about the ocean food chain

Procedures

1. Students read about the various fish listed above and develop a food chain or web.
2. The students note that some of these animals live on the surface and can also be eaten by aquatic birds, thus being a part of a food web that includes creatures that do not live in the sea or in the water.
3. Students make a food web showing aquatic plants as the basis for the web. Without plants to make food, no life would be in the ocean. The students show, in a manner similar to Chart 2, the plankton, and other life that serves as food for the other species.
4. Point out that plankton are both plants and animals living and surviving together as a group. Individual members of the plankton may vary in size from microscopic to very large. Jellyfish can be up to one meter wide with tentacles extending over three meters. Plant plankton are microscopic and appear in such vast quantities that the ocean can appear green.

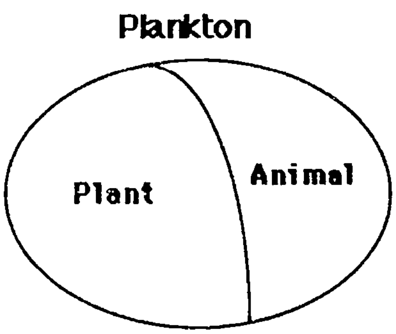
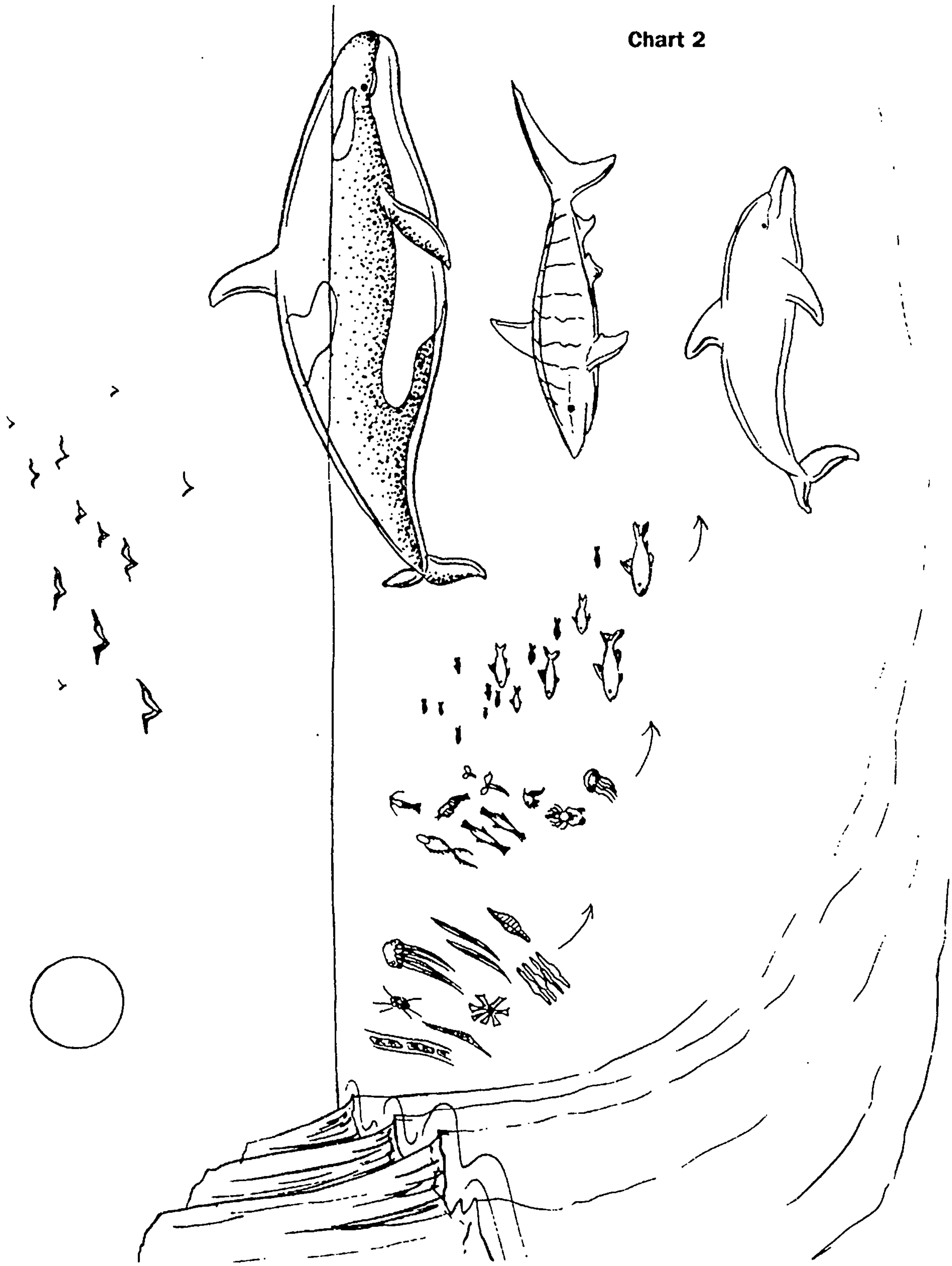


Chart 1

5. The main consumers of plant plankton are microscopic animals. The microscopic animals are the food of larger animals, such as whales, that consume vast quantities of the smaller animals. Thus, the Ocean Food Web is established.

▲ ACTIVITY
Looking for Food in the Ocean: Part 2



LESSON 7 Oceans and Industries

BIG IDEAS The oceans are important sources of food, employment, and recreation.

Whole Group Work

Materials

Book: **I Can Be an Oceanographer** by P.P. Sipiera, **A First Look at Seashells** by M.E. Selsam and J. Hunt and other shell books

Butcher paper; canned tuna; canned salmon; rulers; canned shrimp; string; crackers; napkins; large collection of various seashells

Cards with name, pictures and length (in feet) of several sharks and whales

Encountering the Idea

The lesson begins in a whole class activity.

The ocean is a source of many things that are important to us. Oceans provide us with food, different jobs and even recreation. Let's begin today with a book that describes some of the careers you could choose that deal with the ocean. Read **I Can Be an Oceanographer.**

Let's list other different things we could do in and near the ocean. Solicit student responses. Include: snorkling, scuba diving, traveling on a cruise ship, deep sea fishing, sailing, sail boating, swimming, beach combing, sand castle building, surfing, agate collecting, clamming, crabbing.

Exploring the Idea

1. Before they go to the learning centers, in a whole class activity, the students take two surveys related to seafood as an important food for humans:
   - Do you like seafood? three categories: **Yes, No, A Little** The students count and record the number of people voting in the three categories.
   - How many times a week do you eat seafood? (Students can check at home for responses to this question and can include parents and others in the family.) After the students have collected the responses, they take them to the **Mathematics Center** to summarize and graph. The students select the type of graph they are to employ
     - pictograph, bar graph, or circular graph, etc.
2. **Activity** — Seashell Math, as below.

Materials

Collection of various shells (enough for four for each group)

A First Look at Seashells; Shell by A. Arthur; **Discovering Seashells** by D. Florian

Pictures of various recreational activities in and out of the water placed on display

Various books related to shells

Procedure

Read **A First Look at Seashells.** Students describe four shells by shape, size, pattern, type of animal body (soft, jelly-like, like an oyster) and other characteristics. Students separate the shells into univalve or bivalve shells. Students list the characteristics that made them choose a certain category. Students may use books to verify their choices.

Getting the Idea

1. Each child names a water sport she/he would like to participate in and discusses and names ways to spend leisure time at the ocean.
2. How many of you collect something? Solicit responses. Well, there are many fun and enjoyable things to do at the ocean; for example, we can collect seashells.

Organizing the Idea

1. On a chart list all the sea and ocean products the students can think of, such as food products like tuna, salmon, scallops, shrimp, oysters, clams, etc. List students' responses under "Food".
2. There are other ocean products such as salt, minerals, oil, pearls, diamonds, animal feed and fertilizer. For each of these resources an industry or a business has developed. Ask the students to read about industries connected with the ocean — fishing, mining salt and minerals, drilling for oil, diving for precious stones and precious metals, developing food for animals and fertilizer for plants.
3. Students list some of the jobs they read about in the story **I Can Be an Oceanographer.** Solicit responses — put on board under "Employment". Oceanographer, marine biologist, marine geologist, meteorologist who is a weather scientist. What other jobs can you think of? (Fishermen, shipping, cruises, resorts on shore, oil rigs.)

At the **Art Center**, the students

1. design and complete a display on various recreational activities that are related to or are part of the ocean.
2. include various recreational industries in their mural illustrations as they continue with **Activity** — Ocean Mural.

Applying the Idea

Do **Activity** — Measuring Sharks and Whales.

Closure and Assessment

Oral Assessment

Name two resources from the ocean.
Name three recreation activities.
What is your favorite water sport, and why is it your favorite?

Performance Assessment

Students draw a scene of a beach with sand. Students pretend they are going to the beach. They draw on the picture what they would do and what they would find.

Written Assessment

Students can:

Briefly write about an ocean career they might enjoy.

Write an advertisement fcr their favorite ocean activity.

List of Activities for this Lesson

▲ Ocean Mural (continuation)

▲ Measuring Sharks and Whales

ACTIVITY

Measuring Sharks and Whales

Objective

Student do something that marine biologists might do.

Materials

For each student group:
Rulers (ft.)
String
Display or cards with name, picture and length of several different kinds of sharks and whales

Procedures

1. From the information cards, the students select the shortest animal, the longest and the one in the middle.
2. Working in groups of three, students measure with string the length of the three sharks and/or whales.
3. Each student takes turns comparing his/her own the length with the length of each one of the whales or sharks, using any type of comparison they wish. (Ex. twice as long, 1/2 the length, or the same length, 10 inches longer, etc.).
4. Students compare their results and say why they selected a certain method of comparison and say what mathematical operation they used.

	Maria	Griselda	Jerry
Mako Shark			
White Whale			
Blue Whale			

LESSON 8 Oceans and Pollution

BIG IDEAS The oceans are in danger of increased pollution; we can protect them through awareness and laws.

Whole Group Work

Materials

Book: **Jack, the Seal and the Sea** by G. Aschenbrenner, **Sea Squares** by J.N. Hulme, **The Dying Sea** by M. Bright and **Polluting the Sea** by T. Hare

Resource to use: **50 Simple Things Kids Can Do to Save the Earth** by The Earth Works Group

Fish-shaped cheese crackers

Containers

Paper towels

Newspaper clippings on reports of oil spills and industrial and recreational pollution

Encountering the Idea

Children read newspaper clippings that report oil spills and industrial and recreational pollution. Assign each group of three or four students one article. Each group reports to the class about their article. The students propose and discuss suggestions to protect the ocean environment.

We have studied about the wonderful resources and food the ocean provides for us. What will happen if we don't take care of the ocean? Let's find out some things that harm our ocean and what the results can be. Read one of the suggested books.

Exploring the Idea

Use **The Dying Sea** and **Polluting the Sea** as references for the students to become aware of the conditions that cause pollution.

Play a game — Did You Know?

- 26,000 tons of plastic packaging are dumped at sea each year
- 690,000 plastic containers are dumped by the world's ships everyday.
- 3,000 miles of nylon drift nets are set each night
- 6 miles of fishing net are lost each night
- Everything we dump on land can eventually reach the ocean
- About 1/4 of all waste water is dumped into the ocean

At the **Art Center**, students draw a picture of how they think the sea will look in the future if this trend does not stop.

At the **Social Studies Center**, the students report on their newspaper articles and make a list of suggestions on a poster. Display the poster in and outside the classroom, in the hall.

Getting and Organizing the Idea

1. Students make a list of things that are threatening our oceans under the heading — **OUR OCEAN IS DYING BECAUSE** List can include: disposal of toxic chemicals and garbage; overfishing; dredging; tourism (touching coral reefs); oil spills and disposal (car oil, for example, by ordinary citizens); disposal of sewage into rivers and oceans; industrial pollution.
2. As the students can see, humans behave in many ways that are harmful to the ocean. Let's see if we can think of some solutions. For each item listed above, the groups suggest different solutions. For example: Where will the garbage go? What will we do about the waste products from industry?
   Resource to use: **50 Simple Things Kids Can Do To Save the Earth.**
   - Don't throw litter on the beach.
   - When you visit the beach, take along a garbage bag to pick up trash.
   - Recycle plastics, glass, paper and aluminum; don't leave them on the beach.
   - Never throw fishing line into the ocean.
   - Cut up plastic container rings and dispose of them properly.
   - Take used oil to a recycling center. Don't pour it down the drain or in the gutter.

Applying the Idea

1. Students complete **Activity** — Ocean Multiplication.
2. Separate the class into four groups — The City Council, The Conservationists, B.I.G. Industrial Council, and the Citizens.

The conservationists (Blue Ocean) go to the city council to complain that B.I.G. Industry is dumping its wastes into the ocean, killing the fish, seals and plants. The council passes a law that prohibits B.I.G.I. from dumping in the ocean. B.I.G.I. protests because the corporation will lose money if they have to take the waste somewhere to dispose of it. The industry will close and there will be fewer jobs. What should the citizens and the council do?

Closure and Assessment

Provide each group with a newspaper clipping related to ocean pollution. Students also have available the list of suggestions they made to protect the ocean environment.

Oral interviews

1. Name three forms of pollution.
2. What will be the result of our actions if we don't stop polluting the ocean and begin to clean it up?
3. Name one thing each person can do to help 1) stop pollution , and 2) clean up what has already been contaminated.

Performance Assessment

1. Draw a poster and list problems of and solutions to ocean pollution.
2. Make up a law to prevent ocean pollution and/or to clean up what has already been contaminated. Defend your law to your partner and/or to your teacher.

Written Assessment

1. Suppose you are a fish living in a polluted ocean. Describe your surroundings and how you feel. Illustrate what you see and how you feel.
2. Write a poem about a dying fish, seal or plant.

List of Activities for this Lesson

▲ Ocean Multiplication

▲ ACTIVITY
Ocean Multiplication

Objective

The students develop a notion of multiplication as continued addition by 1) using a chart that shows a rate as partial sums and the product, and by 2) using an array that is a set of objects arranged in rows and columns.

Materials

For each student pair or student group: set of problems, paper and pencil to draw chart and counters to make arrays

An ocean current travels at the speed of six miles every hour. How far will the current carry garbage that was dumped in it, if the garbage travels at that same speed for five hours?

Procedures

The students work in groups to solve the first problem. They report their results and the strategies they used. If the groups do not suggest the following strategies, present the strategies as additional ones that students can use.

1. Summarize the results by using a chart to show the partial sums each hour until the problem is solved.

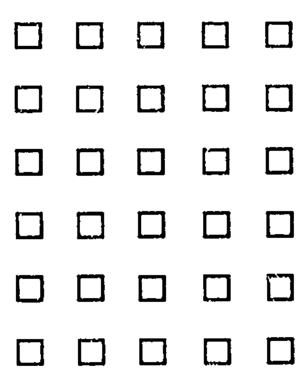
Distance Traveled Each Hour

One Hour	2 Hours	3 Hours	4 Hours	5 Hours	6 Hours

2. Give the students the second problem to solve.

A ship is losing fuel into the ocean at the rate of five tons each time it makes a round trip to its first assignment. How many tons will it lose in six trips?

Instead of using a chart the students draw an array to show the five tons used each trip for six trips. For example, each square represents a ton.



3. Students continue making arrays or using their own strategies to solve a variety of problems.

   One sea creature has four rows of teeth. How many teeth does the creature have if each row has 15 teeth?

   A coral (animal) secretes an external skeleton of limestone at the rate of about 1/2 inch per year. How long will it take the coral to grow to the length of two feet?

This problem lends itself to the use of a chart (since the English measure is a fraction) and to finding a pattern to use so the chart does not have to be large.

4. Students discuss the strategy their group used to solve the problem. The students write number sentences representing the solution to each problem, above.

   Ex. 6 + 6 + 6 + 6 + 6 = 30

5. The students rewrite each addition sentence as a multiplication sentence and practice reading it.

   Ex. 5 X 6 = 30

6. Students write in their journals a rule about when to use multiplication.
7. Students continue to solve problems written by second grade students in another school. They describe and discuss the strategies they used to get the answers.

   One monster shark can destroy seven boats in one day. How many boats can the monster destroy in one day, if it works twice as hard for that day?

   My sea creatures can migrate five times farther than sharks. If a shark migrated 800 miles in one week, how far did my sea creature migrate in one week?

UNIT ASSESSMENT

Oral Assessment

1. Using the ocean mural, the students answer the following questions:
   A. What animals live at the bottom of the ocean?
   B. What are some of the things you notice about ocean plants?
2. What causes the tides?
3. Name an ocean mammal.
4. What are the different layers on the ocean floor? Describe them.
5. Explain verbally (and the student may include illustrations) the effects of the moon's gravity on low and high tides.

Performance Assessment

1. On the ocean mural, students place pictures of plants and animals in their appropriate places.
2. Illustrate a high tide and a low tide.

Written Assessment

1. Write a short story about the ocean mural.
2. List the major characteristics of ocean mammals, fish and plants.
3. Write a short paragraph about what the beach would be like after a high tide recedes.
4. Write about a plan to prevent ocean pollution.
5. List ocean resources.
6. Write and illustrate a story about a water sport.

References

Annotated Children's Books

Arthur, A. (1989). *Eyewitness Books: Shell.* New York: Alfred A. Knopf.
Photographs and text examine different types of shells focusing on such aspects as how shells camouflage themselves and how they may be collected.

Aschenbrenner, G. A. (1988). *Jack, the seal, and the sea.* Englewood Cliffs, NJ: Silver Burdett Press.
Heartfelt story of a man who, after finding an ailing seal, can no longer ignore the sorry state of the world's seas.

Barrett, N. (1991). *Monsters of the deep.* (Picture Library). New York: Franklin Watts.
A look at predatory marine animals such as sharks, jellyfish, and octopi.

Bender, L. (1989). *First sight: Creatures of the deep.* New York: Gloucester Press.
Describes the strange and wonderful animals that inhabit the turlight world of the oceans' depths, including the viper fish, lantern fish, and the worm.

Bender, L. (1989). *First sight: Life on a coral reef.* New York: Gloucester Press.
Describes different kinds of coral and the various array of animals that inhabit coral reefs.

Bennett, D. (1989). *Water.* New York: Bantam Books.
Explains water and its uses. Colorful illustrations. Contains a review of facts.

Bombard, A. (1957). *Dr. Bombard goes to sea.* New York: Vanguard Press.
This book is a true story about how a person can survive at sea. Large illustrations of blue and white color. Higher level of interest for children.

Branwell. (1987). *The oceans.* New York: Franklin Watts.
Describes and explores various aspects of the ocean including currents, tides, ocean life, and ocean resources.

Bright, M. (1988). *The dying sea.* New York: Gloucester Press.
Examines various factors threatening our oceans including overfishing, dredging, and industrial pollutions.

Burton, M. (1970). *Los habitantes del mar.* Weidenfeld and Nicolson (Educational) Ltd. Ediciones Anaya, SA.
Da la historia de la exploración del mar. Describe plantas y animales que viven en el mar. Incluye un glosario para el segundo a tercer grado.

Burton, M. J. (1978). The Color Nature Library: *Sea life.* Westminister, MD: Crescent Books.
Color photographs of the hidden world of animals of the sea.

Coatsworth, E. (1960). *Lonely Maria.* New York: Pantheon Books.
Maria finds a way to entertain herself on a small island in the west Indies. She draws sand figures. This is a good story to discuss the tides.

Cole, J. (1992). *The magic school bus on the ocean floor.* New York: Scholastic.

Cole, S. (1985). *When the tide is low.* New York: Lothrop, Lee and Shepard Books.
This book is about the high and low tides of the ocean. Animals found on the beach after the tide receeds.

Croser, N., Sherwood. (1989). *Help.* Milwaukee: Gareth Stevens.
When Elephant, Lion, Monkey, and Beaver are shipwrecked on an island, each animal thinks he has the solution to being rescued.

Demi. (1991). *Find Demi's sea creatures: An aninal game book.* New York: Putnam & Grosset.
A game book introducing various sea creatures which must be located in the illustrations.

Domanska, J. (1971). *If all the seas were one sea.* New York: The Macmillan Company.
The illustrations are etchings. The volume contains very little printed text.

Editores, S.A. (1979). *Sinbad el marino.* Miami, FL: DDL Book, Inc.
Large, colorful illustrations. This book is about Sinbad's voyages. Great for reading enjoyment.

Editorial Molino. (1971). Mi Primera Biblioteca Básica. *Bajo el mar.* Barcelona: Author
Describe el mar a diferentes profundidades.

Editorial Molino. (1971). Mi Primera Biblioteca Básica. *El agua.* Barcelona: Author.
Explica como el agua de los mares se puede utilizar para el uso humano.

Editorial Molino. (1971). Mi Primera Biblioteca Básica. *Junto al mar.* Barcelona: Author.
Describe el mar y los animales que habitan las diferentes partes del mar.

Farber, N., & Livingston, M. C. (1987). *These small stones.* New York: Harper & Row, Publishers.
Poems about a snail, a crab, and beach stones.

Florian, D. (1986). *Discovering seashells.* New York: Charles Scribner's Sons.
An introduction to various kinds of seashells, where they can be found, and their inhabitants.

Gordon, S. (1985). *Now I know: Dolphins and porpoises.* Mahwah, NJ: Troll Associates.
The book is beautifully illustrated and easy to read. Children can read it independently.

Hare, T. (1991). *Save our earth: Polluting the sea.* New York: Gloucester Press.

Examines the benefits we reap from the oceans and the damage that oil spills, metal poisoning, and sewage dumping cause.

Hulme, J. N. (1991). *Sea squares*. New York: Walt Disney Book Publishing Group.

Rhyming text and illustrations of such sea animals as whales, gulls, clownfish, and seas provide opportunities to practice counting and squaring numbers from one to ten.

Javna, J. (1990). *50 simple things kids can do to save the earth*. New York: Andrews and McMeel.

Ideas for students to help save the earth including energy, animals, pollution, and recycling.

Lauber, P. (1991). *Great whales: The gentle giants*. New York: Henry Holt and Company.

This book has color illustrations along with black and white photographs. This book on whales includes a table of contents and an index. Children and teacher references.

Leonard, R., & Briscol, W. S. (1964). *Skipper the dolphin*. San Fransisco: Harr Wagner Publishing.

Short novel about a dolphin and its adventures with various illustrations.

Lionni, L. (1963). *Swimmy*. New York: Pantheon.

A little fish discovers a solution to the problem of big fish eating up his fellow fish.

MacDonald, G. (1946). *The little island*. Garden City, NY: Doubleday and Company.

Life on an island reveals how the earth is one piece of land under the sea.

Marshak, S. (1991). *I am the ocean*. New York: Arcade Publishing.

O'Neill, M. (1961). *Hailstones and halibut bones: Adventures in color*. Garden City, NJ: Doubleday & Company.

Large, colorful illustrations. Poems dealing with colors. Metaphors and similies.

Parker, S. (1990). *Eyewitness Books: Fish*. New York: Alfred A. Knopf.

A photo essay about the natural world of fish and their importance in human life.

Podendorf, I. (1982). *A new true book: Animals of sea and shore*. Chicago: Childrens Press.

Introduces creatures that inhabit the sea and shore. Animals with fur or shells, fins or legs, spiny skins or soft bodies.

Porter, K. (1986). *Life in the water*. The Animal Kingdom. New York: Schoolhouse Press.

Describes the various forms of animal life found in water and their characteristics.

Sabin, L. (1982). *Wonders of the sea*. Mahwah, NJ: Trolle Associates.

Selsam, M. E., & Hunt, J. (1983). *A first look at seashells*. New York: Walker and Company.

An introduction to seashells, explaining how they are classified and describes the differences that distinguish one shell from another.

Siberell, A. (1985). *Whale in the sky*. New York: E. P. Dutton.

This book is an Indian legend. Easy to read. Explains what Indians used to make totem poles.

Sipiera, P. P. (1987). *I can be an oceanographer*. Chicago: Children's Press.

Discusses the work oceanographers do as they study the ocean's depth.

Steele, P. (1986). *Life in the sea. Do you know about?* New York: Warwick Press.

A description of some of the animals found in the ocean and how they live.

Storin, D. (1980). *Oceans*. Columbus, OH: Xerox Education Publications.

Describes the ocean as a limited natural resource. Background knowledge to help citizens make sound decisions about the use of the oceans. Includes questions at the end of each chapter.

Waber, B. (1975). *I was all thumbs*. Boston: Houghton Mifflin Company.

Large illustrations about an octopus and its adventures.

Wheeler, A. C. (1988). *Discovering saltwater fish*. New York: Bookwright Press.

Describes and illustrates various saltwater fish.

Teacher References

Aschenbrenner, G. A. (1988). *Jack the seal and the sea*. Englewood Cliffs, NJ: Silver Burdett Press.

Morris, R. (1983). *Mysteries & Marvels of ocean life*. London: Usborne Publishing.

Nayer, J. (1992). *At your fingertip: Sea creatures*. McClanahan Books.

Oceans. Learning Center Catalog - 3rd grade. 1-800-334-0298

Oceans, Rocks, and Endangered Animals. (FS-7046)

Oceans. Thematic Units (Grades 2-3) (A Primary Whole Language Theme Unit). Instructional Fair.

Oceans. Thematic Unit (Intermediate). Westminister, CA: Teacher Created Materials, Inc.

Ranger Rick. Washington, D. C: National Wildlife Federation.

Reading Rainbow.

Tayntor, E., Erickson, P. A., & Kaufman, L. (1986). *Dive to the Coral Reefs: A New England acquarium book*. New York: Crown Publishers.

General References

Angell, M. (1976). *The fantastic variety of marine animals.* New York: The Bobbs-Merrill Company.
Uses a question and answer format to introduce animals that live in the sea.

Carter, K. J. (1982). *A new true book: Oceans.* Chicago: Childrens Press.
An introduction to the world's four largest bodies of salt water: the Atlantic, Pacific, Artic and Indian Oceans.

Craig, J. (1982). *Now I know: What's under the ocean.* Mahwah, NJ: Troll Associates.
Brief text and pictures introduce some animals and plants that live in the ocean.

Curran, E. (1985). *Life in the sea.* Mahwah, NJ: Troll Associates.
Introduces some of the animals and fishes that live in the ocean.

Lambert, D. (1984). *The oceans.* New York: The Bookwright Press.
Examines the ocean, waves, currents, and tides, and man and the ocean.

Lambert, D. (1988). *Our world: Seas and oceans.* Morristown, NJ: Silver Burdett Press.
Examine the world's oceans, their physical features, movements, plants and animal life, and relationship with humanity.

Lauber, P. (1991). *Great whales: The gentle giants.* New York: Henry Holt and Company.
Describes the characteristics and behaviors of different kinds of whales and discusses why they are threatened by extinction.

Martin, L. (1988). *The wildlife in danger series: Whales.* Vero Beach, FL: Rourke Enterprises.
Describes the 12 species of whales, threats to their existence and efforts of the World Wildlife Fund to save whales from extinction.

Russell, S. P. (1982). *What's under the sea?* Nashville: Abingdon.
Examines characteristics of the ocean, including the currents, tides, floor, and plant and animal life.

Schulz, C. M. (1980). *Snoopy's facts and fun book about seashores.* New York: Random House.
Snoopy and his friends explore many different things one can observe and do at the seashore.

Shale, D., & Coldrey, J. (1987). *The world of a jellyfish.* Milwaukee: Gareth Stevens.
Text and illustrations describe the physical characteristics, habits, and natural environment of the jellyfish.

Waters, J. F. (1979). *A jellyfish is not a fish.* New York: Thomas Y. Crowell.
Describes the general characteristics and functions of a variety of jellyfish with emphasis on the ones to avoid.

unit

2 Weather

Prior Knowledge

The student has

1. described evaporation, condensation
2. listed and described three forms of water
3. described the earth's rotation on its axis
4. grouped objects by a given single-digit number
5. counted and constructed sets to 100 and skip-counted by fives and 10s
6. placed two-digit numbers correctly on a place value chart and ordered them
7. measured lines.

Mathematics, Science and Language Objectives

Mathematics

The student will

1. use numbers through 1000
2. skip-count by fives, 10s and 100s
3. write and order two- and three-digit numbers
4. draw a chart to describe a rate such as miles per hour
5. use fractional parts of a set or unit to describe a part of a set or unit
6. convert a rate given in fractions to an equivalent rate, such as 1/2 inch per hour to one inch in two hours
7. use addition/subtraction and/or grouping by a base to solve problems related to time, distance and volume
8. use appropriate geometric terms to describe objects
9. estimate linear measurements in blocks, feet, yards and miles
10. read and interpret instrument scales
11. measure time, distance and temperature.

Science

The student will

1. list the activity of the sun and the rotation of the earth as major causes of weather
2. describe the earth's atmosphere
3. describe the effects of the sun's heat on land and water on the weather
4. list, describe and give causes for the seasons
5. list and describe the benefits of "good" weather
6. list and describe the disasters caused by "foul" weather
7. list and describe the various types of clouds and the types of precipitation they cause

8. describe different forms of precipitation such as fog, drizzle, ice crystals, snow, hale, dew and sleet
9. describe different forms of air movement such as wind, tornadoes and hurricanes
10. describe the cause of air currents, wind and high winds
11. find the dew point at a given time and location
12. find the relative humidity of a given location at a given time
13. describe weather forecasting.

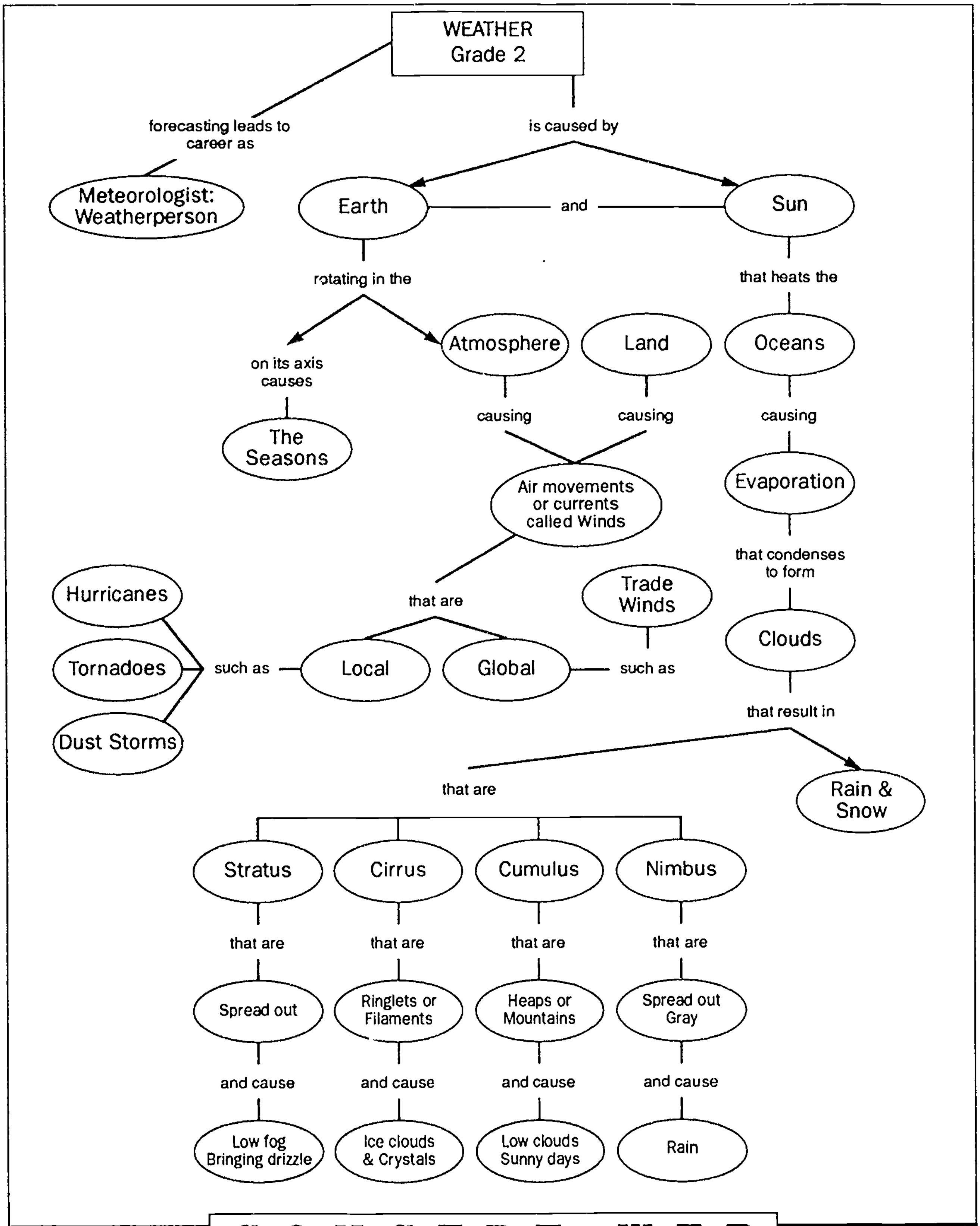
Language

The student will

1. engage in dialogue/discussion
2. engage in observation activities/demonstration
3. record observations about unit activities in a journal
4. identify the main idea of a paragraph
5. create stories using theme-related vocabulary
6. use description to narrate events
7. write complete sentences
8. give reasons to persuade
9. organize information/data
10. use appropriate mathematical expressions and quantities to describe.

VOCABULARY

weather el tiempo	wind viento	hail granizo	direction dirección	it is warm (cold) hace calor (frío)
distance distancia	cloud (s) nube (s)	rain lluvia	sunny soleado	dust polvo
cloudy nublado	dark obscuro	low bajo (a)	fog neblina	snow nieve
tornado tornado	earthquake terremoto	hurricane huracán	drizzle llovizna	snowflake copo de nieve, pluma
thermometer termómetro	block (city) cuadra	atmosphere atmósfera	current corriente	weather wave or wind sock veleta
time tiempo				


WEATHER
Grade 2
forecasting leads to career as
Meteorologist: Weatherperson
is caused by
Earth
and
Sun
rotating in the
on its axis causes
The Seasons
Atmosphere
Land
that heats the
Oceans
causing
causing
causing
Air movements or currents called Winds
Evaporation
that condenses to form
Clouds
that are
Local
Global
such as
Hurricanes
Tornadoes
Dust Storms
such as
Trade Winds
that result in
Rain & Snow
that are
Stratus
Cirrus
Cumulus
Nimbus
that are
Spread out
Ringlets or Filaments
Heaps or Mountains
Spread out Gray
and cause
Low fog Bringing drizzle
Ice clouds & Crystals
Low clouds Sunny days
Rain

CONCEPT WEB

Teacher Background Information ● ● ●

The weather is so important that it is a topic of daily conversation everywhere on earth. The weather affects every single person on a 24-hour basis. The amount of food available for humans to eat around the planet depends on the weather, as do the types of food we eat, the types of houses we live in, the kinds of clothes we wear, the kinds of jobs we have, the ways we find recreation, and the weather even affects our moods, whether we feel good, sad, and so on. The trouble with the weather, however, is that no one can do anything about it. Science and technology help us **forecast** the weather, but that is not the same as doing something about it.

In this unit the students will find out in more specific terms about the types of weather all of us have experienced. They draw on these experiences by performing the activities that help them understand what causes clouds and rain, wind and snow and, generally, the seasons. They understand the role that the sun and the earth play in causing the weather. As they develop these understandings they will be able to discuss among themselves and with others, using appropriate terms and quantifiers, the causes of particular types of weather.

The suggested activities require that students participate in whole- or small-group activities that focus on simulations of certain conditions (physical phenomena). Although complex, these atmospheric conditions can become understandable through the use of appropriate analogues. The students will make charts to describe current weather conditions and then try their hands at forecasting the weather on the basis of what they have learned.

It is strongly recommended that students have the opportunity to watch taped segments of the **Weather Channel** on cable television. They can keep track of the forecasts for one to two weeks, make judgments about the accuracy of these reports and use them as a basis for their own forecasts.

LESSON FOCUS

■ LESSON 1

Today's Weather

BIG IDEAS

Weather affects the way we live, what we eat and wear and how we feel. We can describe weather conditions by using mathematics.

■ LESSON 2

What Makes Weather?

BIG IDEAS

The sun heating the earth and its atmosphere causes the weather. We feel weather as wind, heat or cold, and humidity in the form of rain, ice and snow.

■ LESSON 3

The Four Seasons

BIG IDEAS

The seasons develop from the angle of tilt of the earth's axis as the earth revolves in its path around the sun.

■ LESSON 4

Wind: Air in Motion

BIG IDEAS

Wind, tornadoes, cyclones and dust storms are all moving air, which exerts pressure as it moves.

■ LESSON 5

Clouds, Rain and Snow

BIG IDEAS

Clouds, rain and snow are all different forms of water vapor; the form of the precipitation depends on the temperature of the surrounding air.

■ LESSON 6

Nature's Light Show

BIG IDEAS

Huge exchanges of electrical charges produce lightning; rapidly expanding air produces thunder; we count the seconds between a flash and the clap of thunder to estimate the distance, in kilometers, of a thunderstorm.

■ LESSON 7

Weather Forecasting

BIG IDEAS

Would you like to be a weather forecaster? We base weather predictions on data that we have gathered over many days.

OBJECTIVE GRID

Lessons	1	2	3	4	5	6	7
Mathematics Objectives							
1. use numbers through 1000	•		•				•
2. skip-count by 5s, 10s and 100s	•		•		•	•	•
3. write and order 2- and 3-digit numbers	•		•		•	•	•
4. draw a chart to describe a rate such as miles per hour				•	•	•	•
5. use fractional parts of a set or unit to describe a part of a set or unit				•	•		•
6. convert a rate given in fractions to an equivalent rate, such as 1/2 inch per hour to one inch in 2 hours				•		•	•
7. use addition/subtraction and/or grouping by a base to solve problems related to time, distance and volume	•	•	•	•	•	•	•
8. use appropriate geometric terms to describe objects					•		•
9. estimate linear measurements in blocks, feet, yards and miles						•	•
10. read and interpret instrument scales	•		•	•	•	•	•
11. measure time, distance and temperature	•		•	•	•	•	•
Science Objectives							
1. list the activity of the sun and the rotation of the earth as major causes of weather			•				•
2. describe the earth's atmosphere	•	•	•				•
3. describe the effects of the sun's heat on land and water on the weather		•		•			•
4. list, describe and give causes for the seasons	•		•				•
5. list and describe the benefits of "good" weather	•			•	•		•
6. list and describe the disasters caused by "foul" weather	•			•	•		•
7. list and describe the various types of clouds and the types of precipitation they cause					•	•	•

Lessons	1	2	3	4	5	6	7
8. describe different forms of precipitation such as fog, drizzle, ice crystals, snow, hale, dew and sleet					•	•	•
9. describe different forms of air movement such as wind, tornadoes and hurricanes				•		•	•
10. describe the cause of air currents, wind and high winds		•		•			•
11. find the dew point at a given time and location					•		•
12. find the relative humidity of a given location at a given time					•		•
13. describe weather forecasting.	•						•
Language Objectives							
1. engage in dialogue/discussion	•	•	•	•	•	•	•
2. engage in observation activities/ demonstration	•	•	•	•	•	•	•
3. record observations about unit activities in a journal	•	•	•	•	•	•	•
4. identify the main idea of a paragraph	•	•		•	•		
5. create stories using theme-related vocabulary	•						•
6. use description to narrate events	•	•	•	•	•	•	•
7. write complete sentences	•	•	•	•	•	•	•
8. give reasons to persuade	•	•	•	•	•	•	•
9. organize information/data	•	•	•	•	•	•	•
10. use appropriate mathematical expressions and quantities to describe.	•	•	•	•	•	•	•

LESSON 1 Today's Weather

BIG IDEAS Weather affects the way we live, what we eat and wear and how we feel. We can describe weather conditions by using mathematics.

Whole Group Work

Materials

Books: **Storms in the Night** by M. Stolz, **The Good Rain** by A.E. Gondey or **The Very Windy Day** by E. MacDonald

Chart tablet (divided into columns with labels: Kind of Weather; Clothes; Work; Homes; Recreation; What We Cannot Do, etc.)

Two strips of bulletin board paper for frame sentences

Several books and magazines with illustrations of weather conditions, to place later in the **Library Center**

Word tags: weather, forecast, thermometer, predict

Encountering the Idea

The teacher shows the book **Storms in the Night** to the students and asks them to predict what the story is about. The teacher reads the story aloud, asking students to visualize how it must feel to be in the dark during a thunderstorm. At the conclusion, the teacher asks the students to recall how the thunderstorm affected the grandfather and the grandson. (They remained inside, shut windows, couldn't read or watch TV, had to go to bed early, were afraid of storms, etc.) The teacher and students enter into a discussion of how the weather affects our lives.

Exploring the Idea

In a whole group activity, the students organize and plan a field trip to experience the current weather conditions outside the classroom. They plan their route around the school and into the neighborhood. They list what they want to see, smell and feel. They also plan how far they will walk and how they will measure that distance. Then they will measure or estimate the distance. In preparation for this walk the students, working in groups, design a weather chart to keep the data they collect each day.

At the **Science Center**, the students

1. begin work on **Activity** — Weather Forecasting to continue for approximately three weeks. This activity requires collecting weather data on a daily basis at approximately the same time each day for two to three weeks. At the end of the third week, the students make predictions about the weather for the fourth week. They check their predictions during the fourth week.
2. make a wind sock to carry with them by completing **Activity** — A Wind Sock before going outside. They discuss the function of the wind sock. Has anyone seen a wind sock? How do we use it? (At the airport to tell which way the

wind is blowing, on the side of a mountain pass to warn drivers of high winds.)

At the **Mathematics Center,** the students complete **Activity** — Reading a Thermometer.

At the **Writing Center,** students

1. write a class Big Book on how the weather affects us
2. write frame sentences about the weather on long strips of bulletin board paper:
   "If it is ___________, then I can (can't) _________________."
   The students complete as many of these as they wish.

Getting the Idea

Students contribute to the chart labeled: Kind of Weather, Clothes, etc. to use in writing in their journals about how weather affects our lives.

Students describe what they can see from the classroom, writing new words they need on a chart. They discuss different experiences they have had in relation to the weather. On returning from the walk, the class discusses what they saw, smelled and felt, using appropriate descriptive terms. The students discuss how the wind sock gave them information about the wind and its direction, and what kind of information the thermometer provided. Was it hot or cold outside? How hot (or cold) was it? How can we find out how hot or cold it was? What do we use to find out? (Thermometer.) The students begin to record the data that they have collected on the weather forecasting chart. Was the wind blowing? Hard? Was it humid? Dry? Answer these last questions by taking students' opinions. The students describe the conditions as well as they can. Tell them that in later lessons they will learn to measure these conditions and have more accurate ways to describe the weather.

We learned to use a thermometer to tell how hot or cold the outside air is. We don't have to use words that only tell us if it is hot, cold, very hot or very cold. We can give a more accurate description. How far did we walk? (Blocks, yards.) How did we measure the distance?

Organizing the Idea

The students write about today's weather and draw pictures in their journals of what they have talked about. They may also write questions about something they would like to know about the weather, thunder, lightning or some other interesting weather phenomenon.

Students can write a story of how the weather has affected their plans at some time. They can illustrate their story and write it in their journals.

Students contribute to a daily class weather report. See **Activity** — My Forecast.

Applying the Idea

The activity cn weather forecasting will take at least three to four weeks to complete (two to three weeks to collect data and one week to predict and check). The students collect data as they learn the new concepts and learn how to measure wind direction, wind velocity, air pressure and humidity. They learn also about the different types of precipitation and how to describe them.

The students select a name for their weather forecasting station. See **Activity** — Weather Forecasting.

1. They begin to record the data on the weather chart to keep track of the weather. Remember, weekends count too; draw pictures to tell the weather.
2. Read an outside thermometer every day just before lunch and record the temperature on the weather chart.
3. Learn how to use the windometer made in Lesson 4; take measurements every day just before lunch and record wind velocity on the chart. Record dew point, humidity.
4. Maintain the chart for three weeks. Translate the data from the chart to line graphs, if appropriate, to make predictions. At the end of the third week make a forecast for the fourth week; students check their predictions with their own observations and newspaper or television observations.
5. Review the symbols of the forecasting chart on the first day. The students will add more data every day as they learn to use the instruments.

Closure and Assessment

How far did we walk? How did you measure the distance? (Blocks, feet, etc.) Can we use blocks to tell us how far we walked? Are all the blocks the same length? Can we estimate how far we walked? Can we use blocks to estimate the distance?

Students summarize what new things they learned about the weather focusing on these questions:

1. How did the weather affect us today?
2. Was the weather sunny or cloudy? Windy? Is it raining? Is it foggy? Is it dusty?
3. What instruments did we use to help us describe the weather?
4. Why is it important to use instruments in describing the weather?

Students summarize their experiences in measuring the distance they walked and in collecting data.

If we wanted more than an estimate of how far we walked, what could we use to measure the distance?

List of Activities for this Lesson

- ▲ Weather Forecasting
- ▲ A Wind Sock
- ▲ Reading a Thermometer
- ▲ My Forecast (continued in Lesson 7)

ACTIVITY
Weather Forecasting

Objective

The students predict the weather for one week by using the data they collect during the first three weeks of work on the unit.

Materials

Chart for each student, or one for the entire class.

Procedures

1. Make a weather chart to keep track of the weather.
2. Draw a picture to tell the weather.

Month

	Mon.	Tue.	Wed.	Thurs.	Fri.	Sat.	Sun.
Week 1	temperature dewpoint wind direction air pressure clouds? sun?						
Week 2							
Week 3							
Week 4	(student predictions go here)						

Remember: Weekends count too.
Draw the weather conditions as shown below.

windy partly sunny cloudy, gray rain snow sunny frost

ACTIVITY
Weather Forecasting

Current Conditions

Symbols	Condition	Date	Time	Temp	Air Pressure	Wind Speed	Wind Direction	Humidity	Dew Point
	Sunny, Clear								
	Partly Cloudy								
	Cloudy								
	Rain								
S	Thunderstorm								
|	Fog								
Δ	Dust storm								
Θ	Hail								
X	Haze								
Σ	Sleet								

Note: These symbols are not standard weather symbols.

ACTIVITY
A Wind Sock

Objective
The student constructs a wind sock and is able to explain its function in describing weather conditions.

Materials
For each child:
Small, cylindrical box (salt, oatmeal) with top and bottom removed
Sheet of paper pre-cut to fit the box
Four pieces of string
Eight to 10 strips of crepe paper or ribbon

Procedures
1. Children decorate the paper that they will fit on the box with appropriate weather pictures.
2. Students attach the paper onto the box by stapling or gluing; they punch four holes near the top to tie pieces of string and tie the four pieces together at the top.
3. Attach the ribbons (streamers) at the bottom.
4. Hold the wind sock at the top by the four strings attached to the box.
5. The wind sock is ready for students to take it outside in the wind. Students can attach the wind sock with more string to a pole and leave it outside a classroom window to observe it.

ACTIVITY
Reading a Thermometer

Teacher Information

We measure the ambient (room, or outside) temperature by taking the temperature of the air, or some other medium, that surrounds the thermometer. A thermometer is a cylindrical tube filled with either mercury or red-colored alcohol set against a scale reading either in Fahrenheit or in Centigrade (Celsius) degrees.

The basis for the use of a thermometer is that matter usually expands as it absorbs heat. Mercury is a metal in liquid state that expands readily as it absorbs heat. Mercury is more expensive than alcohol; consequently, thermometers usually contain alcohol as the liquid that expands to give the temperature reading.

A thermometer scale is marked in units called degrees (°), in multiples of 10. The reference points of a thermometer are usually the freezing point and boiling points of water level. Since the ambient temperature may go to below 0°C (the freezing point of water) on some days but does not reach 212°F (the boiling point of water), only those temperatures that are common on earth appear on a room thermometer scale. Thus, the numbers that indicate the ambient temperature range from a low of about 40°F below 32°F to about 120°F.

Each unit is marked with a large slash, in multiples of 10. The unit is usually subdivided with a smaller slash, into five parts. Consequently, each large mark counts for 10 degrees and each small mark counts for two degrees. Thus, students need to count by twos and 10s to take an ambient temperature.

Materials

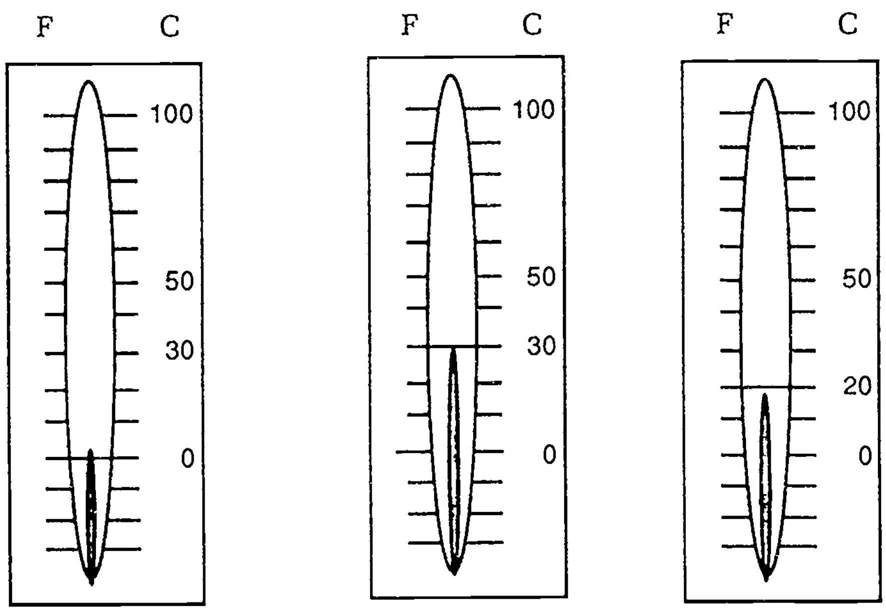
A room thermometer with Fahrenheit and Celsius scales (usually one scale is shown on either side of the thermometer) for each student
Some ice cubes in a jar of water
A lighted lamp

Procedures

1. Each student group examines and describes a thermometer, noting the liquid in the cylinder; how the scale is marked; the number of subdivisions; and any other features they may notice. They find the highest number, the lowest number, and where zero is located. They make these observations using both the Fahrenheit scale and the Celsius scale.
2. The students read the thermometer the way they would read a number line, noting that the scale is divided into multiples of 10, and the subdivisions are either a two, four, six or eight. They write the number as 70 + 8 = 78°F in reading the thermometer, until they can read it without writing it in expanded notation. They record the room temperature.
3. After they take the room temperature, the students cool the thermometer by placing it in cold water for a few seconds. By keeping the thermometer in the water for a longer or shorter time, they can practice reading different measurements. By leaving the thermometer in the jar with ice cubes until the temperature stops falling, they can read a temperature close to freezing, or 32° F. They take and record the temperatures in Fahrenheit and Celsius.
4. After they take the temperature of the water, the students let the thermometer warm a little and then place the thermometer near — but not touching — the

lighted lamp. They take and record the temperature. They take different measurements by varying the amount of time they leave the thermometer close to the lamp.

5. After taking several measurements of the temperature of the cold water and the air near the lighted lamp, the students order the temperatures from lowest to highest, find a middle temperature, state the range of temperatures and describe them in any other way they choose, for both the Fahrenheit and Centigrade scales.
6. Students read the picture thermometers in both Fahrenheit and Centigrade.



ACTIVITY
My Forecast (Lessons 1 & 7)

Name ______________________

Date (today) ____________ ____________ ____________
Day Month Year

Season __________

Outdoor temperature ______________

Sky: ________________
Clouds?

Precipitation: ________________
Rain, Snow

Wind direction: ________________
North, South, East, West

Wind speed: ______________

Barometric Pressure: ____________

Dew Point (Humidity): ______________

____
Tomorrow's Forecast

Indoor temperature ______________

Sky: ________________
Clouds?

Precipitation: ________________
Rain, Snow

Wind direction: ________________
North, South, East, West

Wind speed: ______________

Barometric Pressure: ____________

Dew Point (Humidity): ______________

LESSON 2

What Makes Weather?

BIG IDEAS The sun heating the earth and its atmosphere causes the weather; we feel weather as wind, heat or cold, and humidity in the form of rain, ice and snow.

Whole Group Work

Materials

Large chart tablet for new words provided by class
Large world globe
Plastic jar with colored water
Reference books on weather
Thermometer
Current copy of a daily newspaper
Wind socks

Encountering the Idea

The teacher asks students to gather as much data as they can with the instruments they have learned to use (wind socks; thermometers) to describe the current weather conditions. Students can suggest using the thermometer to measure the temperature and using the wind sock to measure the direction of the wind. What are some other weather conditions that can occur? Tell the students they will explore making weather conditions right in the classroom. After they explore these ideas, they are to hypothesize about what causes different weather conditions. They will also make suggestions on how to gather data to be more accurate in their descriptions of weather.

Exploring the Idea

In this lesson, students will discover how nature produces wind and precipitation. Give the first activity involving **air currents** in two parts. By using talcum powder, the students can see the powder moving in an air current. In the second part, heating the air around a light bulb produces air currents that move a paper swirl above the bulb.

At the **Science Center,** students

1. complete **Activity** — Air Currents
2. complete **Activity** — Rain in the Classroom
3. complete **Activity** — Water Tornado, as shown below.

Water Tornado

Fill a plastic jar halfway with lightly colored water. Do not cover it with a lid. A student vigorously stirs the water in the plastic jar and looks down through the top of the jar to see a water tornado.

Discussion

In making a water tornado, what happens when you move your hands back and forth in the water? Slowly? Rapidly? Can you push the water away from you?

What caused the tornado in the bottle? (You moved the water rapidly with your hand.) What do you think causes a **wind tornado**? (The sun heats air that begins to move rapidly, causing air currents to swirl.)

Getting the Idea

Using a world globe, the teacher demonstrates and discusses the following ideas.

1. The earth has a deep layer of air that surrounds it. This layer of air we call the **atmosphere.** Weather develops usually from the sun heating the land on earth and the earth's atmosphere while as the earth rotates on its axis. As the earth rotates, it rotates in a layer of air and causes the air to move. These movements of air we call **air currents.** The currents make wind. In the meantime, however, the sun is heating the land and the oceans on the earth as well. As the sun heats the land, the land reflects some of the heat it gets from the sun into the atmosphere, heating it more. This process causes more air currents.
2. As the sun heats the water in the oceans, it causes **evaporation** of the water. The evaporation then forms **clouds.** Clouds are a form of **water vapor** that has **condensed.** The water in the clouds turns to rain, snow, sleet, frost and other forms of water and water vapor, depending on the temperature of the air. We will see this happening when we make rain in the classroom.
3. Usually we feel weather conditions as movement of air, or wind, how dry the wind is, or its humidity, and its temperature. We can measure each of these conditions. That's what makes accurate weather prediction possible.
4. We can study the use of the wind sock. What is its purpose? The wind sock tells us the direction the wind is blowing. But, the wind sock does not tell us how fast the wind is blowing. We will learn how to measure wind velocity in another lesson.
5. What is the purpose of the thermometer? Does the temperature have anything to do with the movement of the wind sock? (No, only the direction and velocity of the wind affect the wind sock.) How do we use the two instruments together?

Organizing the Idea

At the **Writing Center,** the students write and illustrate how the sun's heat causes weather. The description includes information about the atmosphere (air around the earth) and about air currents.

At the **Mathematics Center,** the students

1. examine the data collected for the weather forecasting activity
2. again, compare the high and low temperatures and note the differences by subtracting the two temperatures using both Fahrenheit and Celsius scales
3. find the temperature on both scales by reading them off the thermometer — **not by converting** — but simply reading the two scales.

Applying the Idea

In their school library, students research books or almanacs or the daily newspaper for the number of days of sunshine in their city, the inches of rainfall and the wind velocity; students compare these data with data from other cities in the nation. The students can also research how we measure a day of sunshine, as well as how we measure rainfall and wind velocity. They report these findings to the class.

Sample reports:

For City ______, the weather conditions were ___________ on (date). The high temperature was ______, while the low temperature was _______. It's rainfall (or snowfall, etc.) was ___________. The wind was blowing from _____ at _____ _miles per hour. The relative humidity was ____________.

Closure and Assessment

Oral Interview

1. How important is the sun in affecting our weather? What does it do to affect the weather?
2. Wind is moving air. What causes air to move fast?
3. Show your teacher your up-to-date weather forecasting chart. Interpret your chart for your teacher or your partner.

Performance Assessment

1. Demonstrate what causes rain.
2. Demonstrate one of the causes of wind currents.

List of Activities for this Lesson

▲ Air Currents

▲ Rain in the Classroom

ACTIVITY
Air Currents

Objective
Students say that as air gets hot it begins to move upward, above colder air, causing wind currents.

Materials
100-watt light bulb
Six-inch paper circular disk
Small amount of talcum powder (about 1/2 teaspoon)

Procedures
1. The teacher turns on the light bulb and allows it to get hot.
2. Ask students to feel **the air around the bulb but not the bulb itself.**

Talcum Powder activity

3. Sprinkle small amounts of talcum powder over the bulb.
4. Students watch the motion of the powder as it swirls above the bulb.

Discussion
What surrounds the bulb? (Hot air.) Is the bulb hot? What about the air around it? What makes the powder swirl? (Air currents of hot air.)

Paper Swirl activity

5. Cut the paper disk along the lines shown in Fig. 1 to make a paper swirl.
6. Tie a small piece of string around the top of the swirl and hold the swirl above the light bulb at a height of about four inches.
7. The students watch the motion of the swirl above the bulb.

Discussion
Same questions as for the powder.

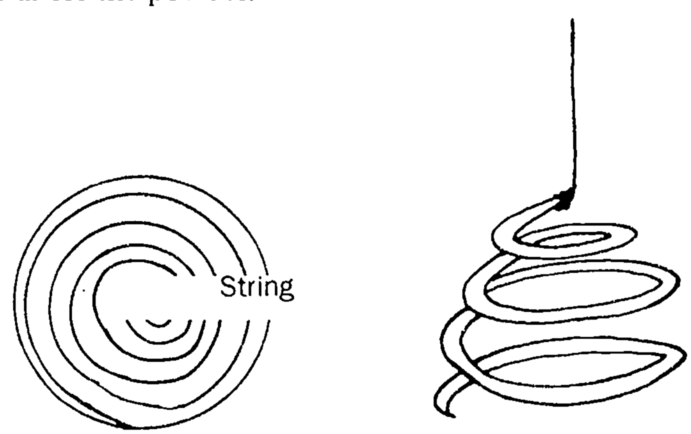


Fig. 1

ACTIVITY
Rain in the Classroom

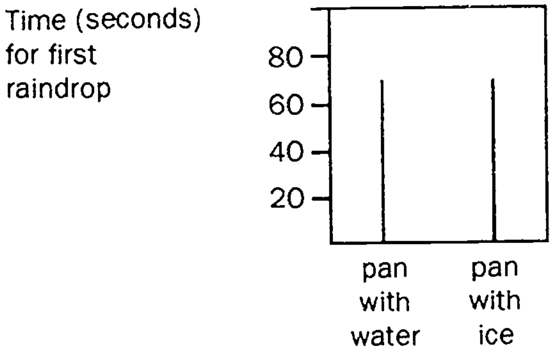
Note: This is a teacher demonstration to avoid having the students work with hot water.

Materials

Skillet or hot plate; pie pan; sponge; water; clock; ice cubes; clear glass large-mouth gallon jar

Procedures

Place a pot of water on a skillet or hot plate to boil. Hold a pie pan that has a wet sponge in it over the boiling water. Students observe the bottom of the pie pan to see when condensation begins to form on the pan. Students time and record how long it takes for the first raindrop to fall from the pan. Repeat the experiment with ice in the pan and record the results. Students compare the lengths of time it took for each activity. Students suggest reasons for the difference in times.



Clouds in the Classroom

Heat a pot of water on a hot plate. Hold a clear glass large-mouth gallon jar upside down over the pot of water to collect the hot air as it rises. Cover several ice cubes with a wet paper towel and place on top of the inverted jar. As the hot air reaches the top of the jar, clouds begin to form. The clouds may become cold enough to condense and "cause rain."

Discuss the water cycle the students observed. They may duplicate the rain pattern with claps, finger snaps or pictures of evaporation, condensation and precipitation.

Discussion

1. Let's talk about the forms of water we saw in this experiment. (Liquid, steam and ice).
2. How did these changes happen? (We heat water; when the steam hit the jar it condensed back into water.)
3. Can you state a rule about this? (Water has different forms.)
4. What was the **same** about the pans? What was different? Why did the pan with ice make the steam condense faster?
5. What causes rain and clouds to form?

LESSON 3 The Four Seasons

BIG IDEAS The seasons develop from the angle of tilt of the earth's axis as the earth revolves in its path around the sun.

Whole Group Work

Materials

Current year-long calendar; world globe; flashlight (pen light preferred); thermometers; wind socks; copies of questions from **Activity** — Mathematics of the Seasons

Word tags: season, summer, winter, spring, fall, tropics, hemisphere, northern, southern, equinox

Encountering the Idea

Begin the lesson by asking the students to review what the main cause of weather is (Lesson 2). Ask them to keep this in mind as they hypothesize as to the cause of the seasons. The students name the seasons and describe what they know about them. What is special about each season? Students are to hypothesize about the following.

Why does it get cold in the winter and hot in the summer? What happens during the spring and the fall? As the children express their ideas, write some of the more plausible ones on a chart tablet, for students to use later in writing their explanations of the seasons in the **Writing Center.** Tell them that you will conduct two demonstrations using a flashlight to simulate the sun as a source of light and heat and using the globe as the earth. After the two demonstrations, students again hypothesize as to what causes the seasons.

Exploring the Idea

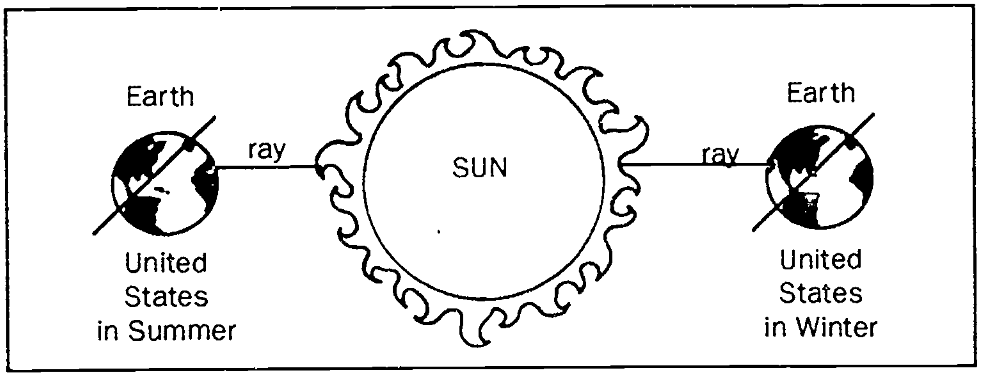
At the **Science Center,** students

1. complete **Activity** — Temperature and Distance. It is important for students to go through this activity first so they can see the earth's tilt in relation to the distance from the sun of a specific area on earth.
2. complete the following activity.

Using the flashlight to simulate the sun as a source of light and heat and using the globe as the earth, ask a student to hold the globe at an angle, as shown in the picture below. (Place a styrofoam ball at the end of a stick to hold it at an angle, as shown.) The student rotates the earth (globe) while keeping it tilted in the approximate angle shown in the illustration below; at the same time the earth revolves around the "sun." The flashlight's rays follow the globe (earth) as it rotates in an elliptical path.

The winter months in the Northern Hemisphere (usually November, December, January and February) do not correspond to the winter months in the

Southern Hemisphere (usually May, June, July and August). The students can see this by experimenting with a globe and moving it around a light bulb or a flashlight to show that when the angle of the tilt of the earth's axis changes, the distance that a ray of sun travels from the sun's surface to the earth's surface varies. In the tropics, however, the seasons remain relatively unchanged, except for periods of increased rain.



At the **Mathematics Center,** the students in groups of four complete **Activity** — Mathematics of the Seasons.

Getting the Idea

Ask the student groups to justify, in their own words, their answers to the questions for **Activity** — Mathematics of the Seasons. After the discussion, tell the students the following ideas, using a globe to demonstrate how the seasons occur.

The seasons are divisions of the year that occur in cycles. Tell students, in general, the kind of weather to expect for each season. In the past, people associated the seasons mostly with the cycle of sowing and harvesting cultivated plants. Winter is the dormant period of most plants, while we associate spring with germination and sowing. Summer is the period of growth, and autumn is the time of harvest.

Outside of the **tropics,** we note the seasons for extreme changes in weather from a minimum of warmth in the winter to a maximum in the summer. The other two seasons, spring and fall are transitional periods. Only the extreme seasons have very different characteristics. Although we cannot make absolute statements about the weather in any one season, it is convenient for us to divide the year into four separate parts that describe the weather in general.

Changes in the angle of the sun's rays striking the earth and in the length of day cause the seasons. The amount of solar radiation (heat) absorbed by the earth's surface and by the atmosphere changes as the earth revolves around the sun. As the earth moves in its orbit, its axis maintains a nearly constant orientation in space, inclined at about a 66 ° angle to the plane of the orbit.

Organizing the Idea

Students write about and illustrate the causes of the seasons.

At the **Music** or **Listening Center,** the students can listen to a tape of Vivaldi's **Four Seasons.** In this composition the music depicts the composer's feelings about winter, spring, summer and autumn. The students try to identify those parts of the music that remind them of a winter storm or a summer day.

Applying the Idea

Problem Solving

1. Can you show on the world globe where the area of the **eternal night,** or the **eternal day,** could be? (At the poles.) What does **eternal** mean? What causes a day to be that long? Students demonstrate this with the globe and flashlight.
2. Can you show on the world globe where there might be **eternal summer** on earth? (In the tropics.) **Eternal winter?** The students demonstrate this.

Closure and Assessment

1. The students illustrate the tilting of the earth's axis and its relationship to the seasons along with a drawing of a seasonal activity.
2. Students write a poem about their favorite season.
3. Students can justify their answers to questions on **Activity** — Mathematics of the Seasons.
4. Students write a rule that relates distance from a heat source (the sun or a light bulb) to the temperature of an object.

List of Activities for this Lesson

▲ Mathematics of the Seasons

▲ Temperature and Distance

ACTIVITY
Mathematics of the Seasons

Objective
Using the topic of the seasons, the students use whole number operations to solve problems.

Materials
Copy of a year-long calendar for the current year
List of questions
World globe
Flashlight, if necessary

Procedures
Groups of four students work on the following calendar activities.
Make a chart with a list of facts.

On the chart make a heading for each of the four (4) seasons. Under each season list the months of the year that go with that season for the Northern Hemisphere.

On the chart make a fact list of the seasons.

1. There are _____ days in the Winter.
   There are _____ days in the Spring.
   There are _____ days in the Summer.
   There are _____ days in the Fall.
2. The shortest day of the year is ______________ in the Northern Hemisphere.
   It is _______ hours long.
   The night is ________ hours long.
3. The longest day of the year is _______________ in the Northern Hemisphere.
   It is _____________hours long.
   The night is ________ hours long.
4. The word "equinox" means __________________.
5. The two days of the equinox are _______________ and ________________.
6. There are ________ hours of __________ and _________ hours of _________ on the equinox.
7. On the globe find Argentina. What month is it in Argentina when it is December in the United States? (Same month.) In Argentina, in what season does Christmas occur? Explain.

Do the same for the seasons in the Southern Hemisphere.

ACTIVITY
Temperature and Distance

Objective
Students demonstrate with a world globe and a flashlight how the distance of a specific place, like the United States, changes in relation to the sun because of the tilt of the earth, and how the distance affects the amount of heat that places on earth receive from the sun.

Materials
Lighted lamp; 100-watt bulb; measuring tape; clock; world globe; flashlight; thermometer at room temperature

Activity 1— Since the 100-watt light bulb can become very hot, do this activity under the teacher's close supervision.

1. Place an **unlighted** 100-watt bulb in a stationary position on a table.
2. Measure a distance of 12 inches from the bulb; mark the distance with a piece of masking tape marked "12 inches."
3. Measure and mark a distance of 20 inches from the bulb with masking tape marked "20 inches."
4. After the bulb has been lit for approximately five minutes, place a thermometer that has been at room temperature for at least 1/2 hour (record this temperature) at the distance marked 12 inches.
5. Time how long it takes for the thermometer to rise 3° F. Record the length of time.
6. Record the room temperature of the thermometer after it has cooled to room temperature. Place the thermometer at the distance marked 20 inches. Record the time it takes for the temperature to rise 3° F. Record the time.

Activity 2

1. Using the flashlight to simulate sunlight and using the world globe, the students take turns showing each other how the tilt of the earth brings some areas of earth closer to the sun than others.
2. The students explain to each other how the tilt of the earth causes summer, winter and the other seasons.

LESSON 4 Wind: Air in Motion

BIG IDEAS Wind, tornadoes, cyclones and dust storms are all moving air, which exerts pressure as it moves.

Whole Group Work

Materials

Book: **Iva Dunnit and the Big Wind** by C. Purdy
Blow-dryer with two temperature settings (slow and fast) and a no-heat setting
Wind socks
Thermometers
For each student group: drinking straws, cotton balls, pieces of paper, pieces of tissue

Encountering the Idea

The teacher presents the book **Iva Dunnit and the Big Wind** to the students and asks them to predict the plot of the story. The teacher reads the story and then asks: Is this story meant as a **tall tale**? Why? Do you think the wind was strong? What made you think this?

The teacher tells the students they will discover how wind causes weather and the kind of weather conditions it produces. The following activities will help them learn about the strength of the wind.

Exploring the Idea

At the **Science Center,** the students perform the following activities.

Activity 1: Using Wind Socks

Using the wind socks made in Lesson One, the students again go outside to describe the current wind conditions. They can describe the direction from which the wind is blowing and whether they believe it is a strong wind or a light breeze. Ask students to think of a way to determine the direction of the wind with more accuracy than by merely identifying one of the four directions of the compass.

Activity 2: Air Exerts Pressure

Children explore one of the important characteristics of air — it exerts pressure. As it moves from one place to another, it pushes against itself and against things. That is how we can see air. In this activity, children can see how air pressure is created by blowing or sucking through a straw. The air pressure affects objects.

Materials

For each child: A drinking straw, a cotton ball, a piece of paper, a piece of tissue

Procedures

Students working in small groups
1. blow through the straw against their hand
2. blow against the cotton ball to make it move

3. pick up a sheet of paper using only the straw
4. pick up a piece of tissue using only the straw.

Discussion

1. What did you feel against your hand when you blew on the straw ? (Air.) How do you know that it is air? Can you see air? Can you feel air? Why can you feel it?
2. Why did the cotton ball move? (Air pushed it.)
3. Can you make the piece of paper stay on the end of the straw? What is making it stay there? (Air is pulling on it.)

Students name at least two other situations that require the use of air (cooling food, drying clothes fast).

Activity 3

Students complete **Activity** — Making a Windometer and **Activity** — Make Your Own Barometer.

Activity 4

Students explore air pressure. Do **Activity** — Colliding Balls. Do **Activity** — Air Pushes in All Directions.

At the **Mathematics Center**, the students complete **Activity** —Destructive Wind.

Getting the Idea and Organizing the Idea

Air that is in rapid motion causes many changes in the weather. We can experience wind as a pleasant cooling or warming breeze, but when its velocity is great we experience it as a **tornado** (a whirling wind seen as a funnel-shaped cloud traveling in a narrow area over land) or a **cyclone** (a strong wind traveling in a wide circle around a center and often bringing much rain). In each of these natural phenomena, air pressure is an important component of the storms, for example, in the calm in the eye of a storm.

1. Students discuss the wind conditions they have measured. The students use their windometer to take some more measurements of the current wind conditions. They talk about the velocity of the wind and its direction.
2. Students discuss ways to determine the wind's direction with more accuracy than only one of the compass directions. If the students don't suggest it, the teacher suggests the idea of a weather vane, and how we could construct one.
3. Students also discuss the air pressure experiment. The teacher asks the students to think of ways that we could use air pressure.
4. When you have been running and get hot, what do you do? (Drink water, etc.) You want to get some AIR to cool you off by fanning yourself. Why?

If you have wet hair and want to dry it quickly, what do you do? Blow-dry it. Does the air have to be hot for your hair to dry? No, but it's faster. Put a wet washcloth on a student's arm. With the blow dryer on low, and no heat, blow on the washcloth. Now, set the dryer on high, no heat, and blow on the washcloth. The student describes the difference. (If there is no blow-dryer, fan a cardboard slowly and then quickly.)

The students **make a rule** about air and cooling, for example, the harder the wind blows, the colder the temperature.

5. After using the windometer, the students discuss the wind velocity as shown by the data they collected and discuss whether the Beaufort scale describes the current conditions accurately. They write in their journals about the cur-

rent weather conditions including their experiences with air pressure, the wind sock, the weather vane and the windometer.

6. At the **Writing Center,** the students write about air pressure, how we measure it and how we measure the velocity of the wind.
7. What information does a barometer give us to help us forecast the weather? (A barometer measures the pressure that air is exerting at a particular location at a specific time. It also tells us if the pressure is increasing or decreasing.)

Applying the Idea

Students complete **Activity** — Go Fly A Kite!

Students begin to summarize the collected data, as time permits. See **Activity** — Data and Line Graphs, Lesson 7.

Problem Solving

Can you make a piece of tissue stay on the end of a straw? Is it harder to make the piece of tissue stay on the end of the straw than the piece of paper, or is it easier? What about the cotton ball? Is it easier or harder to keep it on the end of the straw than the piece of tissue? How many cotton balls can you make to stay on the end of the straw?

Closure and Assessment

1. Show what causes tornadoes.
2. What is a cyclone?
3. How does air pressure affect the weather?
4. What is wind?
5. What did we do today to show that air exerts pressure?
6. How do we measure the velocity of the wind?
7. What is a weather vane? Is it the same as a wind sock? How are they different?
8. What makes a kite fly?
9. What did you record on your weather chart for today? (Temperature; wind direction and velocity; air pressure; cloud/clear conditions; precipitation.)

List of Activities for this Lesson

▲ Making a Windometer

▲ Make Your Own Barometer

▲ Colliding Balls

▲ Air Pushes in All Directions

▲ Destructive Wind

▲ Go Fly A Kite!

ACTIVITY
Making a Windometer

A Windometer Measures Wind Velocity

A windometer is an instrument that measures wind velocity. Students can make in the classroom a simple one that will provide fairly accurate information.

Materials

For each group of students:

1. Cut a posterboard in the shape of a protractor with a handle as shown on the drawing. Mark the protractor shape in degrees, in multiples of five.
2. Attach a ping pong ball as shown on the figure.
3. Use a piece of string about 33 cm; the string should measure 30 cm from the attachment on the windometer to the top of the ball.
4. Copy on the handle the scale associating windspeed in miles per hour (mph) and angle in degrees. See below.

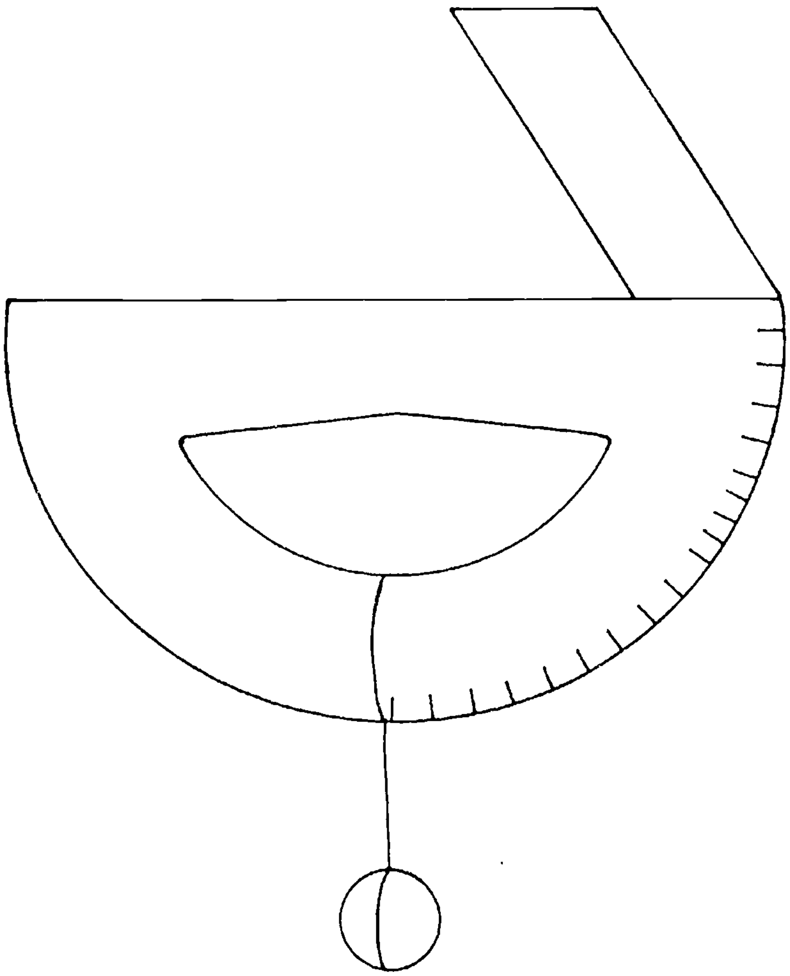
Procedures

1. Holding the windometer by the handle, point it into the wind.
2. Hold the windometer so that the ball is free to move along the scale.
3. Read and record the angle the string marks on the protractor.
4. Read the mph (miles per hour) associated with that angle.

Angle	Miles per hour
90	0
85	5.8
80	8.2
75	10.1
70	11.8
65	13.4
60	14.9
55	16.4
50	18.0
45	19.6
40	21.4
35	23.4
30	25.8
25	28.7
20	32.5

The **Beaufort Scale** associates a number, the Beaufort number, with a wind speed in mph that then translates into a description of how that wind velocity affects climate conditions outdoors.

Beaufort #	Observation	Description
0	Smoke rises vertically	Calm zero to one mph
1	Smoke drifts slowly	Light breeze two to three mph
2	Leaves rustle	Slight breeze four to seven mph
3	Twigs move, flag extends	Gentle breeze eight to 12 mph
4	Branches move, dust and papers rise	Moderate breeze 13-18 mph
5	Small trees sway	Fresh breeze 19-24 mph
6	Large branches sway, wires whistle	Strong breeze 25-31 mph
7	Trees in motion, walking difficult	Moderate gale 32-38 mph
8	Twigs break off trees	Fresh gale 39-40 mph
9	Branches break, roof damaged	Strong gale 41-54 mph
10	Trees snap, damage evident	Whole gale 55-63 mph
11	Widespread damage	Storm 64-72 mph
12	Extreme damage	Hurricane 73-82 mph



ACTIVITY
Make Your Own Barometer

Objective

Students experiment with air pressure by constructing a simple barometer; students relate barometric readings with weather conditions.

Materials

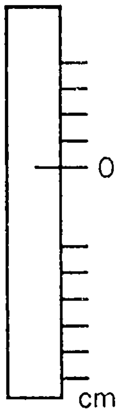
Reference (encyclopedia) on air pressure
Narrow-mouth bottle filled with water
Clean clear glass or plastic bowl
Two small pieces (same size) wood or plastic to balance the bottle
Tape to mark water levels

Procedures

1. Fill the bottle with water. Hold the bowl over the bottle and tilt the bottle and bowl together quickly.
2. Tilt the bottle to let in air until the bottle is about 1/3 full of air.
3. Rest the bottle on the two pieces of plastic or wood.
4. Mark the water level both on the bowl and on the bottle. Take readings of the water level at least twice a day and record weather conditions.

Day	1	1	2	2	3	3	4	4	5	5
Water level (Bottle)	__cm	__cm	__cm	__cm	__cm	__cm	__cm	__cm	__cm	__cm
Weather Today (sunny or cloudy?)	________		________		________		________		________	
Water level (Bowl)	__cm	__cm	__cm	__cm	__cm	__cm	__cm	__cm	__cm	__cm
Weather Today (sunny or cloudy?)	________		________		________		________		________	

5. Make two copies of the ruler below on paper. Glue one ruler on the outside of the bottle and the other one on the outside of the bowl. Be sure to put the zero mark on the first mark you put on the bowl and on the bottle.



Getting the Idea

The students answer these questions before reporting to the class.

1. What happens when the level in the **bottle** goes up? (Air pressure is pushing the water into the bottle and out of the bowl.)
2. What happens when the level in the **bowl** goes up?
3. What is making the water go up into the bottle? (Air pressure is decreasing so the water in the bottle goes down into the bowl.)
4. How can we use air pressure to do work?
5. How does air pressure relate to weather? (Look in a book and report.)

Applying the Idea

1. Use your barometer to find the current air pressure.
2. Enter your data for the air pressure on a daily basis onto your weather forecasting chart.

ACTIVITY
Colliding Balls

Objective

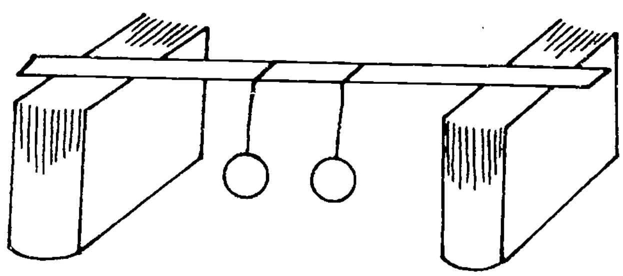
Students say that moving air pushes less than nonmoving air.

Materials

Tape; ruler
One board or stick about 20 inches long; two pieces of string, each about six inches long
Two books each about six to eight inches high
Two balls — ping pong or nerd balls are best, and apples or lemons work too

Procedures

1. Tape the string to each ball.
2. Set up the books and ruler.
3. Tape one end of the string to the stick so that the balls are one inch apart. Tape the other end to the balls. Make sure the balls swing freely without touching the tabletop.
4. Blow between the two balls. What do you think will happen? Do they move apart or collide? Make sure you blow straight between the balls.
5. Move one of the strings so that the balls are about 1 1/2 inches apart. Blow again. Do the balls still move?
6. Repeat Step 5 moving the balls 1/2 inch farther apart each time.
7. Keep moving the balls apart until they no longer move.



Getting the Idea

Tell the students that the air on the outside of the balls is not moving. But the air between the balls is moving. Moving air pushes less, because it exerts less pressure.

1. Students will predict what will happen before they blow between the balls. Then they write what actually happened and if they predicted correctly or not.
2. After teacher discussion, students explain in their journals why the balls moved in the direction that they did.

ACTIVITY
Air Pushes in All Directions

Objective
The student says that air pushes in all directions.

Materials
Clean duplicating fluid can; eight-ounce glass; hot plate; 5 inch x 8 inch index card; cup of water; water

Phase I

Procedures
1. Put one cup of water into a clean ditto fluid can.
2. Boil the water **with the lid off.**
3. Remove the can from the stove and put the lid on tightly.
4. Students observe and record results.

Phase II

Procedures
1. Fill the glass with water (not too full).
2. Put the index card over the mouth of the glass.
3. Hold the card with one hand, the glass with the other.
4. Turn the glass upside down and slowly remove your hand from the card.
5. Slowly turn the glass right side up, but don't touch the card.
6. Students observe and record results.

Getting the Idea

Discussion
1. Say what you think crushed can.
2. Say what you think kept the water from falling out.
3. Write and illustrate your explanations in your journal.

Teacher Information
When heated, the water changes to steam and drives most of the air from the can. When you put the lid on tightly, no air can get back in. As the steam inside the can cools, it condenses and returns to a liquid, and a vacuum is created. The air pressure outside the can will become much greater than the air inside and will gradually crush the can.

ACTIVITY
Destructive Wind

Objective

Students compare and order numbers by subtraction.

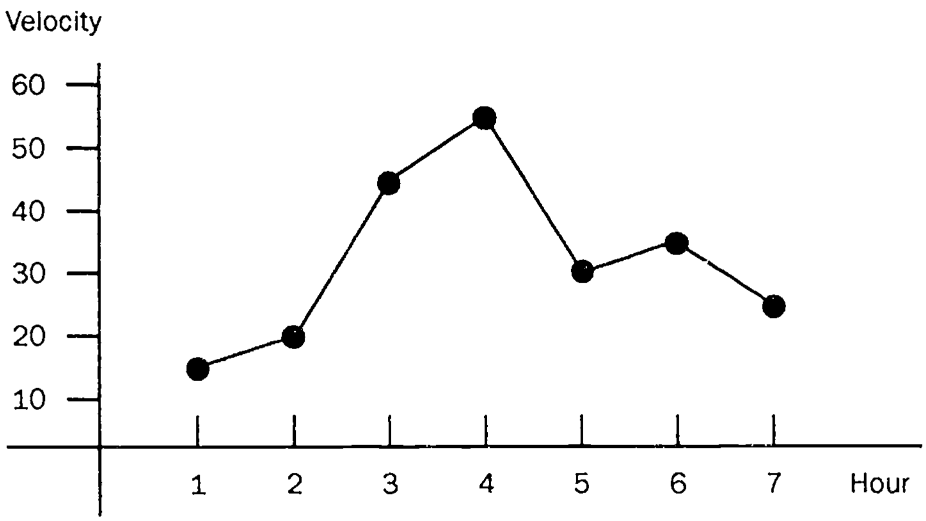
Materials

Set of questions
Chart with description of effect of wind
Counters
Trading Chip Board

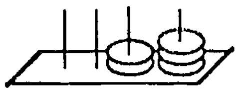
In a wind storm in west Texas during the Spring, the velocities were measured over a 35-hour period every five hours. The first reading showed a wind speed of 15 miles per hour, the second reading 23 miles per hour, the third 45 miles per hour, the fourth 53 miles per hour, the fifth 32 miles per hour, the sixth 36 miles per hour, and the seventh 28 miles per hour. Make a line graph showing the velocity of the wind over the 35-hour period.

Problems

1. Order the velocities from greatest to least.
2. What was the least destructive velocity?
3. What was the difference between the greatest and least velocities? Can you show the difference on the line graph?
4. What was the difference between the two smallest velocities?
5. What damage does a 53 mile per hour wind cause?
6. What effect does a 15 mile per hour wind have?
7. What was the greatest velocity during the storm? How can you see it on the graph?



To subtract 2-digit numbers, students may want to use counters (either as single counters, or by grouping into 10s and ones) to represent the velocities
Trading Chip Board - demonstrates 10s and ones to subtract



8. After answering the questions, the students write or draw and explain their answers. Students may use
   1. a Trading Chip Board to perform the subtraction.
   2. an expanded notation format to help them subtract using the idea of "renaming" instead of "borrowing", e.g.,

5 tens 3 ones	renamed to	4 tens 13 ones
-1 ten 5 ones		-1 ten 5 ones
		3 tens 8 ones

   Use a laminated chart with 10s and ones labels and erasable markers.

Assessment

Paper and Pencil Assessment

1. Use the numerals 1,2,3 only once each to write as many different numbers as you can. For example, 123 is one number and 312 is another.
2. Put the numbers in order from least to greatest.

Performance Assessment

1. Use a counter, a Trading Chip Board or a Place Value Chart to show which number is greater 29 or 34, 71 or 66? Explain your answer to your teacher.
2. On a set of cards write the following numerals on one side of the card and these letters on the back of each card, respectively.
3. The students order the numbers and then turn the cards with the letter-side up. If the order is correct, they can read a sentence.

3	6	14	19	21	36	48	51	62	79	81	92	95
y	o	u		a	r	e		r	i	g	h	t

ACTIVITY
Go Fly a Kite!

Objective

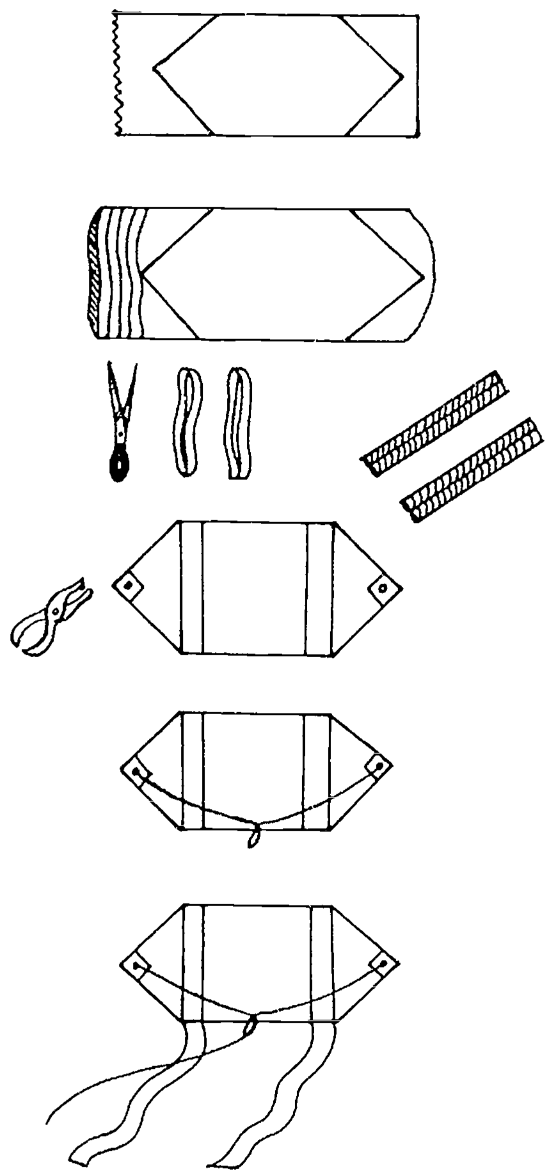
The students construct a kite following these directions.

Materials

Two drinking straws; masking tape; garbage bag; kite string; large paper bag; pattern cutout as shown; the kite is as wide as the straws are long

Procedure

1. Cut a pattern from paper in this shape.
2. Trace the kite pattern onto a plastic garbage bag with a permanent marker. Leave room at the end to cut two kite tails.
3. Cut two loops of the plastic bag in one place to make two tails. Cut out the two kites with scissors.
4. Lay two straws on the sticky side of wide masking tape. Trim off excess tape. Invert the tape and straws onto the kite and attach them, as shown.
5. Put a piece of tape on each side of the kite. Punch a hole through both the tape and the plastic.
6. Tie one end of a thin string through each of the holes. Tie a loop in the center of the string to attach your long kite string.
7. Tape a tail to the kite at the bottom of each straw.
8. Decorate your kite with permanent markers. Tie on a kite string.



LESSON 5 Clouds, Rain and Snow

BIG IDEAS Clouds, rain and snow are all different forms of water vapor; the form of the precipitation depends on the temperature of the surrounding air.

Whole Group Work

Materials

Thermometer; stopwatch/digital clock marking seconds; glass tumbler with frozen water; two washcloths; piece of string

References on the Dust Bowl in the United States; reference books on precipitation

Word tags: snow, cloud, rain, precipitation, freezing, dew point, condensation, evaporation, names of the types of clouds, humidity

Prior Preparation

Very early in the day, students working in small groups fill a bottle **almost** to the top with water and then cap it to prevent water from leaking. A piece of tape marks the top of the water level on each group's bottle.

Place the filled bottles in the freezer. Put a piece of clear tape around the top of each bottle so if the cap is opened the tape will pull off. The students can see that no additional water went into the bottle.

After the water has had an opportunity to freeze, the students hypothesize as to the cause of the increase in volume of the water that is now frozen. **Caution:** If students fill the bottle to the top or very close to the top, the bottle will break and may cause an injury. Before removing the bottles from the freezer, check to see that none are broken. If one has broken, the teacher removes the bottle and the pieces.

Encountering the Idea

A few minutes before beginning this lesson, bring out the bottles with the frozen water. Ask the students to predict what will happen if you leave the bottle outside the freezer for several minutes. As they offer answers, have them watch the outside of the bottles carefully. Soon, frost will begin to collect on the sides. Ask students what it is. Yes, it is frost, but what is frost? (Water, water vapor.) Where did it come from? It is in the air. Water vapor is one of the gases in the air we breathe. Sometimes there is more water vapor in the air than at other times, and sometimes less. The water vapor in the air we call **humidity.** Humidity is one of the conditions we feel in weather. High humidity in the air can make us feel hotter at a particular temperature than we would feel at the same temperature if the air were not humid. We will learn how to measure the humidity in the air.

Showing pictures of different types of clouds, ask the students what a cloud is. Write the correct responses such as water, water vapor, rain, etc. on the chalkboard for further use.

Look outside the classroom and ask the students if they can see clouds. If there are clouds, the students go outside to describe the clouds. Students note the different shapes, colors, size, number (many, few, or just one large one covering a large area, etc.) and as many other weather conditions as possible.

On returning to the classroom ask what makes clouds have different colors. What makes clouds have different shapes? Size? Ask students what makes rain. Where does the water come from that makes rain? When does rain turn to snow? Yes, when it gets cold. What is snow? How are rain, snow and clouds different? Are rain, snow and clouds the same in any way? Tell students that they will discover what makes clouds, why clouds have different shapes and what rain and snow are.

Exploring the Idea

At the **Science Center:**

1. Before letting the students work on their own in the center, ask a student to take a wet washcloth, place it on his/her arm and secure it with a piece of string. Place and secure the other wash cloth on the other arm. The student swings his/her arms around rapidly. The student describes what he/she feels. The students hypothesize as to the reason for the sensation of cold. Students discuss their experiences of getting out of the swimming pool or shower and feeling cold when wet but warm when dry. Ask the students to think about this as they complete the activities in the learning centers.
2. Complete **Activity** — Making a Hygrometer
3. Complete **Activity** — Clouds
4. Complete **Activity** — The Dew Point
5. Complete **Activity** — Six-sided Snowflakes.

Getting the Idea

After students have had an opportunity to complete the activities, ask:

1. Why does a wet washrag feel cold on your arm?
2. What makes rain? Where does the water come from that makes rain? (Water, in the form of water vapor, is always in the air. As warm air rises, it condenses into small droplets of water that come down as rain.) Review the experiment in which students made rain and clouds in the classroom. The students may wish to repeat the activity. When does rain turn to snow?
3. Did you discover what makes clouds have different colors? Guess what it might be.
4. What makes clouds have different shapes? Size?
5. What is snow? How are rain, snow and clouds different? Are rain, snow, clouds and water vapor the same in any way? If so, how?
6. From the experiments we completed, what would you guess are the main things, or factors, that make rain, snow and clouds? (Humidity and temperature of the air.) Give students the names of the clouds and a general description of the clouds' appearance.
7. What word is used to refer to clouds, rain, drizzle, fog, snow, hail, frost, ice and so on? (Precipitation.)
8. What happened to the water that was frozen overnight? What made the volume (the space that it took up in the bottle) of the water increase? Did we put

more water in the bottle? How do you know someone didn't put more water in the bottle? (Water expands as it freezes. At 4° C water has its lowest density.)

Cloud Types

Cirrus (curl, "churro") — high, ice crystal clouds that look like wispy curls, are often signs of bad weather.

Cumulus (heap, collection) — fluffy puffs that look like cauliflowers, appear in sunny, summer skies.

Nimbus (rain, "neblina") — thick, dark gray clouds that bring rain or snow.

Stratus (layer) — low, gray blanket that often brings drizzle, cover high ground and cause hill fog.

Fog — condensed water vapor in the air, usually lying close to the ground.

Hail — ice crystals in a cumulonimbus cloud can form hail. The ice crystals are tossed around in the cloud, and caps of frozen water form on the crystals like skins on an onion. When they get big and heavy, the hailstones fall to the earth.

Dust Bowl — when there is no rain in a region for a long time, the soil becomes so dry that the wind blows it away easily.

Snow — the solid form of water that freezes and grows while floating, rising or falling in the free air of the atmosphere. Snow is a crystal of six sides. Snowflakes usually have the shape of plates, or of stars.

Organizing the Idea

After students complete **Activity** — Clouds, they make a chart showing the differences and likenesses among the different types of precipitation. (Air temperature is an important factor as is the humidity in the air.)

Applying the Idea

Problems

1. Why does frost form on ice cubes in the refrigerator?
2. Why do the insides of car windows get cloudy if you blow on them in cold weather? (The frost that forms in ice cube compartments of refrigerators and in freezers develops from the water vapor condensing on surfaces that are below 0° C, the temperature at which water freezes. The more often we open the door, the more warm, moist air gets in. The insides of auto windows are cold; warm, moist breath condenses and, if it is cold enough, turns to frost.)
3. Research and report on the causes a "Dust Bowl." (The lack of humidity in the air and the lack of plants to secure the soil.)

Problem Solving

1. Draw a picture of a frozen lake in the winter. What can people **do and not do** on a frozen lake? Explain your answer.
2. Will a river freeze? When?
3. What happens to the fish under the lake?
4. What would happen if the lake froze from the bottom to the top, instead of freezing on the surface first?

Closure and Assessment

1. The student constructs a hygrometer (or another of the instruments to collect weather data that students have constructed) and explains to his/her partners and/or the teacher how it works. The student also explains what information about weather conditions a hygrometer (or other instrument) provides.
2. Student describes and/or draws a snowflake. The student explains how snowflakes (and/or other forms of precipitation) form.

List of Activities for this Lesson

- ▲ Making a Hygrometer
- ▲ Clouds
- ▲ The Dew Point
- ▲ Six-sided Snowflakes

ACTIVITY

Making a Hygrometer

Objective

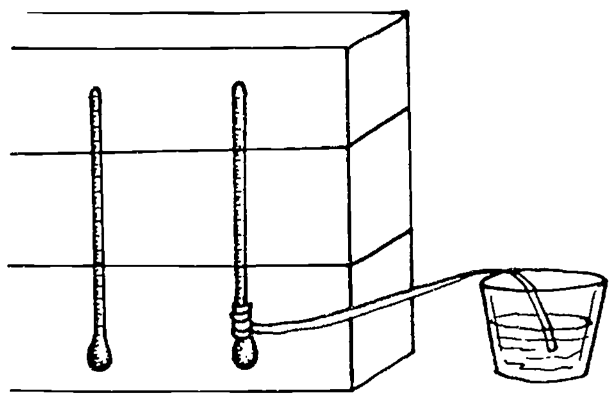
Students construct a hygrometer and read the relative humidity.

Materials

Two identical thermometers; shoelace (with tips cut off) 20 cm. (eight in.) long; two rubber bands; piece of styrofoam 12 x 6 inches long

Procedures

1. Use the rubber band. Fasten the two thermometers side by side on the styrofoam about four inches apart with the rubber bands.
2. Moisten the shoelace and wrap one end around the bulb of one thermometer. Put the other end of the shoelace in the glass of water.
3. After about five minutes, compare the temperatures of the thermometers.
4. What do you think caused the temperature to drop? Convert the wet-dry difference in temperature to relative humidity.



Getting the Idea

Tell students that, after a few minutes, the wet bulb will have a lower temperature. This is a wet-dry bulb hygrometer. The shoelace cools from the evaporation of the water on it into the air. Humidity is the amount of moisture the air contains compared to the amount it *can* contain. The less moisture the air contains, the greater the amount it can absorb. As the ability to absorb water increases, the temperature drops. The greater the difference in temperature between the wet and dry bulbs, the lower the humidity (amount of moisture already in the air). Or the greater the difference in temperature between the wet and dry thermometers, the greater the amount of moisture the air can still absorb.

▲ ACTIVITY
Clouds

Draw these clouds in your journal and label them.

Stratus — spread out; low fog that brings drizzle

Cumulus — look like heaps or mountains; low clouds bring sunny spells

Cirrus — curly; ringlet; ice crystals high in the sky

Nimbus — rain clouds; bring mist; gray

Record the cloud conditions on your weather chart each day, labeling and describing the clouds as you observe them.

ACTIVITY
The Dew Point

Objective

Students find the dew point of the air in the classroom.

Materials

Two identical metal cans without labels
Two thermometers
Ice water in a container for at least one hour at room temperature

Procedures

Students work in small groups.

1. Take and record the temperature of the air in the room (rounded to the nearest degree Celsius).
2. Fill one shiny can with water from a container. This is Can 1.
3. Insert a thermometer in the container, take a temperature reading and record; have student pairs read and check each other's reading.
4. Half fill a second can (Can 2) from the **same** supply of water and place a second thermometer in it; take temperature reading and record. Both readings should be the same.
5. Fill Can 2 with ice, and wipe the surfaces of both cans with a paper towel to be sure they are dry.
6. As soon as droplets of water appear on the surface of Can 2 containing ice and water, take and record the temperature of both cans. Students discuss:
   (1) where the droplets of water came from
   (2) why we need two cans
   (3) why it is important not to get our breath (warm, moist) on the can
   (4) under what conditions they have noted similar events in everyday life.
7. What is the dew point?

Getting the Idea

Tell the students that the amount of water vapor (an invisible gas) in the air varies with atmospheric conditions, as does **the dew point, the temperature at which water vapor condenses.** Since metals are good conductors of heat, the surfaces of the can are essentially the same temperature as the water inside the cans. The can of water at room temperature (on which dew does not form) shows that the droplets on the other can are not leaking or "sweating" through the can and must be forming from the air.

TEMPERATURE RECORD

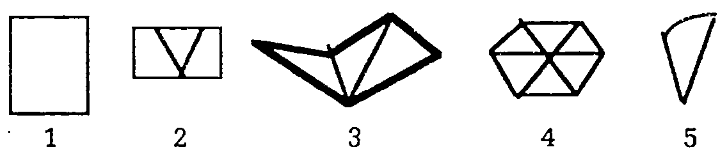
	Air in Room	Water in Can 1 (No Ice)	Water in Can 2 (No Ice)	Water and Ice in Can 2 Dew Point
First Reading				
Second Reading				
Hot, Humid Day				
Cool, Dry Day				

ACTIVITY
Six-sided Snowflakes

Objective
Student describes snowflake patterns.

Materials
Sheet of paper for each student; protractor to measure angles; scissors

Procedures
1. Fold a square piece of paper in half, on the diagonal. (Fig. 1)
2. Locate the midpoint of the folded edge. Draw two 60° angles from the midpoint of the diagonal. (Fig. 2)
3. Fold the piece of paper in thirds along the lines drawn for the two 60° angles. (Fig. 3) (The edges will not be straight.)
4. Cut the folded sheet across the lowest part (or the shortest side) of the paper. (On unfolding the paper, you will see a six-pointed shape that is the base for the snowflake.) (Fig. 4)
5. With the paper folded in thirds, and then again in half, students can cut out shapes on each side. (Fig. 5)
6. Open the paper to see the snowflake.



Usual Shapes

Discussion
1. How many different lines of symmetry can you find in a snowflake?
2. How many sides do snowflakes have?

LESSON 6 *Nature's Light Show*

BIG IDEAS Lightning is produced by huge exchanges of electrical charges; thunder is produced by expanding air; we can estimate the distance of a thunderstorm.

Whole Group Work

Materials

Small pieces of tissue; piece of rabbit fur or wool cloth; paper sack; inflated balloon; piece of carpet, 2 x 2 feet; rubber mat; chart showing the distance/time relation

Encountering the Idea

Ask students if any of them have ever walked on a thick carpet across a room, then touched the television set or some other object and had a spark hit them. The spark was an electrical discharge, like lightning. Take the inflated balloon and pop it with a pin. Ask the students what they think caused the noise. What happened to the air in the balloon when the balloon popped? Tell the students that by doing the following experiments they will discover some of the conditions that cause lightning and thunder.

Exploring the Idea

Ask a student to stand on the piece of carpet close to a metal object (like a drinking fountain) and shuffle her/his feet briskly on the carpet, then reach out to touch the piece of metal. What happened? Take the piece of fur, rub it briskly on the glass rod and then pick up pieces of tissue with the rod. (The rod acts like a magnet and attracts the pieces of tissue. As the glass rod is over the paper, the rod may even crackle and spark.) Both of these actions — walking on a carpet and the piece of fur — have the same thing in common: both of them involved rubbing. Ask the students to hypothesize as to the reasons for the spark. Write the ideas on a chalkboard.

A student stands on a rubber pad. Another student rubs the first student's back briskly with the piece of fur. Place the glass rod over the student's head. What happens?

Take the paper sack and pop it with your hand. Take the soda pop bottle, shake it and then open it. Again, ask the students what they think caused the noise. They can hypothesize about the cause of the noise.

Students complete **Activity** — Estimating the Distance of a Thunderstorm.

Getting the idea

Lightning is a form of electrical energy. When clouds move against each other, one of the clouds receives electrical charges from the other cloud. The cloud with extra charges is now at a different energy level than the other cloud and/or the earth. This difference in the number of electrical charges between the clouds we call "static electricity." Static electricity builds up in a thundercloud and releases as a brilliant flash of light into the ground, or into another cloud, in order to obtain a balance with the electrical charges.

Sound waves traveling in the air cause noise. When air heats, it expands, and when it expands rapidly, it causes sound waves in the surrounding air. Rapid heating of air, because it is expanding like the air released from the balloon, causes the noise. Lightning causes thunder as it heats the air in its path to 30,000° C (54,000° F), which is five times hotter than the sun's surface. As the air expands very rapidly, the speed of the moving air causes the booming noise called thunder.

Thunderstorms usually occur when the air is humid and warm. Cumulonimbus clouds form and, as these clouds form, the air begins to move rapidly, causing gusty winds. Lightning can occur between the earth and a cloud, or from cloud to cloud.

Organizing the Idea

If you have listened to Vivaldi's **The Four Seasons,** were you able to detect the lightning and thunderstorm the composer included in the music? In what season did the thunder appear? Try to find the thunder in the music. Can you imagine the thunderstorm? Is Spring usually the season for thunderstorms? Why?

At the **Writing Center**, write a poem that describes your favorite season, for example, how "April showers bring May flowers" or about Frosty the Snowman.

Applying the Idea and Assessment

In the activity on estimating the distance of a thunderstorm, read the line graph to answer the following questions.

1. How far is the lightning if you see the flash and hear the clap of thunder almost immediately after?
2. If you are four kilometers from a thunderstorm, how long will the noise of thunder take to reach you after you see the lightning?

List of Activities for this Lesson

▲ Estimating the Distance of a Thunderstorm

ACTIVITY
Estimating the Distance of a Thunderstorm

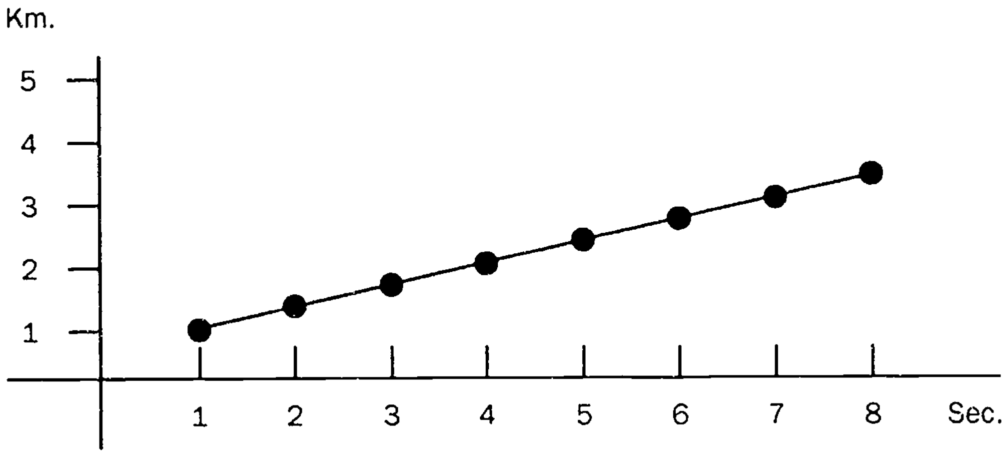
Objective
Students read and interpret a graph.

Materials
A copy of the graph for each student group.

Procedures
1. Explain to students the difference between the speed of sound and the speed of light.
2. Students study the line graph.
   - What does the horizontal line (axis) tell us? (Seconds it takes the thunder to reach the listener after the lightning.)
   - What does the vertical line tell us? (The kilometer.)

Lightning and the ensuing clap of thunder occur at the same time. We sometimes think the lightning occurs first because we see it first, and then we hear the thunder. The reason for this delay is that light travels much faster than sound.

If you see a bolt of lightning and begin to count the number of seconds it takes to hear the clap of thunder, the storm is a little less than half that number of kilometers away. For example, if you hear thunder six seconds after you see the flash, the storm is about three km away. You can estimate the number of seconds by counting one thousand one, one thousand two, one thousand three, one thousand four, and so on, or time them on a watch with a second hand.



You can use this chart to estimate the distance between you and a thunderstorm.

3. How far is a thunderstorm if it takes eight seconds for the sound of thunder to reach you after you see the flash?
4. How far is a thunderstorm if it takes three seconds for the sound of thunder to reach you after you see the flash?

LESSON 7 Weather Forecasting

BIG IDEAS Would **you** like to be a weather forecaster? We base weather predictions on data that we have gathered over many days.

Whole Group Work

Materials

Chart from **Activity** — Groundhog Weather Station and **Activity** — Data and Line Graphs
Markers
All the data collected to date
All the instruments used in collecting weather data

Encountering the Idea

Tell the students that they will now become weather forecasters at **Groundhog Weather Station** (or any name they wish to give to their weather station — name of school, school mascot, etc.) They will predict the weather for the next week and compare their forecast to the radio or television forecast, one day at a time.

Ask students to suggest ways of making a weather prediction for the next day. What information will they use? Why? What temperature will they predict for tomorrow? Air pressure? And so on.

Exploring and Organizing the Idea

If the students do not suggest it, suggest that since the class has been keeping records of weather conditions such as outside temperature, dew point (humidity), air pressure (barometer), precipitation, wind direction (wind sock) and speed (windometer), they can use this data to make predictions, to make a forecast. In making their predictions, the students must defend their forecast with reasons based on the data.

At the **Groundhog Weather Station** (GHWS), the students complete

1. **Activity** — Data and Line Graphs
2. **Activity** — Weather Forecasting, continued from Lesson One.

Using the idea suggested in **Activity** — Data and Line Graphs, the students summarize the data collected on the previous days into line graphs.

Getting the Idea

1. Discuss making decisions based on data, as given in the activities.
2. The class may wish to invite a local meteorologist to review the work of the class and to give further explanations. The meteorologist may want to discuss forecasting the weather as a career.
3. The students design, organize, write and draw weather maps for a daily television program to forecast the next day's weather.

Closure and Assessment

1. At the **Music Center**, the students may want to sing and listen to a tape of **Oh, What a Beautiful Morning!** The students write a paragraph telling about how the weather affects their feelings during a beautiful day or during an ugly, cold, wet day.
2. The entire lesson may serve as a final unit assessment, involving oral, performance and written activities that indicate the level of a student's understanding of the concepts and the level of performance in the various skills required in the unit.
3. Individual assessments can be made on the chart for **Activity** — My Forecast.

List of Activities for this Lesson

▲ Data and Line Graphs

▲ Weather Forecasting (see Lesson One)

▲ My Forecast

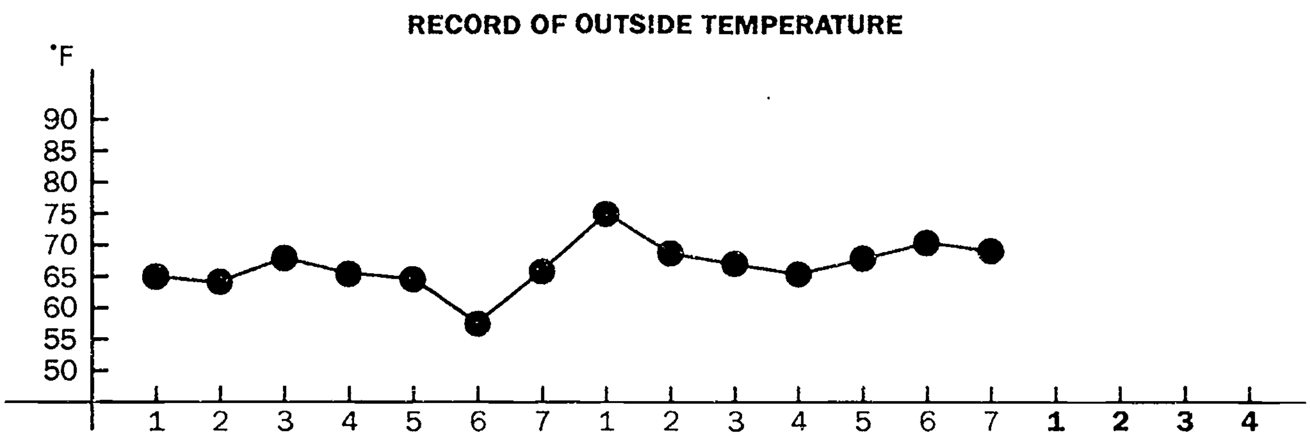
ACTIVITY
Data and Line Graphs

Objective

Students show summarized data on a line graph.

Procedure

Rewrite the information on a graph that shows the date and the temperature at the same time.



Information to consider:

1. Which is the most frequent, or common, temperature?
2. Which is the highest temperature? What other weather conditions occurred at that time? Was it sunny? Air pressure?
3. Which is the lowest? What other weather conditions occurred at that time? Was it cloudy? Air pressure?
4. What is your temperature forecast for tomorrow?

ACTIVITY

My Forecast (continued from Lesson 1)

Name ____________________

Date (today) __________ Day __________ Month __________ Year

Season __________

Outdoor temperature ______________

Sky: ________________
Clouds?

Precipitation: ________________
Rain, Snow

Wind direction: __________________
North, South, East, West

Wind speed: _______________

Barometric Pressure: ____________

Dew Point (Humidity): ______________

____
Tomorrow's Forecast

Indoor temperature ______________

Sky: ________________
Clouds?

Precipitation: ________________
Rain, Snow

Wind direction: __________________
North, South, East, West

Wind speed: ________________

Barometric Pressure: ____________

Dew Point (Humidity): ______________

UNIT ASSESSMENT

Students answer the following, using the words **evaporate, cold, warm, rain** to complete the sentences.

Oral or Written Assessment

1. When water vapor cools we get ____________.
2. When water vapor becomes ____, it will evaporate.
3. When the water in the lake becomes warm, it will ________.
4. When water vapor becomes _______, it will condense.

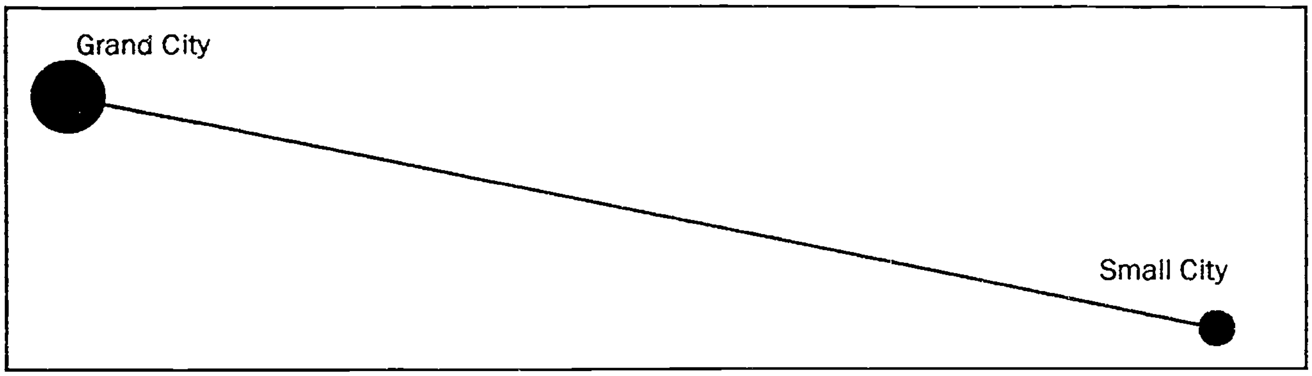
Performance Assessment

1. A snowstorm is moving at 45 miles an hour. Complete this chart to show how far the storm will have traveled after five hours.

hours	½	1	1 and ½	2	2 and ½
miles	45				

2. Draw a snowflake and describe it to your teacher. Be sure to use the geometric terms you learned in this unit when you describe your snowflake.
3. Describe the current weather conditions to your teacher. Tell your teacher what you predict the weather will be for tomorrow. Be sure to take all the information you can find about the weather outside your classroom with you before you talk to your teacher; use a chart to help you summarize your report. (E.g., outside temperature, wind direction, wind velocity, type of cloud cover, and **prediction of the conditions that are likely to prevail,** etc.)
4. A weather map shows that Grand City and Small City are 3 1/2 inches apart. If 1/2 inch represents (stands for) each 80 miles, how many miles apart are **Grand City** and **Small City**? You may want to draw a chart to help you explain how you decided on the distance between the two cities.

inches	1	1 and ½	2	2 and ½	3	3 and ½
miles	(80)	(160)	(240)	(320)	(400)	(480)



5. **Snow City** is 240 miles from **Grand City.** How many inches apart are the two cities on the map? Use the same table that you used for #4, to help you decide. Draw **Snow City** anywhere on the map using the same scale as in problem #4 above.
6. Explain to your teacher what causes rain. You may use any materials you need from the **Science Center** to help you in your explanation. Or, you may draw a set of pictures to explain what causes rain.
7. Additional assessment items are available in **Activity** — Weather Forecasting and **Activity** — My Forecast.

References

Annoted Children's Books

Branley, F. M. (1962). *Air is all around you.* New York: Thomas Y. Crowell.
A basic book about air. It contains very simple text.

Branley, F. M. (1983). *Rain and hail.* New York: Thomas Y. Crowell.
Contains a clear explanation of the fornation of rain and hail.

Branley, F. M. (1985). *Flash, crash, rumble, and roll.* New York: Thomas Y. Crowell.
Explains formation of thunder clouds, occurrence and dangers of lightning, and the causes of sound of thunder.

Branley, F. M. (1985). *Hurricane watch.* New York: Thomas Y. Crowell.
Contains descriptions of the origin and nature of hurricanes. It also suggests ways of staying safe when in hurricane areas.

Branley, F. M. (1986). *Snow is falling.* New York: Thomas Y. Crowell.
Explains the ecology of snow and includes some simple experiments for grades PK-2.

Branley, F. M. (1987). *It's raining cats and dogs: All kinds of weather and why we have it.* New York: Houghton Mifflin.
Describes strange weather condition such as pink and green snowstorms, mixed with scientific explanations of the weather.

Branley, F. M. (1988). *Tornado alert.* New York: Harper Collins Childrens Books.
This K-4 volume provides explanation of the tornado.

Broeckel, R. (1982). *Storms.* Chicago: Children's Press.
Illustrated for grades 1-4, this contains causes and effects of storms.

Busch, P. S. (1971). *A walk in the snow.* New York: J. B. Lippincott.
Shows winter scenes, enabling children to raise and answer questions about snow. It is recommened for grades 2-4.

Catherall, E. (1991). *Exploring weather.* Austin, TX: Steck-Vaughn.
A textbook-style volume, which contains questions, a glossary, books to read, and an index. It addresses air currents, temperature, air pollution, and other topics.

De Paola, T. (1975). *The cloud book.* New York: Holiday House.
Illustrated by the author, this K-3 volume provides information on the 10 most common types of clouds.

Dickinson, T. (1988). *Exploring the sky by day: The equinox guide to weather and the atmosphere.* Ontario: Camden House.
Provides explanation of weather and its formation.

Dorros, A. (1989). *Feel the wind.* New York: Thomas Y. Crowell.
Explains causes, effects and usefulness of wind.

Editorial Molina. (1971). *Mi primera biblioteca básica: El aire.* Barcelona: Author.
This is one of a series in a basic science library in Spanish. Describes several experiments to detect the presence of air.

Editorial Molina, (1972). *Mi primera biblioteca básica: Tiempo atmosférico.* Barcelona: Author.
One of a series, this addresses wind velocity, kinds of clouds, and many other atmospheric conditions.

Ellentuck, S. (1968). *A sunflower as big as the sun.* Garden City, NY: Doubleday & Company.
Uncle Vanya's boasting leads to darkness and cold and the end of the world.

Evans, E. K. (1965). *The snow book.* Boston: Little, Brown and Company.
In addition to defining and explaining snow formation, the author addresses how snow affects different segments of our population.

Gibbons, G. (1987). *Weather forecasting.* New York: Four Winds Press.
Provides a tour of a weather station during the four seasons.

Goudey, A E. (1950). *The good rain.* New York: E. P. Dutton.
This is the story of what the lack of rain can mean both to a city and a country child. For shared reading or just for sustained reading.

Hood, F. (1966). *One luminaria for Antonio.* New York: G. P. Putnam's Sons.
Story about Antonio, a poor boy, who finds a blessing on Christmas Eve.

Horton, B. S. (1992). *What comes in spring?* New York: Alfred A. Knopf.
The story describes events in the different seasons, including how a baby grew inside her mother as the seasons changed.

Larrick, N. (1961). *Rain, hail, sleet and snow.* Champaign, IL: Garrard.
Offers clear explanations of the formation of hail, sleet, dew, frost, and many other weather conditions. Contains a simple illustration of the water cycle.

MacDonald, E. (1992). *The very windy day.* New York: Willian Morrow and Company.
Humorous tale of how four people running errands on a very windy day lose their possessions by the force of the wind, and by the same force, regain them.

Munsch, N. (1984). *Millicent and the wind.* Ontario: Annick Press.
Story of a young girl whose only playmate is the wind.

Newton, J. R. (1983). *Rain shadow.* New York: Thomas Y. Crowell.
Contains an explanation of how the "rain shadow" or dry environment develops on the leeward side of many high mountain ranges.

Purdy, C. (1985). *Iva Dunnit and the big wind.* New York: Dial Books for Young Readers.
A tall tale about a pioneer women with six children and their experience with a windstorm.

Simon, S. (1969). *Wet & dry.* New York: McGraw-Hill.
This volume poses questions and suggests projects for young readers.

Simon, S. (1989). *Storms.* New York: Morrow Junior Books.
This book is an excellent way to introduce children to meteorology.

Stolz, M. (1988). *Storm in the night.* New York: Harper Collins.
A fictional story for ages 5-8 tells of how a grandfather and his grandson sit through a thundersorm and get to know more about each other.

Webster, V. R.(1982). *Weather experiments.* Chicago: Childrens Press.
Provides a simple explanation of how weather evolves.

Wyler, R. (1986). *Science fun with peanuts and popcorn.* New York: Julian Messner
Contains simple experiments that explain scientific principles.

Zim, H. S. (1952). *Lightning and thunder.* New York: William Morrow and Company.
Presents a good explanation of lightning and thunder. Contains do's and don'ts during a lightning and thunder storm.

Teacher References

Adler, I. (1959). *Weather in your life.* New York: The John Day Company.
Addresses many questions about weather. It includes an explanation and illustration of the Beaufort scale.

Alcántara, R. (1989). Baul de cuentos. *La bruja que quiso matar el sol.* Madrid: Hymsa.

Andersen, H. C. (1987). *Cuento de Hadas: La reina de las nieves.* Costa Mesa, CA: Everest

Balzola, A. & Parramón, J. M. (1986). *La Primavera.* Woodbury, NY: Barron's.

Barret, J. (1978). *Cloudy with a chance of meatballs.* New York: Macmillan.

Jean-Claude, B. (1990). *Albumes ilustrados: Un invierno en la vida de gran oso.* Madrid: Ediciones Susaeta.

López-Lomas, E. A. (1991). *El hombre de la lluvia.* Mexico. Edamex.

Ross, F. Jr. (1965). *Weather: The science of meteorology from ancient times to the Space Age.* New York: Lothrop, Lee & Shepard.
This is a book for a general reading, yet scientific enough. It contains some illustrations and good background information.

Schneider, H. (1961). *Everyday weather and how it works.* New York: McGraw-Hill.
With good illustrations, this volume cover many aspects of weather.

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Vasquez, Z., & Montelongo, J. (1980). *Cuentos del abuelo: El naranjo que no daba naranjas* Mexico: Trillas.

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unit

2 Sun & Stars

Prior Knowledge

The student has

1. referred to the north, south, east and west as directions
2. counted to 100
3. shown two- and three- digit numbers on a place value chart
4. subtracted two- and three-digit numbers with renaming and regrouping using manipulatives
5. multiplied single-digit numbers in arrays
6. divided two-digit numbers by forming equivalent groups
7. graphed and read information from graphs
8. used fractions such as 1/2, 1/3, 1/10.

Mathematics, Science and Language Objectives

Mathematics

The student will

1. use numbers through one million to discuss/describe number, distance and temperature
2. compare large numbers using subtraction, division and "times"
3. sequence the planets in our solar system by size and/or distance from earth using given data
4. find points on a plane using two dimensions
5. use "sphere" to describe stellar bodies
6. compare two objects using **times**, as well as "**more than**"
7. use the logical sentence structure: If ..., then ... .
8. describe closed paths as circular, elliptical; parabolic paths are not closed
9. use integers.

Science

The student will

1. describe stellar objects using terms such as stars, planets, satellites, orbits and light
2. say that stars are objects that produce their own energy in the form of light and heat
3. list star characteristics as color, brightness, distance from earth and size
4. say that a star's color depends on its temperature
5. demonstrate how light and heat are important to living things such as plants
6. describe the difference among stars, planets, meteors, satellites and comets

7. list the nine planets of our solar system
8. list and describe at least four types of stars
9. describe our sun as a yellow star that is about average in temperature and small in size
10. say that the gravity a stellar body exerts depends on its mass
11. describe how stars can be seen as patterns called constellations
12. say that our sun is the only star in our solar system, but not in the universe
13. demonstrate moon phases and a lunar eclipse
14. demonstrate how stellar objects stay in orbit.

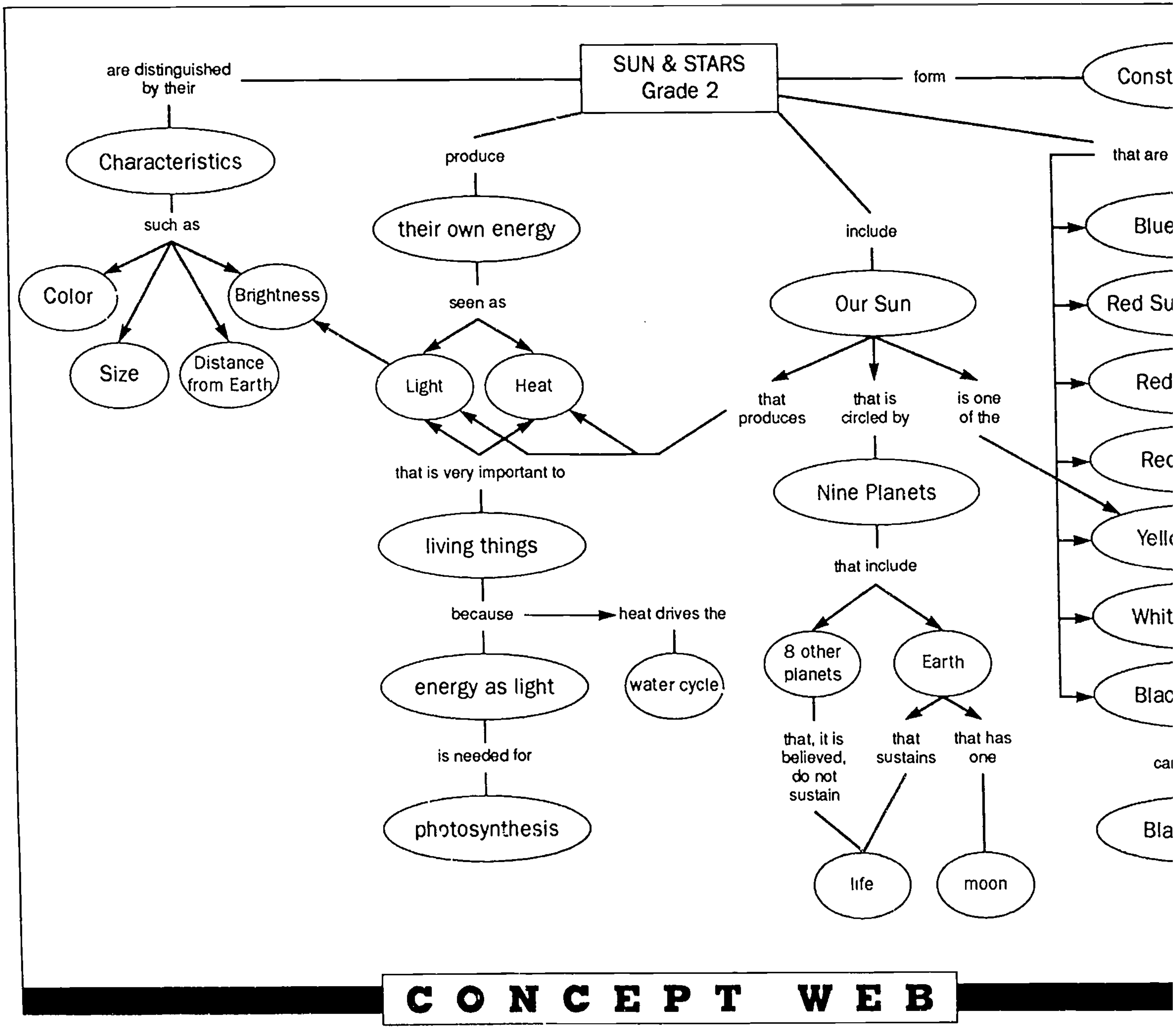
Language

The student will

1. engage in dialogue/discussion
2. define terms, using them to discuss new ideas
3. listen to narration
4. write complete sentences in a theme journal
5. read for information, organize and report on information and data gathering
6. create stories, using theme-related vocabulary.

VOCABULARY

sun sol	earth tierra	sky cielo	rotate rotar	revolve girar	space espacio
bright brillante	dim opaco	star estrella	telescope telescopio	shade sombra	solar system sistema solar
sphere esfera	glowing brillar	gases gases	hydrogen hidrógeno	helium helio	core centro
sunspots mancha (s)	particles partícula (s)	eclipse eclipse	atmosphere astmósfera	corona corona	solar flares resplandor solar
astronomers astrónomos	reflect reflejar	planets planetas	orbit órbita	gravity gravedad	asteroids asteroide
craters crater (es)	comet cometa	meteor meteoro	meteorite meteorito		


SUN & STARS
Grade 2
are distinguished by their
Characteristics
such as
Color
Size
Distance from Earth
Brightness
produce
their own energy
seen as
Light
Heat
that is very important to
living things
because
heat drives the
water cycle
energy as light
is needed for
photosynthesis
include
Our Sun
that produces
that is circled by
is one of the
Nine Planets
that include
8 other planets
Earth
that, it is believed, do not sustain
that sustains
that has one
life
moon
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Blue
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Teacher Background Information ● ● ●

Before the 16th century most people in the Western World, that is to say Europe, believed the earth was the center of the universe and the sun, moon, stars and all of the other "heavenly" bodies revolved around it. The path the earth traveled was called an **orbit**. Copernicus, a Greek astronomer, was the first person to say the sun was the center of a system composed of the earth and some other planets that revolved around the sun. He also believed that the earth's path around the sun was circular, and that a few stars, which he called **planets**, also moved through the sky in circles around the sun and were similar to earth.

Soon after Copernicus, a mathematician named Johannes Kepler observed that the true movement of the earth and other planets was not what Copernicus believed. Using his knowledge of mathematics, Kepler changed the round path or orbit to an elongated circle called an **ellipse**.

Copernicus' theory as modified by Kepler was again modified by Galileo, who was one of the first astronomers to study the sky with the use of a telescope. People did not want to believe that the **earth was not the center** of the universe. Galileo set up a telescope in the center of town and asked the scientists of the day to observe the sky, in other words, to engage in scientific inquiry. The scientists refused and Galileo was later convicted of heresy, partly because of his support of the Copernican model of the solar system.

Since the day of Galileo, many scientific advances have made it possible to design and construct new telescopes that give us information about outer space. Although Galileo and the other astronomers were correct about the sun being the center of our solar system, no one has claimed to have found the center of the universe!

Current thinking describes stars as self-luminous objects that shine by radiation produced in continuous nuclear and other processes within the stars themselves. By contrast, planets shine because they only reflect light. As far as its properties can be compared to other stars, the sun is a typical star. It has a mass more than 300,000 times that of the earth and a radius of 696,000 km (432,200 miles). Star temperatures can range around 5,000 to 20,000° C. Our sun's temperature is about 6,000° C, which puts it in the medium range.

Information about stars depends on scientists being able to know the stars' distances from earth. One important way to calculate these distances is to look at their luminosity. The luminosity of shining objects varies with the distance of the object from the observer, and we use that principle to calculate the distance of stars. Thus, we accurately know stellar distances for nearby objects, but the distances of stars in the more remote parts of the galaxy we can only estimate.

How the universe and stars formed is a question astronomers continually study. The solar system in which we live came into being many millions of years ago. There may be other solar systems in our own galaxy; perhaps 100 million stars have orbiting planets, thus making other solar systems. There are perhaps about two or three million solar systems that have planets capable of supporting higher forms of life, similar to that on earth. The chances are, however, that we may never get to know or study any of the possible life-bearing planets.

Advance preparation

In preparation for **Activity** — Plants and Sunlight, as below.

Students bring several plants to class or plant some beans in several pots. Keep one half of the pots in the sunlight and water them, and keep the other half in a closet or some other dark place and water them also. Beans will need about seven to eight days to germinate and begin to grow.

LESSON FOCUS

LESSON 1 — ***Our Solar System Is Not Alone Out There!***

BIG IDEAS Our sun, the earth and its moon are not alone in the universe — there are many other stellar bodies that accompany them. We use very large numbers to describe the universe.

LESSON 2 — ***Stellar Bodies Beyond Our Solar System***

BIG IDEAS Star, comets, meteorites, novas and asteroids are only some of the stellar bodies in outer space. We can compare sizes, distances and brightness by using the notion of "times."

LESSON 3 — ***Stars Produce Their Own Energy***

BIG IDEAS We can see stars with a telescope because they emit self-produced energy; this energy travels as light for millions of miles and for millions of years.

LESSON 4 — ***Our Sun Is a Small Star***

BIG IDEAS Living things exist on Earth because of sun energy. We can see stars as light that has traveled for millions of miles.

LESSON 5 — ***Our Sun's Family — The Planets and Their Satellites***

BIG IDEAS The sun in our solar system has 9 planets traveling in elliptical orbits around it.

LESSON 6 — ***The Moon Is Our Nearest Neighbor***

BIG IDEAS As the earth's follower, the moon affects the earth in many important ways. We know the distance from Earth to the moon because humans have calculated the distance and traveled there.

LESSON 7 — ***Constellations***

BIG IDEAS We see light from faraway stars as reliable patterns called "constellations". These patterns in the sky guide travelers on earth at night and tell astronauts where they are in space.

OBJECTIVE GRID

Lessons	1	2	3	4	5	6	7
Mathematics Objectives							
1. use numbers through one million to discuss/ describe number, distance and temperature	•	•	•	•	•	•	
2. compare large numbers using subtraction, division and "times"	•		•		•	•	
3. sequence the planets in our solar system by size and/or distance from earth using given data	•	•	•	•	•	•	•
4. find points on a plane using 2 dimensions							•
5. use "sphere" to describe stellar objects	•	•	•	•	•	•	•
6. compare 2 objects using "times", as well as "more than"	•				•	•	
7. use the logical sentence structure: If ...., then	•	•	•	•	•	•	•
8. describe closed paths as circular or elliptical; parabolic paths are not closed					•	•	
9. use integers.		•	•				
Science Objectives							
1. describe stellar objects using terms such as stars, planets, satellites, orbits and light	•	•	•	•	•	•	•
2. say that stars are objects that produce their own energy in the form of light and heat			•	•			
3. list star characteristics as color, brightness, distance from earth and size			•	•	•		
4. say that a star's color depends on its temperature			•	•	•		
5. demonstrate how light and heat are important to living things such as plants				•			
6. describe the difference among stars, planets, meteors, satellites and comets			•	•	•		
7. list the 9 planets of our solar system	•				•		
8. list and describe at least 4 types of stars			•	•	•		
9. describe our sun as a yellow star that is about average in temperature and small in size			•	•			

Lessons	**1**	**2**	**3**	**4**	**5**	**6**	**7**
10. say that the gravity a stellar body exerts depends on its mass						•	
11. describe how stars can be seen as patterns called constellations			•				•
12. say that our sun is the only star in our solar system, but not in the universe	•		•		•		
13. demonstrate moon phases and a lunar eclipse						•	
14. demonstrate how stellar objects stay in orbit.				•	•	•	
Language Objectives							
1. engage in dialogue/discussion	•	•	•	•	•	•	•
2. define terms, using them to discuss new ideas	•	•	•	•	•	•	•
3. listen to narration	•	•	•	•	•	•	•
4. write complete sentences in a theme journal	•	•	•	•	•	•	•
5. read for information, organize and report on information and data gathering	•	•	•	•	•	•	•
6. create stories, using theme-related vocabulary.	•	•	•	•	•	•	•

LESSON 1 Our Solar System Is Not Alone Out There!

BIG IDEAS Our sun, the earth and its moon are not alone in the universe — there are many other stellar bodies that accompany them. We use very large numbers to describe the universe.

Whole Group Work

Materials

Book: **The Sky Is Full of Stars** by F.M. Branley and **Why the Sun and Moon Live in the Sky** by E. Dayrell.
Many and varied reference books, pictures and films on stars, planets and space
Chart for each student to record nightly observations of the sky
Place Value Chart (PVC)
Word tags: stellar bodies, gravity, million, universe, earth, moon, solar system, sphere

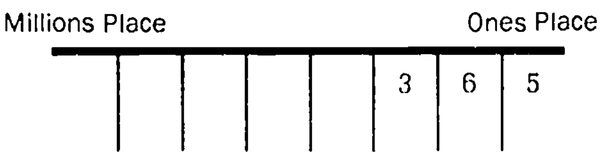
In preparation for this unit ask the children to go outside on several nights (ask a parent to go with them) when it is clear, not cloudy, and dark enough to see the stars to make the following observations to bring to class. (Put these questions on a chart and review them periodically for the students to work on each night.) See **Activity** — Star- and Moon-Gazing.

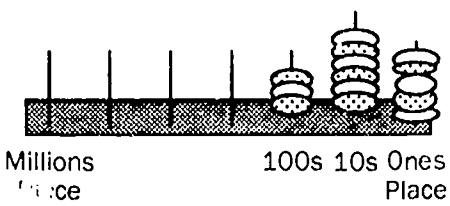
1. How many stars were you able to count in two minutes?
2. Were some brighter than others? Were some twinkling?
3. Did they shine in different colors? What colors did you see?
4. Find the star you think is the brightest. Where is it — in the north, south, east or west?
5. Can you find some patterns in the sky? What do these patterns make you think about?
6. Where was the moon on the different days that you saw it? Draw its shape and bring your drawing to class.

Encountering the Idea

For the first lesson read **Why the Sun and the Moon Live in the Sky** to the students. After reading the story, ask: How would you feel if you always went to someone's home to visit but that person never visited you? When should a promise be kept? Always? Sometimes?

[1]Place Value Chart (place the digits in the appropriate place in the chart, for example, 365) and Trading Chip Boards (place the appropriate number of chips on the nail that corresponds to the correct place value).





How would you feel if you were pushed out of your home? Why didn't the sun stop the water? Do you think that was the thing to do? Why?

Do you think that our solar system is alone in the universe? What other stellar bodies are found in the universe beside the sun and the moon? Is earth a stellar body?

After the discussion, ask the students to go outside and look for the moon, to look for any stars they may be able to find, but **not to look at the sun.** After returning to the classroom ask the students if they were able to see the moon? (You generally, can't see the moon in the day). Is this always true? Why? Or why not? Did you see stars? Then the students can dictate other questions to add to the chart. They will try to answer those questions that night as part of their continuing work on the unit. They may select the questions that are the most interesting for them, or they may wish to try to answer all of them.

Tell students that before going to the learning centers, they should record the information from the previous night's observations on their charts. Who counted the stars? Were all the shining objects in the sky stars? Was the moon out? Did you see some shapes on the moon? Do you know what they are? What color were the stars? (White, red, blue.) Were they twinkling? What was the first star you were able to see last night? Can you name some of the stars? Did you see some patterns that looked like pictures drawn out of shining dots of light? All of these questions are very interesting, and we will be discovering the answers to these as we study this unit.

Exploring the Idea

At the Science Center, the students

1. begin work on **Activity** — Star- and Moon-Gazing
2. begin work on **Activity** — Our Solar System.

The class needs to take time to organize itself into groups to construct the model solar system. The first step is to design the model by studying the suggestions in the activity and dividing the work into groups. For example: groups of two to three students select one planet and **research** the information on it, construct the planet according to the information they receive and report their findings to the class. Then use the material to make a class Big Book. Parents may be interested in working with the class to help the students construct and hang the planets, or help in other ways.

At the **Mathematics Center**, each student makes a laminated Place Value Chart or uses a Trading Chip Board to:

1. begin the **Activity** — Comparing with "Times." (It is important to initiate this activity before the students begin on the activity on large numbers.)
2. begin the **Activity** — What is a Million?
3. begin the **Activity** — Large Numbers. The students may want to repeat parts of the latter two activities until they begin to get a feel for the notion of a large number like **million.**

Getting the Idea

Show pictures of stars and/or planets from books, posters or magazines. Show word tags with names of various stellar bodies. Define stellar body as any object in space that is a star, like the sun; a planet, like earth; a satellite, like our moon; a comet; or a meteor (a "shooting star"). Stars have the shape of a sphere, or a ball. Discuss the idea that there are many, many more stellar objects in space besides our sun, the earth and its moon. Talk about the universe as comprising more than the stellar bodies we are able to see.

Ask: How many stars are there? How far away are they? What is a "shooting star" (or a meteor)? Would you like to travel to the moon? Why are there both night and day?

When we look up into the early evening sky, we usually see only three things that look different — we may see the setting sun as a bright half-orange, or maybe violet; we see the moon that can appear very large as it rises; and then we see some bright dots of light, some larger and brighter than the others but very much of the same appearance. Not all of these small bright dots of light are the same type of stellar bodies — they are very different. In the following lessons we'll discover what makes these stellar bodies different.

On a daily basis the students describe new observations they have made and record them in their **Moon-** and **Star-Gazing** charts. As they learn new concepts, students include these in the daily discussions.

Organizing the Idea

At the **Writing Center,** the students make a chart for the words "sun" and "moon" and supply different words that begin with each letter of the word, for example:

S is for sunrise	M is for moonlight
U is for universe	O is for orbit
N is for near	etc.

Applying the Idea

Problem Solving

Students respond to these ideas:

1. Is this true? If it is a shiny object in the night sky, then it is a star. (The moon shines, but it is not a star.)
2. Is this true? If it is a star, then we can see it shine in the sky. (There are more stars that exist than we can see because they are very far away.) Explain your answers and demonstrate with pictures, if you wish.

Closure and Assessment

Using either a PVC or a Trading Chip Board, students working in pairs take turns finding large numbers in books and/or newspapers and placing them on the PVC, saying their names and checking each other's work.

During the **Exploring the Idea** phase, the students begin construction of the three-dimensional model of the solar system. Assess students' participation and mastery of the concepts as they work on the mural and models.

List of Activities for this Lesson

- ▲ Star- and Moon-Gazing
- ▲ Our Solar System
- ▲ Comparing with "Times"
- ▲ What Is a Million?
- ▲ Large Numbers

ACTIVITY
Star- and Moon-Gazing

Objective

Students become aware of characteristics of stellar bodies by making and recording observations.

Procedures

1. Make Star- and Moon-Gazing charts to take home. See **Activity** — Finding Our Way, Lesson 7.
2. After recording the data obtained over several nights, students report to the class.

Star-Gazing

Stellar Body	Date	Brightness	Color	Position (sky) (N, S, E, W)	Patterns
Polaris					

Moon-Gazing

Shape	Date	Color	Surface Features

[1]First, find Polaris, the North Star, and use it to compare to the brightness of other stars. Are other stars brighter, less bright, or as bright as Polaris?

ACTIVITY
Our Solar System

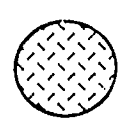
Objective
The students make a three-dimensional "scale" model of our solar system, name the planets and color-code them to suggest their temperatures.

Materials
Different-size buttons and juice, soup and soft-drink can tops
Large pictures of the nine individual planets with details about surface features, number of moons, rings, etc.
Meter stick; masking tape; glue; colors; ball of heavy string

Procedures
1. Students make spherical masking tape models of each of the nine planets.
2. Use different-size buttons as diameters for masking-tape spheres to represent the smaller planets, Mercury, Venus, Earth, Mars and Pluto.
3. The planets closest to the sun are rocky planets because they are made of solid materials. Students can color these planets with darker brown colors. (Earth is a rocky planet, but astronauts describe it as **The Big Blue Marble** when looking at the earth from outer space.)
4. Use cans of different sizes as patterns for Jupiter, Saturn, Uranus and Neptune. Remember Jupiter and Saturn are much larger than the others. As the students research each of the planets, they can decide which color or combination of colors will make each planet distinct from the others.
5. The last three planets are called icy planets. Because they are sc far from the sun they get very little heat and their temperatures are very, very cold. Some scientists believe there may be other planets farther out in the solar system than Pluto. (Light blue may suggest an icy climate.)
6. Label the planets and indicate their size in relation to Earth.
7. Hang each planet and its name from the ceiling in an auditorium or large room, a distance from the sun as given on the table below. Measure the distances from the sun with a meter stick. Select a room that is large, at least 80 meters on the diagonal; hang the sun in the center and the planets in concentric circles around the sun, but not in a straight line. If no large room is available, you can place the sun and planets on a wall in the hall for other classes to see. You need at least 40 meters from the sun to Pluto.
8. Your planets are now in rough-scale distance from the sun. Close your eyes and try to image how far they really are in space.

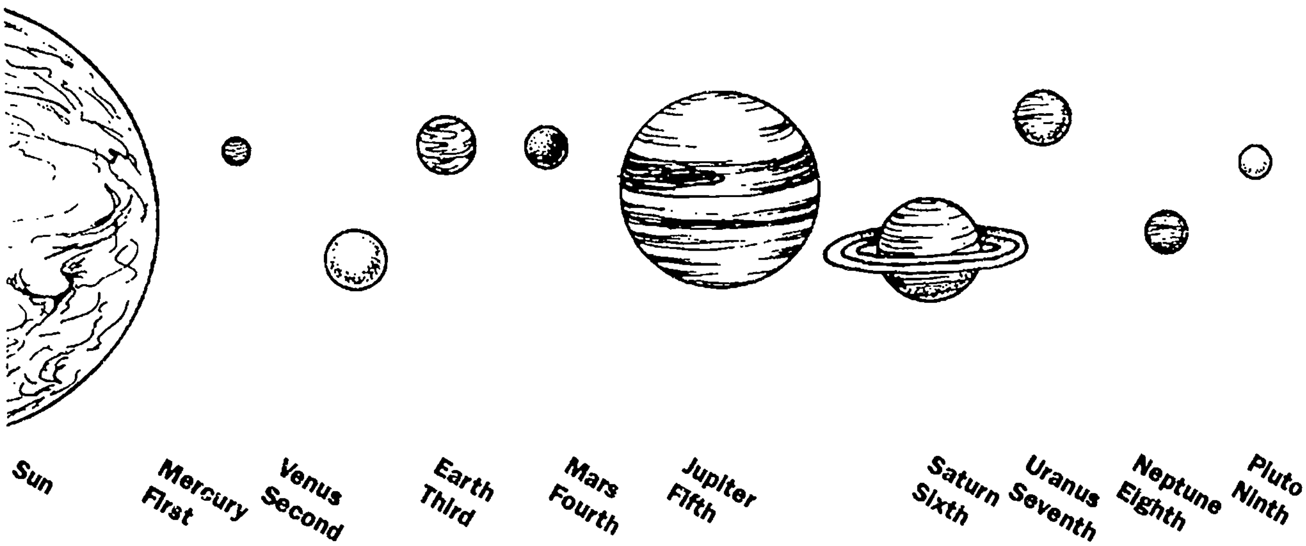
Note to Teacher
The measurements suggested to represent the distance of each planet from the sun were computed by using a unit of distance called an *astronomical unit* (AU). The distance from the earth to the sun, 149,600,000 kilometers (93,000,000 miles), is one AU. The distance of one meter has been assigned to each AU.

*Students can make the sun and the larger planets by inflating a balloon to the desired size and then covering with masking tape. Coat the tape with paper that has been covered with glue and shaped with mountains and other imagined features of the planet.



Planet	**Distance from Sun**	**Relative Size**
Mercury	39 centimeters	1 (smallest button)
Venus	72 centimeters	4 (same as Earth - Very large button)
Earth	1 meter	5 (small juice can top)
Mars	1 1/2 meters	3 (slightly larger button)
Jupiter	5 meters	9 (larger than Saturn) largest
Saturn	9 1/2 meters	8 (two times larger than Uranus)
Uranus	20 meters	7 (same as Neptune)
Neptune	30 meters	6 (four times bigger than Earth)
Pluto	39 meters	2 (smallest button)

ACTIVITY
Sequence of Planets in the Solar System (p.3 of Solar System Model)



Locate and hang the planets in a manner that will give a three-dimensional perspective. Do this by not hanging the planets in a straight line. (See Lesson 5, **Activity** — Partial View of the Solar System.)

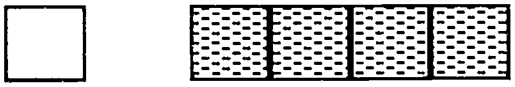
Students add other details to the model as they wish, e.g., comets, asteroids, etc., as they learn about them in subsequent lessons.

ACTIVITY
Comparing with "Times"

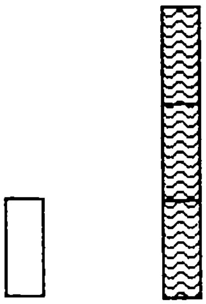
Objective
The students describe relative sizes of objects using the word "times".

Materials
Two transparent containers, one approximately twice as large as the other
Sufficient number of marbles to fill to fill the two containers
Large pictures showing the two areas as shown below
Small plastic bags (or some other transparent containers) to help count marbles

Procedure
1. Place two transparent containers (milk containers, 1/2 gallon or one-liter/three- liter soda bottles) filled with marbles at the front of the class.
2. Students guess the number of marbles in each container and record the guess.
3. After making their guesses for both containers, the students count the marbles by placing them into baggies by 10s, then by 100s.
4. After they have counted the marbles, the students put them back into the containers and label the containers with the number of marbles contained in each.
5. Show students a picture like the following and tell students that the size of the earth can be compared in size (volume) to the sun and giant stars the same way we compared the marbles to the containers.



Tell the students the second picture is four "times" bigger in area than the first (the smaller one) because you can fit four of the small ones on the larger one.



In this illustration, the second picture is three times taller than the first one and has three times the area because we can fit three of the small ones on the large one. You can use the words "times" to compare things using numbers.

Using a PVC or a trading chip board the students "trade" 10 ones for one 10 and "trade" 10 10s for one 100. They say that the 10s place is "10 times" greater than the ones place and each place to the left is "10 times" greater than the place on the right.

ACTIVITY
What Is a Million?

Objective

The student become aware of the number one million by estimating how many volumes of an encyclopedia it would take to read a million words.

Materials

One volume of an encyclopedia (a volume that has few illustrations to make estimates more accurate)
Place Value Chart (PVC)

Procedures

Part 1

As a whole group activity the students do the following:
1. Using a PVC, the students review place value to the highest place studied.
2. The teacher points out that each place stands for 10 "times" the place to the right, e.g. the 10s place is "10 times" the ones place; the 100s place is "10 times" the 10s place, etc.
3. Extend the place value pattern to show the one millions place.
4. Students design a plan to count the letters on a page using the PVC.
5. Discuss the idea of "estimating". The students' determination of the number of words in the encyclopedia will be an estimate and not an actual count.

Part 2
1. Working in pairs, students implement the plan to estimate the number of letters in a page, in 10 pages, in 100 pages, and so on, in the volume.
2. The students show the estimates on the PVC.
3. The students estimate the number of volumes it would take to count one million words.

Discussion

The number one million is not large enough to count the stars in the universe.

NOTE
One estimate: in one volume of 1000 pages of the Encyclopedia Britannica 1965, it was estimated that each page (without illustrations) contains 1500 words. The entire volume contains approximately 1000 x 1500 words or 1,500,000. Depending on the print size and the number of pages in a given book, estimates about how many pages it takes to get to one million words will vary.

ACTIVITY
Large Numbers

Objective

Students use a PVC to explain the importance of numbers in everyday affairs and place given large numbers on the PVC.

Materials

Several copies of the daily newspaper
One calculator per student group

Procedures

1. Using the newspaper the students search for and list the uses of numbers in the news stories, ads, etc.
2. The students locate the largest and smallest numbers found in the newspaper and write them out on the PVC*.
3. (Optional step if students have learned to roundoff numbers.) Using the PVC, the students round each number to the largest place shown (or to a given place), e.g. if a house costs $57,500 they round it to $60,000; $213,700 to $200,000; a budget for $2,327,000 to $2,000,000, or to a place given by the teacher.
4. The students say whether the largest number found in the newspaper was exact or an estimate. (What made them make that decision?)
5. Using a calculator the students display the largest number the calculator can accept. Put this number on the PVC. What number does the display show?

***Place Value Chart**

millions	100 thousands	10 thousands	thousands	hundreds	tens	ones

Tell students that in this activity, they will look for large numbers in the newspaper to see how we use large numbers and what these numbers look like written out. Although the numbers students read in the newspaper may be very large, they are not even close to the number of stars there are in the universe.

6. **Discuss:** The number one million is too small to estimate the number of stars in the universe.

LESSON 2 *Stellar Bodies Beyond Our Solar System*

BIG IDEAS Stars, comets, meteorites, novas, and asteroids are only some of the stellar bodies in outer space. We can compare sizes, distances and brightness by using the notion of "times".

Whole Group Work

Materials

Many and varied references on star-planets, space, etc.
Word tags: luminous (compare to Spanish "lumbre" - fire), comet, meteor, nova (compare to Spanish "nueva"), asteroid, meteor, meteorite, sphere

Encountering the Idea

Have you ever thought or heard talk about:

1. the birth of a star? How a new star appears in space? Have you ever thought that if a new star can begin, how can it end?
2. comets that appear quickly and also leave quickly — where do they go?
3. bright lights falling very rapidly to earth that people call "shooting stars"? Are these really "stars"?
4. a space belt called an "asteroid belt"?
5. a "black hole"?

Exploring the Idea

Divide students into at least five small groups. They research and create poster-and-chart reports on one of the following: star, comet, meteorite, nova or asteroid.

At the **Mathematics Center**, students

1. review **Activity** — Comparing with "Times", see **Lesson 1**
2. complete **Activity** — Numbers that Show Direction.

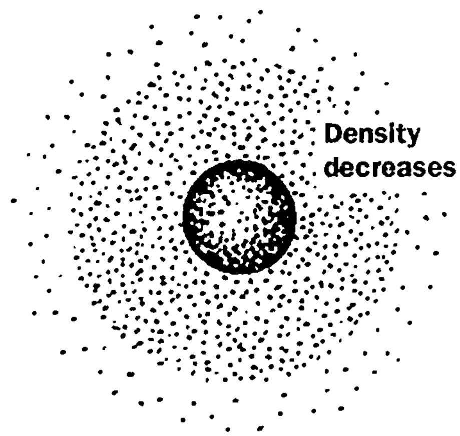
Getting the Idea

After student groups have had time to look for the information and have reported to the class, discuss the following main ideas.

The Major Force in Space — the major force in space behind many of the processes that go on in the universe is gravity. We know that all bodies attract each other in a way that depends on their masses and the distance between them. Hydrogen gas and dust particles form enormous interstellar clouds that begin to attract each other because of these two forces and gradually draw closer together. Eventually (after millions of years) these huge clouds grow so large that the edges collapse inward and separate a huge cloud from the other particles in space. If the developing star has enough material or mass, the core—the center—begins to heat up enough to cause nuclear reactions.

A Star Begins — Stars, scientists believe, form when large masses of cosmic dust and hydrogen gas collect close together somewhere in the universe. When they heat up enough and hydrogen gas begins to burn in a nuclear reaction, a new star begins — it is a nova. Scientists believe that new stars are coming into being all the time. How long a star continues as a star depends on how much mass or material it started out with.

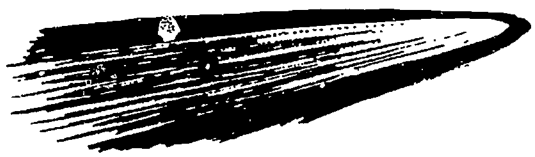
Red Giants — When the hydrogen that is fueling the star's nuclear processes is used up, the core, or center, starts to collapse. As the star grows, the process of turning hydrogen into helium moves away from the core and releases huge amounts of radiant (light) energy. The intense heat of the nuclear reactions causes the star's surface color to change from white to red. When this happens, the star grows into a vast red sphere. It grows so vast it is then called a "red giant." Someday, our own sun will use up its energy and begin to grow to the point of engulfing Mercury, Venus and possibly Earth and Mars, as the sun too becomes a red giant.



White Dwarfs — When there is no nuclear energy left in the red giant, the star collapses into a small dense star called a "white dwarf." Its atoms pack together so tightly that, in comparison, a sugar cube whose molecules were packed that tightly would weigh thousands of kilograms. Over many millions of years the white dwarf cools and gradually turns into black cinder. This is the fate of not only most stars, but of our sun also.

Black Holes — When a star with a large mass, more than three times the mass of our sun, begins reaching the end of its nuclear burning cycle, it shrinks until it is extremely dense, smaller than a white dwarf, and its gravity increases to the point that not even light can escape its pull. Any matter that comes close to a black hole is sucked into it by its extremely strong gravity.

Comets — Comets are the "different" kinds of members of the space community. They are luminous stellar bodies that may or may not come under the influence of the sun's gravitational field. When a comet's orbit comes near the earth's orbit, it is attracted to earth and we can see it because of its luminosity. Comets are the largest stellar bodies in the universe. A comet consists of its head, mostly condensed material, and as it approaches the sun, it develops a coma, which has hair-like structures that become the tail. Then the comet can be seen from earth with the naked eye. One comet had a tail that stretched to about 28 million miles. Comets, such as **Halley's Comet,** travel in elliptical orbits and have cycles in which they travel close to the earth and we can see them. Halley's Comet comes around about every 75 years. Other comets have parabolic orbits and therefore are seen only once.



Asteroid — Small bodies that are not self-luminous are called minor planets, or asteroids. These are small interstellar bodies that range in size from a few kilometers in diameter to as much as 620 miles or 1000 kilometers in diameter. Many thousands of asteroids orbit the sun between Mars and Jupiter. Some scientists believe these asteroids may have developed when a planet exploded. An **asteroid belt** is any place in space where many asteroids travel in groups.

Meteor — A meteor is a small particle of matter traveling through space that burns up and produces a light and a flash when it encounters the resistance of the earth's atmosphere. If there is sufficient matter in the meteor to survive its entry into the atmosphere, it strikes the earth and digs into the earth, creating a **crater;** then we call it a **meteorite.**

Organizing the Idea.

1. Students make a chart listing at least three known comets and when the comets were last seen.
2. At the **Language Center,** students make a list of root words that they can use later to guess the meaning of new words. For example: Astro, astral, asteroid, all these words mean "planet", or having to do with planets; nova, meaning "new"; etc.
3. Any new information that students have found they add to the model of the solar system.
4. Students give three examples of things or objects that they can compare using 'times". The students make a class chart of these examples. Every new example students can supply they add to the chart.

Using Times

The distance between Uranus and the Sun is _____ times greater than the distance between the Earth and the Sun (See **Activities;** Lesson One.)
Bobby's mother weighs _____ times more than Bobby.
Tomas ran 2 miles and Dolores ran 4 miles. Dolores ran _____ times the miles Tomas ran.

Applying the Idea

1. Suppose we represent the earth by a marble and a small container represents the sun. If **115 marbles** fit into the small container, we can say the sun is ______ **times larger in volume than the earth.** Explain this.
2. Suppose we represent the earth by a marble and the larger container represents a giant star. Then, if **345 marbles** fit into the larger container we can say the giant star is ______times __________ the earth. Explain this.

Closure and Assessment

1. Given illustrations and models of stars, comets, novas, and other stellar bodies, students identify each and describe their place in the solar system or in the universe.
2. Students list at least two other ways that they can use numbers to show direction, or "opposites".

List of Activities for this Lesson

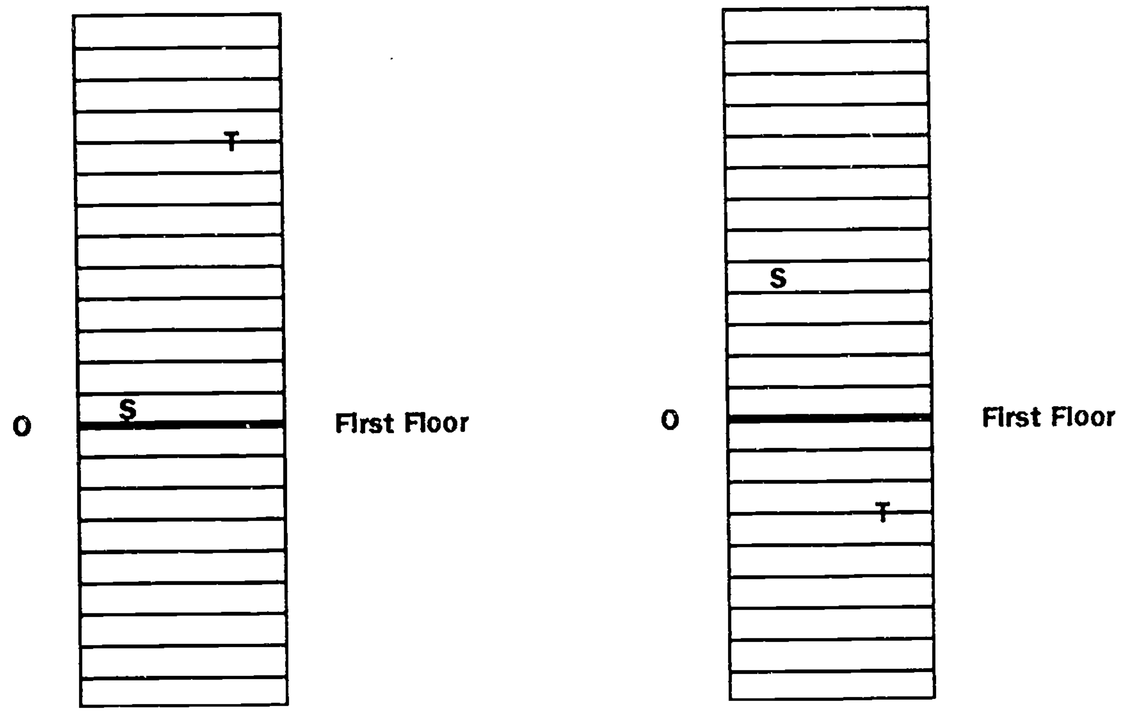
▲ Numbers That Show Direction

ACTIVITY
Numbers That Show Direction

Objective
The students explore "directed" numbers by assigning numbers and their "opposites" to a variety of situations.

Materials
Two laminated charts, as shown below, with a square centimeter grid
Erasable markers (two different colors)

Exploration
Tell students they are going to give directions to a friend to help her find a treasure that's hidden in a very tall building. The **S** is the starting point, and the **T** is the treasure. They are going to use a code so that other people can't find the treasure. They will use the "secret words" **plus** and **minus.**



Procedures
Students work in groups of three.
1. One student locates the **S** and the T.
2. The second student, looking at the map of the building, tells the third student the directions—for example, **Plus 9**—and then erases the **T** so that no one else can see it.
3. The third student was not looking while the second student was looking at the map. Then the third student locates the treasure and puts a T on the correct floor.
4. When a student fails to locate the treasure, the students change places and tasks.

5. If the treasure is below the first floor, then the students use "minus" to tell the floor. The treasure in the second example is on **minus three.**
6. If the treasure is on the ground floor then the treasure is at **zero (0).**

After the students have had opportunities to play the treasure game, tell them they are using a new set of numbers. Some of these numbers are not new, for example, nine, three, zero and the other whole numbers students used to play the game. In this new set, however, each number except zero has an "opposite", as they found out. This new set of numbers helps us give a "direction" such as up or down. These "directed" numbers have many uses besides giving a direction and are called the "integers".

In using these numbers, we use a "+" (plus) sign for one direction, and a "–" (minus) sign for another direction. Notice that zero is the only number that does not have an "opposite". The zero is where we begin giving the directions, **not where we are starting.** Where we start from is **S.**

Applying the Integers

1. Use the idea of "directed" numbers or integers to tell a jet plane where it is **above sea level.** Would you use **plus** or **minus** 30,000 feet? Why? (**Above** is usually given the designation of plus, while **below** is usually give the designation of minus.) How would you write this number? (+30,000 feet.) In your journal draw a picture of the jet, label where sea level is and label where the jet is in the air.
2. Use the idea of "directed" numbers or integers to tell a nuclear submarine where it is **below sea level.** Would you use **plus** or **minus** 700 feet? Why? (- 700 feet.) In your journal draw a picture of the sub, label where sea level is and label where the sub is in the water. In using directed numbers, or integers, when the number is a + 30, say, the plus is usually left out. It is **very important,** however, that if the number is - 16, for example, that you include the minus so that people know that you are talking about a level that is below zero.
3. Water freezes at 0° C and boils at 100° C at sea level. Suppose you read in the newspaper that the day's low temperature was at - 12° C, what does that mean? Was the temperature hot or cold? What else does this number tell you? If you left a can of water outside, would it have frozen?
4. You look at your room thermometer and it reads 30° C (about 90° F). What kind of clothes are you going to wear?
5. In the wintertime, you go skating on some water that froze overnight and made a big frozen puddle. What is the temperature of the water? Choose one or more of the numbers that **could show** the water's temperature. 0° C, or is it + 15° C, or is it - 5° C? Explain your choices.
6. If a star's surface temperature is 20,000° C, what can you say about the star? If a star's surface temperature is - 200° C, what can you say about the star?

LESSON 3 Stars Produce Their Own Energy

BIG IDEAS We can see stars with a telescope because they emit self-produced energy; this energy travels as light for millions of miles and for millions of years.

Whole Group Work

Materials
Book: **Energy from the Sun** by M. Berger
Flashlight or candle
Balloon covered with aluminum foil
Mirror
Word tags: reflect, absorb, telescope, horizontal, vertical

Encountering the Idea

Darken the room as much as possible. Flash a light and place the lighted candle near the aluminum-covered balloon. What do the students see? Is the light coming from the balloon? No, it reflects from the flashlight or the candle.

In the darkened room, hold a mirror to reflect the light of a flashlight, the candle or a match. Ask students to say where the light is coming from. (The mirror, match and the flashlight.) Is the mirror producing the light? No, the only thing that is producing light is the flashlight. The mirror only **reflects** the light. Take the batteries out of the flashlight. Ask what makes the flashlight give off light. (The batteries turn on the lightbulb.) Ask the students what makes the sun shine. (It generates its own energy through atomic processes that do not normally occur on earth.) What makes the moon shine? (It reflects light.)

Did the balloon produce its own light? Do human beings produce their own energy? (No, we have to get our energy from the food we eat.) Do plants produce their own energy? (No, plants produce their own food, but they produce it by using the energy from the sun.) Do animals produce their own energy? (No, they must eat food — they eat plants or they eat other animals.) In other words, the only thing that produces its own energy is the sun.

Exploring the Idea

At the **Mathematics Center**, the students begin **Activity** — Star Data.

At the **Science Center**, the students

1. complete **Activity** — Star Energy
2. complete **Activity** — Star Color Chart.

Getting the Idea

After students have completed the activity working with objects that emit or reflect energy in the form of light, we can see there are very few things in the universe that produce their own energy — stars generate their own heat and light, but other objects, including stellar bodies, only reflect the light.

1. Do human beings reflect light? How do you know? (If we didn't reflect light we couldn't see each other.)
2. Can a human being absorb light? How do you know? (When we sit out in the sun we get very hot.)
3. How do Venus, Mars and Mercury appear from outer space? (These planets look bright to our eyes because they reflect light. Since planets only reflect light, we can only see that part of the planet the sun is shining on. We say that the moon has a "dark side" because we can never see that side of the moon when the sun is shining on it.)
4. Does the sun have a "dark side"? (No, it shines in every direction because the sun is burning hydrogen all over its entire surface.)

Organizing the Idea

Students make a list to classify stars using color, brightness, temperature and distance from earth as descriptors. Using this preliminary list, students make a chart to add important information to as they receive it.

Stellar Body	Energy Type	Size	Color	Temperature
Star				
Sun			yellow	6100
Giant				
Dwarf				

The students make a list of the things that we have to count in millions, and things that we don't need large numbers to count. For example: people on earth, ants on earth, grains of sand, and so on. Every time they think of something that we count in millions, they add it to the list, as they add things that we count with small numbers.

Things we count in millions	Things we need small numbers to count
grains of sand	money in my piggy bank
people	my pet goldfish
insects	houses on my block
money	

At the **Writing Center**, students write and draw about the idea: The number one million is too small to count the number of stars in the universe.

Applying the Idea

The reflection of light is very important. As we said before, if things were not able to reflect light, we would not be able to see them. This is an important idea in several ways:

1. Why do football players wear dark coloring under their eyes when they are playing? (Dark coloring decreases the reflection from the sun in daylight or the stadium lights at night.)

2. Why do soldiers put dark color on their faces at night? (So their faces won't reflect light.)
3. Why do skiers were very dark sunglasses? (The glare of the snow is very bright.)

Something to think about
Do you think plants can grow on Mars? Take a position yes or no, and defend it.

Closure and Assessment

1. Will the sun run out of fuel to produce light at some point in time? What do you think of this idea?
2. How big is a million? Is the number one million big enough to count the stars in the universe? Do you think there might be a number that is large enough to count all the stars in the universe? Tell your partner about that number, if you think there is one.
3. What would happen to Earth if the light from the sun no longer reached Earth? Explain your reasons.

List of Activities for this Lesson

▲ Star Data

▲ Star Energy

▲ Star Color Chart

ACTIVITY
Star Data

Objective
The student uses a chart to compare given numbers by identifying each place value of the digits of the given numbers.

Materials
Copy of the chart given below for each student group.

Chart

STAR	TEMPERATURE in C°	DISTANCE in Light Years from Earth	TIMES BRIGHTER than Sun
SUN	6,100	3/20[2]	
Sirius	10,700	9	20
Canopus	7,700	99	1200
Alpha Centauri	6,500	4	1
Arcturus	4,800	36	90
Rigel	12,100	815	40,000
Betelgeuse	3,500	489	11,000
Beta Centauri	21,300	293	33
Alpha Crucis	21,300	391	2,700
Antares	4,300	293	4,400
Beta Crucis	22,300	489	4,800
Procyon	6,800	11	about 1
Deneb	10,200	1402	40,000

Problems
1. What is the **hottest** star listed and what is its temperature?
2. What is the **coolest** star listed and what is its temperature?
3. How many **times hotter** is Alpha Crucis then Deneb?
4. What is the **farthest** star? How far is it in light years?
5. What is the **closest** star? How far is it in light years?
6. What is the **difference** between the temperature of the hottest and coldest star?
7. What is the **difference** between the temperature of the hottest and medium stars?
8. What is the **difference** between the temperature of a medium star (Sirius) and the coldest star (Betelgeuse)?
9. How can you tell these temperatures and distances are only estimates?
10. Which are the **brightest** stars? Are they much brighter than our own sun? How do you know?
11. What does it mean when a star is **five times** brighter than the sun? (The light of five suns equals the light of that one star.)

[1]The Light Year is a standard of measure of distance. It is the distance light travels in one year. Since light travels at the speed of 670 million miles per hour, one light year equals 670 million miles x 24 hours x 365 days (an earth year), or about 5,900,000,000,000 miles.
[2]Since the earth is 93 million miles from the sun, it takes the light from the sun about 0.15 hour to travel from the sun to the earth — about 3/20th of an hour.

Discussion

1. Suppose that star, **Star Light,** has a surface temperature of 3000°C. Another star, **Star Bright,** has a surface temperature of 21,000°C.
2. Which of the following comparisons would you use? Star Bright is 18,000°C hotter than Star Light. Star Bright is seven times hotter than Star Light.
3. Which comparison uses subtraction? What does that comparison tell you?
4. Which comparison uses multiplication? What does that comparison tell you?
5. Which method of comparison would you select and why?

TEACHER DEMONSTRATION
Star Energy

Objective

The student will say that the energy large stars produce is many times greater than the energy from our own sun.

Materials

Pictures of the stars in the night sky, of large, bright stars
Powerful magnifying glass; mirror; crumpled tissue paper

Procedures

1. Place a crumpled piece of tissue paper on a pie plate.
2. Using the magnifying glass, shine a ray of sunlight on the paper.
3. Focus the glass to a very small area on the tissue paper and then raise the glass slowly.
4. Students describe what happens to the tissue paper. (It will suddenly catch on fire and burn.)
5. Repeat the experiment, but this time instead of shining the sunlight directly on the tissue paper, first, focus the ray on the mirror and then reflect the ray from the mirror onto the paper. Students discuss what happens.

Getting the Idea

Our own sun shines on earth for several hours each day giving us large quantities of light and heat. Stars larger than our sun send out much more energy because they are many times larger than the sun. We don't see the light and feel the heat from those stars because they are millions and millions of miles away. We can see only small dots of light that have traveled that immense distance.

1. What do you suppose it would feel like on earth if Alpha Centauri took the place of our sun in the solar system?
2. Do you think we would feel the heat?
3. How many times hotter do you think it would feel here on earth?
4. What two things do we have to look at on the chart to answer these questions?

ACTIVITY
Star Color Chart

Objective

The student classifies stars using color as one indicator of their stars' differences in surface temperature.

Materials

Copy of the Star Color Chart, as below, for each student

Star Color Chart

Star Type	Temperature K	Color	Examples
Super Giants	20,000 to 50,0000	Blue	P Cygni
Giants			Antares
			B Centauri, Aldebaon
Dwarf	10,0000	White	Deneb, Serius B
Nova	An average star that suddenly leaves the main sequence and explodes becoming very luminous, then fades back to its original luminosity.		
Main Sequence (medium, average)	6 - 7,0000	Yellow	Sun, Procyon, Altair Centauri A, Cygni A
	4,5000	Orange	Arcturus
Pulsating	Alternating between hotter and colder		
Red Giants	2 - 3,3000	Red to very red	
Dwarf	-2500	Black (cinders)	
Black Hole	A collapsed star with such immense gravity that it swallows its own matter. The star becomes a black hole because no visible light can escape from its gravity's pull.		

Applying the Idea

1. Using your Star-Data Chart, classify as many of the stars as you can, such as white dwarfs, super giants and so on, using the star color chart. Try to guess what color they would show.
2. Problem: Many times we can identify the planet Mars as a bright red light in the night sky. Why does it look red? Is it a red giant? (No, Mars is not a red giant star; it is a planet that reflects red light.)

LESSON 4

Our Sun Is a Small Star

BIG IDEAS Living things exist on Earth because of sun energy. We can see stars as light that has traveled for millions of miles.

Whole Group Work

Materials

Book: **Millions of Cats** by W. Gág
Chart - Star-and Moon-Gazing
Reference books on the sun in our solar system
Word tags: corona, stars, stellar bodies, chromosphere

Encountering the Idea

Students report on what they observed the previous night. The students use the information they recorded the night before on their charts. Ask if all the lights looked the same. Ask if any of the stars looked red, yellow, blue? Did they differ in size, color and brightness? Why do you think these lights in the sky appear different — some in size, others in color and so on?

This lesson will focus on the only star in our solar system — the sun. What do we know about the sun, so far? As you give us these facts we'll write them on a list to use later to finish our solar system model. Write the suggestions on word strips.

Exploring the Idea

At the **Mathematics Center,** the students complete **Activity** — Star Candle-Power.

At the **Science Center**, students

1. complete **Activity** — Plants and Sunlight
2. complete **Activity** — An Energy Cycle
3. complete **Activity** — Star Types.

Getting the Idea

In these activities, we find that not all the lights that shine in the sky are what we call stars. As we learned in the first lesson, some stellar bodies emit, or send out, their own light, like our sun; but other stellar bodies only reflect light, like our moon. But even among the stars themselves, there are differences that make them appear different to us in the night sky.

For example, some stars are close to the earth, and some are very far. Scientists have been able to estimate the distance of the stars by the amount of light that reaches the earth, by the color of the light that reaches earth, and because scientists have been able to calculate the speed of light.

We can compare stars by size using large numbers and multiplication, or "times", using one of the stars as the unit, or as the reference. As we learned, some stars are dwarfs and some are giants, and still larger ones are supergiants when compared to other stars.

Stars also differ in color and brightness. The differences we see are related to the stars' distance from earth and to their temperatures. What experiment helped us understand that the brightness we see depends on the distance of the star?

We can see stars through a telescope because they produce and emit energy as light. That is the main characteristic of a star — **it produces its own energy through a process of changing matter into energy.** The amount of energy produced in this process of changing matter into energy makes the stars different in brightness, temperature and color.

Our sun is only one of millions of other suns. It is small in size — compared to the giants and supergiants. Because our sun is of average temperature, we classify it as a yellow star. As you learned, other stars we call white stars, and others are blue stars, but **all of them** make and emit their own energy.

Organizing and Applying the Idea

Students draw and/or write about:
- the ways planets and stars are alike or different
- what the difference is between an asteroid and a comet
- what a "shooting star" is.

Students make a chart listing the properties of the sun.

Closure and Assessment

1. Is the earth a star? Explain.
2. Is the moon a star? Explain.
3. When you look up at the sky at night and see a very bright light, can you tell whether it is a star, a moon or a planet? Explain and/or draw your opinion.
4. What can you say about how the sun compares to a giant star? Is it two times larger? Is it three times larger? How do you know?
5. Have the students look at the scale-model of the solar system and describe the relative sizes of the planets using the word "times".
6. Will the sun run out of energy to make light? What do you think of that?

List of Activities for this Lesson

- ▲ Star Candle-Power
- ▲ Plants and Sunlight
- ▲ An Energy Cycle
- ▲ Star Types

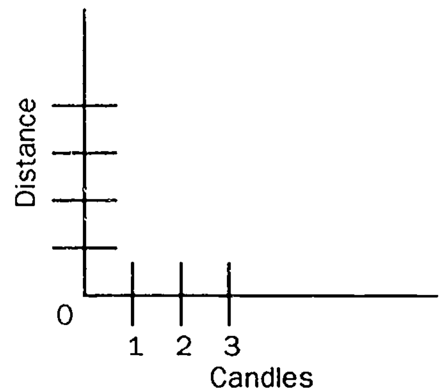
ACTIVITY
Star Candle-Power

Objective
The student says that the closer a light source is to an object, the more light the object will receive, and it will look brighter.

Materials
Several candles of the same size; tape measure
Chart to record number of candles and distance; chart to make a graph

Procedures
Darken the classroom as much as possible.
1. One student sits at one end of the classroom holding and looking at a picture with letters written on it. (Student's name, for example.)
2. A second student holds one candle close enough for the first student to be able to see the letters.
3. The second student moves away from the first student slowly and stops when the first student says it is hard to see the letters. Measure and record the distance between the candle (light source) and the observer (the first student).
4. Repeat the same procedure using two and then three candles that are tied together to make a single source of light. Measure and record the distances.
5. Students discuss the effects of distance on the amount of light received. They make a graph of the data and summarize their conclusions in their journals.

Number of Candles	Distance from source of light to observer
1	
2	
3	
4	



Getting the Idea

1. Why can we see light from a star that is millions of miles away? (Stars emit a lot of heat and light; we cannot feel the heat of faraway stars, but we can feel the heat from the sun.)
2. Are there stars in the sky that we don't know about? If you say yes, explain your answer, and if you say no, explain that also.

Problem Solving
You see two stars in the night sky. They look exactly the same size to you but one is brighter than the other. What can you say about the two stars? Are they the same distance from earth? Is one star hotter than the other? Explain.

ACTIVITY
Plants and Sunlight

Advance preparation

In preparation for **Activity** — Plants and Sunlight

1. Students bring several plants to class or plant some beans in several pots. Keep one half of the pots in the sunlight and the other half in a closet or some other dark place.
2. Place two small dishes with water in a sunny place; place two small dishes with the same amount of water in a dark place.

Objective

The students say that plants need sunlight, or star energy, to produce their own food; all other living things on earth need food from plants or from animals that eat plants.

Procedures

1. Students list the types of food various living things (animals) eat.
2. What do plants eat? (They make their own food through **photosynthesis.**)
3. Examine the bean plants. Describe the difference between those kept in the sun and those kept in a closet.
4. Students describe what happened to the water left out in the sun and water left in a shady place.

Discussion

1. The maximum surface temperature of Earth is 140° F. The maximum surface temperature of Mars is 50° F. The maximum surface temperature of Venus is 800° F. Do you think a human being or an E.T. could live on Mars? Without protection? With protection? On Venus? With and without protection? Why?
2. If there is life on Mars or Venus, would it look like an earth human being? Why? Why not?

ACTIVITY
An Energy Cycle

Objective

The students describe the sequence by which energy from the sun becomes a very important source of energy on earth as coal and oil.

Materials

Picture of a mature tree
Encyclopedia for children to read about how we produce oil and coal

Procedures

1. Show the picture of the mature tree to students. Ask them to find out how long it takes a tree to grow to maturity to begin producing new trees.
2. The students draw and label an energy cycle that includes: energy from the sun as light, converting to plant food energy through **photosynthesis** in green trees; dead trees becoming oil and coal over millions of years; the coal and oil being used as fuel in homes and in industry.
3. Students name other sources of energy. (Natural gas and gasoline that is a distilled product of oil are also products of the process that made oil and coal; we use coal and/or oil to generate electricity.)

Getting the Idea

Are coal, natural gas and/or oil replaceable? Why can they not be replaced? (The process that produced them practically stopped long ago; there are, however, peat bogs that are currently producing oil, but it is a very slow process. We are using up oil and gas much faster than it can be produced.)

Discuss with the students that every important source of energy on earth can be traced back to the energy that is received from the sun. Discuss the idea that many houses and other buildings now have solar collectors placed on their roofs to collect sunlight, to convert it into electricity.

ACTIVITY
Star Types

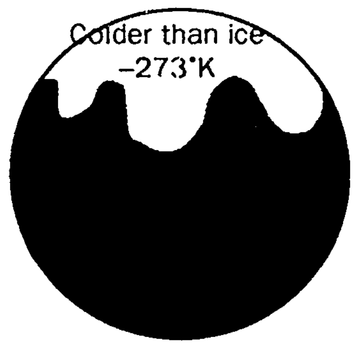
Objective
The students make comparisons using charts.

Materials
Copy of the STAR TYPES Chart

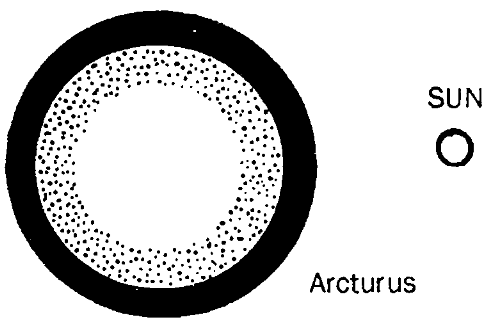
STAR TYPES

Dwarf Star
A star of small size, low mass, low brightness

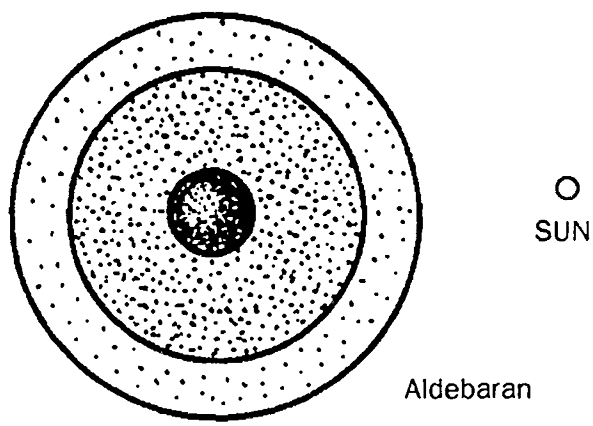
Black Dwarf
A star in its final stage of life, a low energy source emitting no visible light.

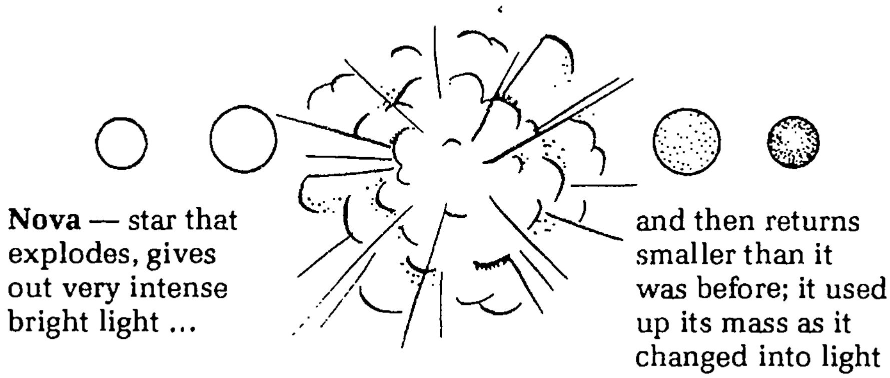


Giant Star
Large size and high brightness

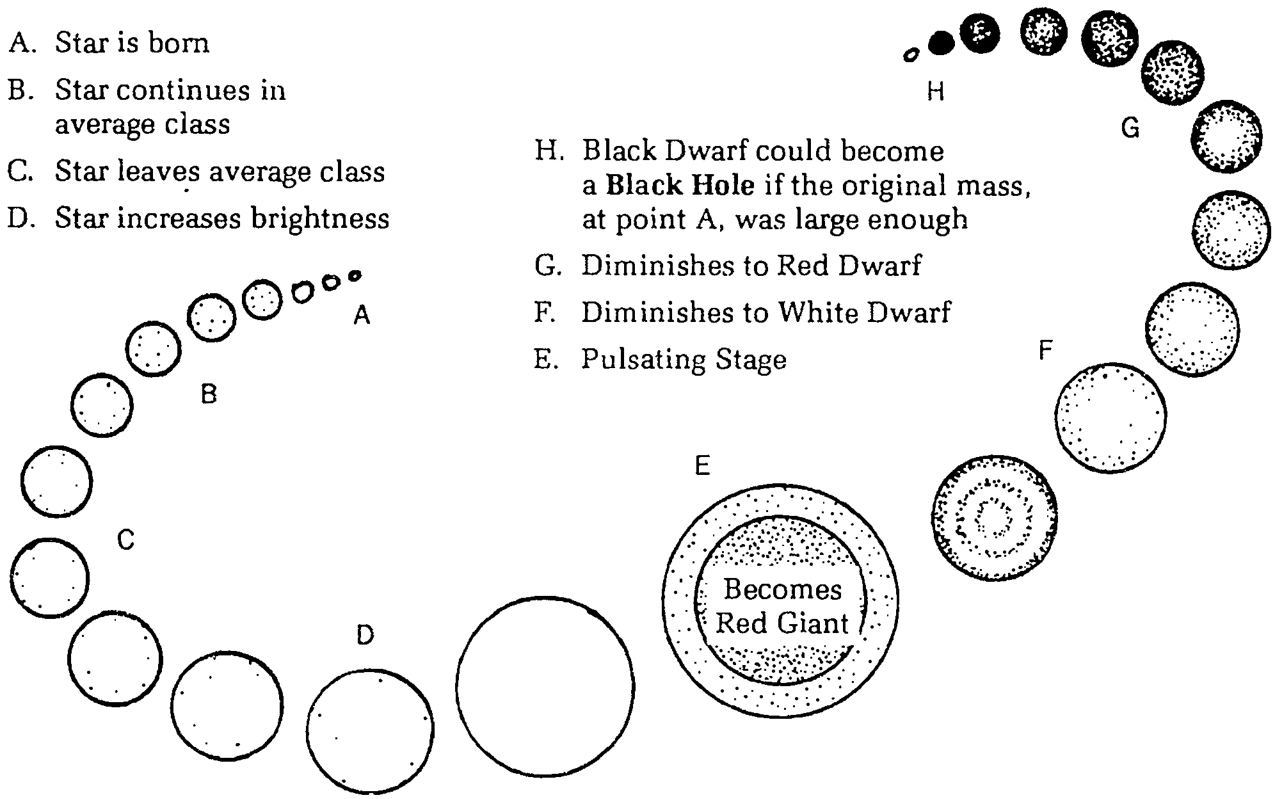


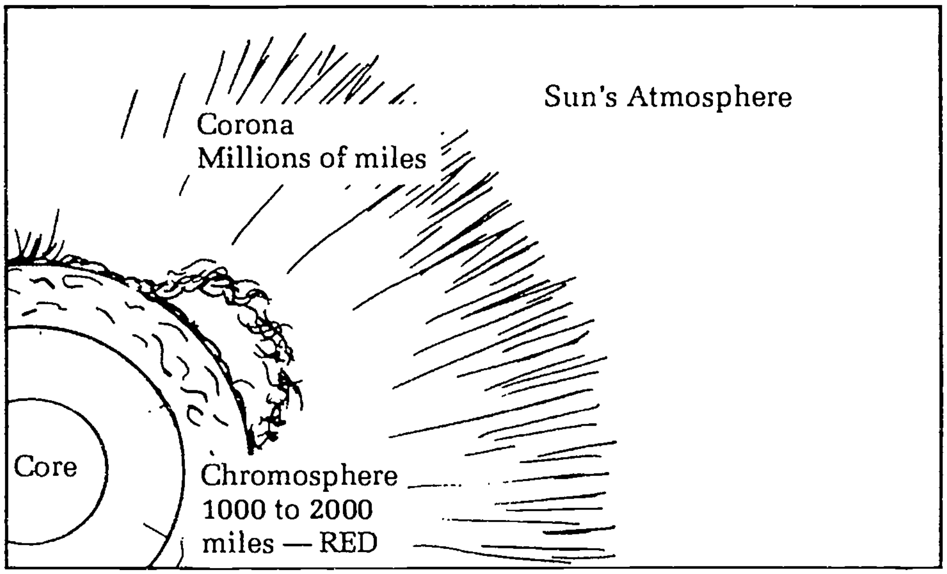
Red Giant
Large, hundreds of times brighter than the sun, but has cooled.





The Life Cycle of a Star





The Sun

Application

Students use the information above and read in reference books to answer the following:

1. Using a picture similar to the one above, write a paragraph describing the core, the chromosphere and the corona of the sun, or
2. Design and complete a chart to compare the sun to other stars in color, size, brightness and distance from earth, and then write a paragraph or make a drawing and label it, or
3. Describe the sun in as many ways as you can.

LESSON 5 *Our Sun's Family — The Planets and Their Satellites*

BIG IDEAS The sun in our solar system has nine planets traveling in elliptical orbits around it.

Whole Group Work

Materials

Model of the solar system that includes the earth's moon; this can be a commercially made model to demonstrate the relative motions or the model(s) made by the students during **Lesson One**

Chart for students to draw the solar system in their journals

Word tags: names of the planets, static, dynamic, elliptical, orbit, path, sphere, sidereal

Encountering the Idea

At night when we look up at the night sky, we find it difficult to distinguish many of the things we see, one from the other. We can, however, see that the points of light have different brightness and that they are different in size. The one stellar body we can see without difficulty, if there are no clouds, is the moon. Night after starry night, the sky appears very much the same. But the night star picture does change. The moon travels across the sky quickly, while other stellar bodies take months for their motion to be noticeable.

One question all ancient people have asked: How do the planets stay in their paths, or orbits, all the time? Why doesn't one planet or star just fly off into outer space. What binds the planets to each other and to the sun? In this lesson, we will study the forces that keep stellar bodies in their orbits.

Using a model of the solar system, name the planets in order of their distance from the sun. See **Activity** — Planet Data. Describe their size, their distance from earth and other details students have researched. Tell the students that in reality the planets and the sun itself are moving at very high velocities. The **awesome** thing about their movement, however, is its regularity. We know that the earth's gravity attracts the moon, and the moon's gravity affects the earth, **BUT** the moon does not fall on earth, the earth does not fall into the sun, and the sun comes up every morning. What keeps all the planets in their orbits? What kinds of orbits, or paths, do these stellar bodies follow? We will learn about the shape of the orbits and also what forces keep the stellar bodies in the universe in their place.

Exploring the Idea

In order for the students to complete **Activity** — How Planets Stay in Orbit, they go into the playground or to a large space where they can swing a tennis ball and not cause damage.

At the **Science Center**, the students complete **Activity** — Stellar Bodies that Reflect Light.

At the **Mathematics Center**, the students

1. complete **Activity** — Closed Paths (this activity gives students the background they need to complete the activities on orbits)
2. complete **Activity** —Elliptical Orbits
3. complete **Activity** — Parabolic Orbits.

Getting the Idea

If the class has made the model of the suspended planets, talk to the students about the model being static — it does not move. A moving model would be called a "dynamic" model.

When planets move, they move, as we know, around the sun. The earth takes a little more than 365 days to make its journey around the sun. This is its sidereal period. But, what is the path of the earth? Is it a circle?

In the year 1500, Copernicus claimed that the earth traveled around the sun in a circle. Another astronomer and mathematician, Kepler, claimed that the orbit was an ellipse. Scientists today believe the orbits are elliptical for most of the stellar bodies. As we said, some comets travel in elliptical orbits, but others travel in parabolic paths, and we see those comets only once. Why? (Parabolic paths are not closed paths.)

Remember, we have said that the major force dominating the movements of the stellar bodies is the gravitational force the bodies exert on each other. In rotating the tennis ball, you experienced two forces at the same time — one is the velocity of the tennis ball as you make it rotate around you, and the other force is the string that is keeping the ball from flying away. Those two forces keep the stellar bodies in their place.

Next time you go to an ice skating show, or see one on television, notice what the skaters do **to stop** after they have been whirling around very fast. When you see this, see if you can make a guess as to what forces are acting on the ice skater.

Organizing the Idea

In your journals, describe how the tennis ball felt as it was rotating around. Describe its path when you released it. Draw the path in your journal.

Make a chart of the different geometric curves we have looked at in this lesson and write an illustrated description of each figure: ellipse, circle, parabola.

Students make a chart to compare the various stellar bodies after reading about them in reference materials.

Stellar Body	Description/Classification	Average Size	Average Temperature
Planet			
Satellite			
Meteorite			
Comet			
Asteroid			
Black Hole			

Applying the Idea

1. Think about the activity of the rotating tennis ball. If you were a rocket scientist, how would you design your rocket so that it would escape the earth's gravity? (It would have to have a very powerful engine to go fast enough to escape the pull of the earth's gravity.)
2. Make several paper cones as you did in the activity with the parabola, and try to make other figures by cutting through the cones in different ways. Try putting two cones together, peak to peak, cut through two cones at a time and see what happens.

Closure and Assessment

Students draw and/or write about

- the way planets and stars are alike or different;
- the difference between an asteroid and a comet;
- what a "shooting star" is.

Student groups select and write or dictate illustrated reports with information from any of the activities they have completed. All of the reports can become a Big Book for their class library.

After showing the charts with information on the planets, discuss the distance of the planets from earth, again in terms of large numbers. How far is the nearest planet? How do we know how far it is from earth?

List of Activities and Appendix for this Lesson

▲ Planet Data

▲ How Planets Stay in Orbit

▲ Stellar Bodies that Reflect Light

▲ **Appendix**—Partial View of the Solar System (from Saturn)

▲ Closed Paths

▲ Elliptical Orbits

▲ Parabolic Orbits

ACTIVITY
Planet Data

Students use this chart to compare the planets and to help them complete their mural.

	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune	Pluto
Distance in millions of miles from sun	36	67	93	141	484	893	1767	289	3674
Diameter (Mi.)	3000	7,600	7,927	4,200	88,700	75,100	30,900	33,00	3,600
Diameter Earth=1	1/3	1	1	1/2	11	9	4	4	1/2
Mass Earth=1	1/10	1	1	1/10	317	95	15	18	?
Volume Earth=1	1/10	1	1	1/10	1,318	736	50	42	1/10
Period of Rotation	59d	243d	24h	25h	10h	11h	16h	6d	24d
Sidereal Period (around sun)	88d	225d	365d	2y	12y	29y	84y	165y	248y
Surface Gravity Earth=1	1/3	1	1	1/3	3	1	1	1	1/3
Known Moons	0	0	1	2	12	10	5	2	0
Max. Vel. Mi./Sec.	30	22	19	15	8	6	4	3	3
Maximum Surface Temp. (F)	640	800	140	50	-215	-240	-280	-300	-370

h = earth hours; d = earth days; y = earth years

ACTIVITY
How Planets Stay in Orbit

Objective

Student demonstrate with a string and a weight how the gravitational pull of the earth balances with an object's tendency to move in a straight line to stay in orbit around the sun.

Preparation

Conduct this activity outdoors to permit students to make several types of observations. Take care when releasing the ball that students are careful to stay out of its way.

Materials

Several pieces of heavy string about three to four yards each
Several tennis balls — one per student pair

Procedures

1. Tie a tennis ball securely on the string.
2. Students take turns swinging the ball in an arc over their heads. Each student is to notice how the tennis ball feels as it swings around in a circle.
3. The student holds the string securely in her/his hand as it swings and then releases **the thumb only.** They describe how the ball feels.
4. Tell the students that after they get the ball swinging, they are to release it. **Before they release the ball,** the students **predict** the trajectory of the ball from the moment they release it to the moment it lands. They check their predictions and discuss why they were correct or incorrect.
5. Students compete to see who can send the ball the farthest. Later they describe what they had to do to get it to go as far as possible.
6. Tell the students that they are now going to swing the ball **as slowly as possible.** They are to predict what will happen. Who can swing it the slowest?
7. What force keeps the tennis ball from falling? (The velocity of the ball as it goes around its orbit.)

Organizing the Idea

1. In this activity of the rotating ball, what does the string represent? (The pull of the sun's gravity.) What does the tennis ball represent? (The earth.)
2. Could the string represent the earth's gravity and the ball represent the moon?
3. Are all planets and satellites kept in their orbits in a similar way?
4. What happened when you didn't swing the ball hard enough? Yes, it fell to the ground.
5. What would happen to the moon if it began to slow down?
6. What would happen to Pluto if it started to speed up?

Remember

The two forces — the velocity of the planet and the strength of the gravitational attraction of the sun — have to be in balance for the planets to stay in orbit.

ACTIVITY
Stellar Bodies that Reflect Light

Objective

The students experiment with materials that emit, reflect and/or absorb light and categorize them correctly.

Materials

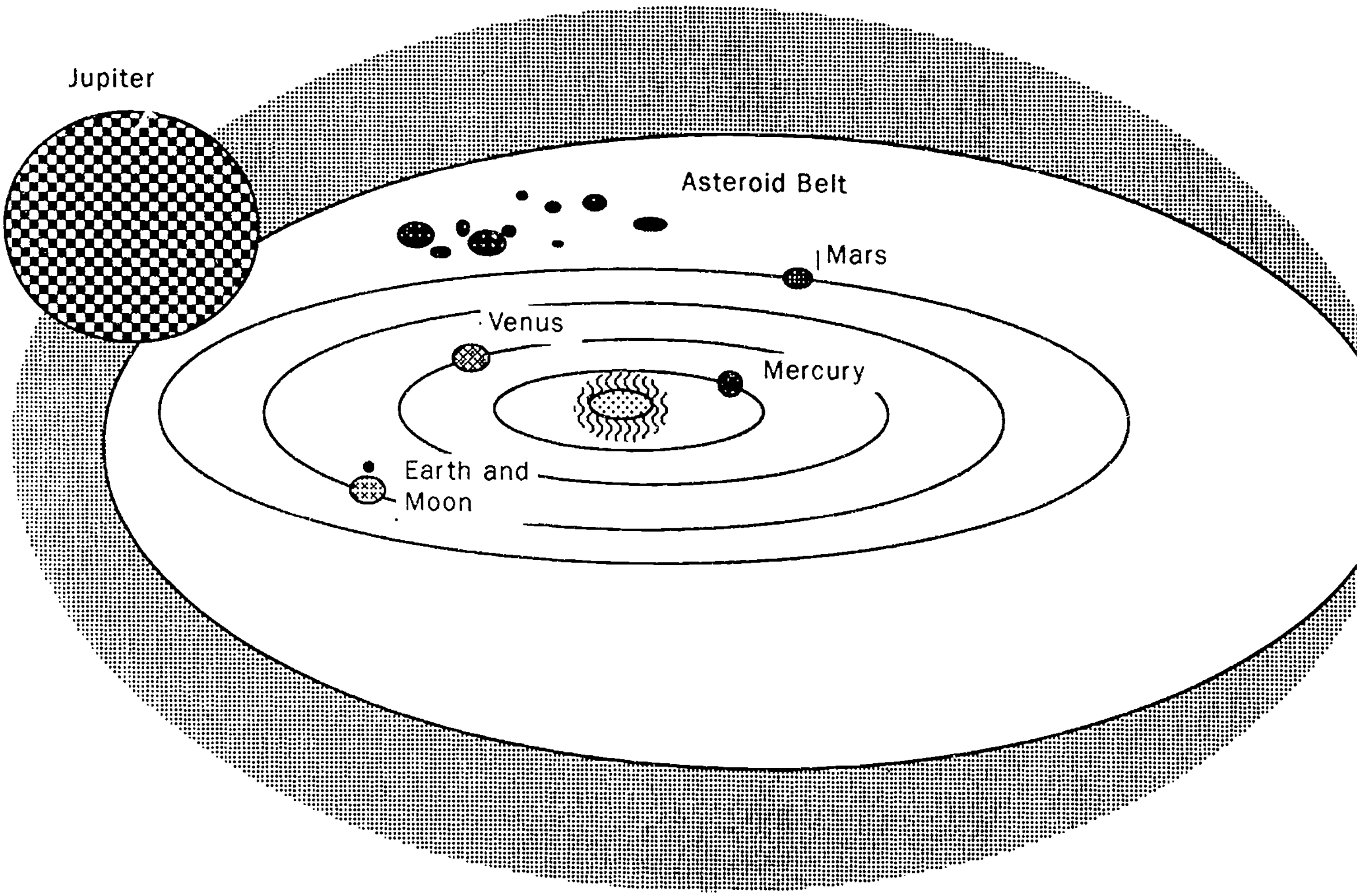
Flashlight; aluminum foil; black and white construction paper; match; candle; wax paper; mirror; ceramic tile; glass; other objects that emit light

Inflated balloon covered with aluminum foil

Procedures

Students work in small groups.

1. Students categorize objects as those that emit, reflect or absorb light.
2. Students justify to each other why they classified each object as they did. When objects reflect light do they shine all over or just in some places? (They shine only where they reflect the light.)
3. When do you know that an object is absorbing light? (It gets warm, hot.)
4. Can we classify some objects in more than one category? Can an object reflect and absorb light at the same time? (Even though some objects reflect light, they also absorb it. If the students cannot give an example, ask: Have you walked barefoot in the summer on hot dirt? Have you walked on the sidewalk and on a street paved with black asphalt? Why is the dirt hot? Which was hotter — the dirt, the sidewalk or the black asphalt? Why? Does earth reflect or absorb sunlight?)
5. Can any of these objects make their own energy?
6. Darken the room as much as possible. Using a flashlight and the aluminum covered balloon held at a distance, the students shine the light on the balloon. Is the balloon emitting its own light? (It is just reflecting it.)
7. Some of the students stand behind the balloon as the sun is shining on one side of it. Is the balloon reflecting light from the other side? Why? (It's getting light from only one direction.)
8. If the balloon is the earth and the flashlight is the sun, why can astronauts see the earth from the moon?
9. Take the batteries out of the flashlight. Does it turn on? What gave it its energy (the batteries).
10. Place a sheet of black construction paper and a white sheet in a sunny place. After several hours the students touch each sheet and report. Does paper reflect or absorb light? (Both; the black sheet, however, gets hotter — it absorbed more heat.)


Jupiter
Asteroid Belt
Mars
Venus
Mercury
Earth and
Moon

ACTIVITY
Closed Paths

Objective

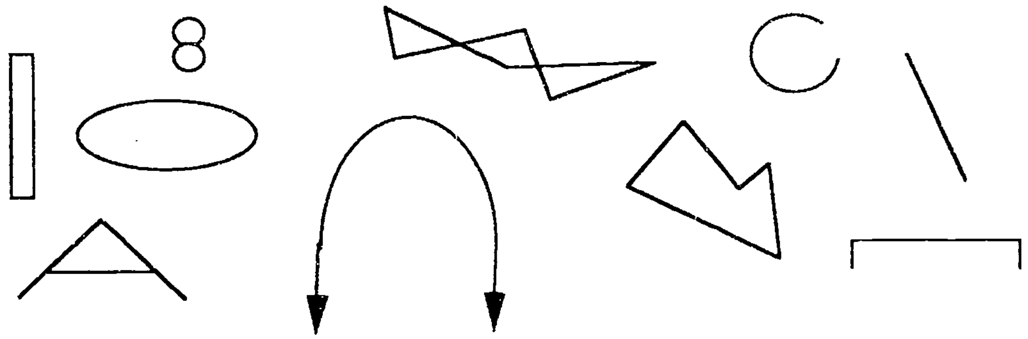
The student names at least two geometric figures that form closed paths and describes a geometric figure that is not a closed path.

Materials

Copies of the figures shown below

Procedure

1. Show students the following geometric figures and ask them to categorize them in any way they wish:



2. After the students have mentioned several ways to categorize the figures, if they have not suggested it, point out that some of the figures are **closed.**
3. What do they think a closed figure is? Yes, the rectangle is closed and also the ellipse. The figure that looks like part of an arrow is also closed.
4. The part-rectangle is not closed, nor is the figure that looks like the letter C or like an open circle. The horseshoe figure is not closed. The arrows show that the figure continues indefinitely in those two directions and will not come together again.
5. The figure that looks like the number "8" is also closed, because you can trace it with your pencil — start at one point and go all around it and get back to the beginning without lifting the pencil.
6. A line segment is not closed.
7. The figure with the zig-zags is also closed. The figure that looks like the letter "A" has one part that is a closed figure.

Application

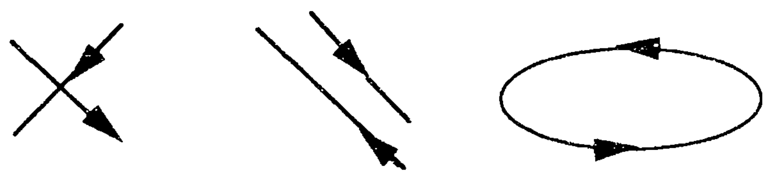
1. Which of the letters of the alphabet (use capital, printed letters) do you think are closed? Which ones are not closed? Which have a part that is closed? Make a list and see.
2. Are there more letters that are closed or are there more letters that are not closed?
3. Which of the numerals zero through nine are closed? Not closed? How many more?

Remember

If you can trace a figure with the tip of your pencil beginning at one point all the way around and get back to the beginning without lifting your pencil, then the figure is closed.

Problem

A dog and a cat are walking on the paths shown in these three pictures. If the dog and the cat meet, they will fight. Where do you think there will be a fight? Explain your reasons. Remember, the arrows **points in the direction in which the dog and cat can walk,** the arrows show where they are, and they can't walk backwards.



Discussion

The only path where there can be a fight is in the last figure. If one of them stops or one goes faster than the other they will meet. The dog and cat will not meet in the first figure because one of them has passed the only point where they could meet. In the middle figure, they can never meet because there are no common points.

ACTIVITY
Elliptical Orbits

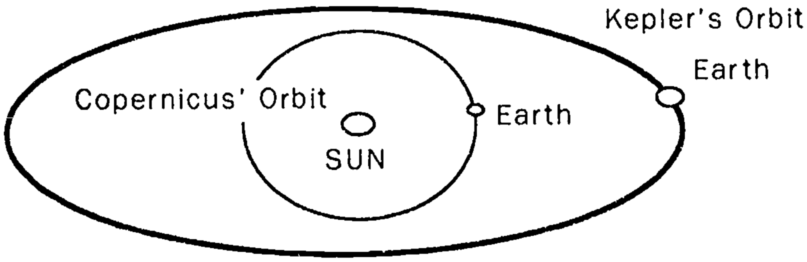
Objective
The student draws a circle, an ellipse as an elongated circle and an ellipse using two focal points.

Materials
Large sheet of paper; large piece of cardboard placed under the paper
One seven-inch piece of string and one 24-inch piece of string, tied end-to-end to form a loop
styrofoam cup; pencil; thumbtacks

Procedures
Part 1
Drawing a circle and an ellipse with a cup.
1. Trace the mouth of a styrofoam cup on a piece of paper.
2. Using the same styrofoam cup, gently squeeze it into an elongated circle. Trace the mouth of the cup in its elongated form.

Part 2
Drawing a circle with a piece of string.
1. Place the large sheet of paper on the cardboard. Draw a picture of the sun (measuring about one inch in diameter) in the center of the paper.
2. Tie the seven-inch piece of string securely to the pencil in a position slightly above the point. Secure the other end of the piece of string to the center of the sun.
3. With the point of the pencil, draw a circle around the sun using the thumbtack as a pivot point.

Part 3
Drawing an ellipse with a piece of string.
1. Press two thumbtacks about eight inches apart into the paper and cardboard on the same line across the picture of the sun.
2. Place the loop of string around the thumbtacks.
3. Place the pencil, tip down, inside the loop of the string and, keeping the string taut against the pencil, draw an arc as before.
4. Make other ellipses by changing the distance of the thumbtacks from each other. An astronomer and mathematician, Kepler, claimed that the orbit of the earth around the sun was an ellipse.



Discussion
In the year 150 A.D., Ptolemy proposed that the earth was the center of the universe and the sun, planets and moon moved around the earth. In the year 1500 A.D., Copernicus claimed that the earth traveled around the sun in a circle.

ACTIVITY
Parabolic Orbits

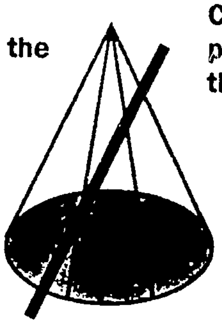
Is an ellipse a closed curve? How do you know?

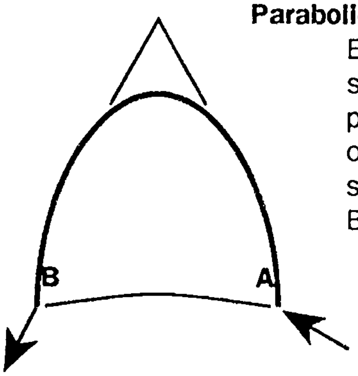
Objective
The student sketches a parabolic shape and says that some stellar bodies, such as comets, travel in parabolic paths; once those bodies come by earth's orbit, they leave and never return, because the parabola is not a closed curve.

Materials
Any cone-shaped object, such as a paper cone made from a piece of paper cut into a semicircle and taped

Scissors; transparent tape

Procedures
1. Using the paper cut into a semicircle, form a cone by bringing the two edges of the semicircle together; fasten with tape.
2. Flatten the cone only enough to get a slant side of the cone.
3. Cut the cone along a line that is **parallel** to the slant edge of the cone.
4. The cut edge of the cone will show a **parabolic** shape.





Parabolic Shape

Entry and exit paths of comets that are seen only once from earth. Since the parabola is not a closed curve like a circle or an ellipse, if a comet comes close to our solar system at point A and leaves at point B, it will not come on this path again.

LESSON 6 The Moon Is Our Nearest Neighbor

BIG IDEAS As the earth's follower, the moon affects the earth in many important ways. We know the distance from Earth to the moon because humans have calculated the distance and traveled there.

Whole Group Work

Materials

Book: **Eclipse: Darkness in Daytime** by F.M. Branley
NASA pictures showing astronauts walking on the moon.
Pictures of the moon's craters
Word tags: eclipse, lunar, tide

Encountering the Idea

Let's start our lesson on the moon by looking at the data, or information, we have collected and recorded on our charts. What can you tell about the moon from the charts? Describe it as you have recorded it on your charts. (Pause for students, working in small groups or pairs, to prepare responses.) First, we can see that every day it has a different shape, and every day it rises in a different part of the sky. Sometimes we can even see it during the daytime — it may be very faint, but we can still see it. Why do you suppose the moon has a different shape every day? Does the moon ever have the same shape again? If we keep records of the moon's shape for a long enough period of time, we will see that its different shapes have a pattern. What is that pattern? In our activities, we will learn about the moon's shapes and what causes them. We will also learn other things.

Have any of you heard about an **eclipse of the moon**? Do you know what it is? Have you seen one? That's one of the things we are going to study today — about the eclipse of the moon and what causes it.

Exploring the Idea

At the **Science Center**, the students

1. continue working on the chart on **Star-** and **Moon-Gazing**, adding as many new observations as possible and discussing them within their student groups and with the class.
2. complete **Activity** — Moon Phases
3. complete **Activity** — The Moon Affects the Tides
4. complete **Activity** — Eclipse of the Moon.

At the **Mathematics Center**, the students complete **Activity** — My Weight on the Moon.

Getting the Idea

1. The students make a paper-mache model of the moon. After researching the surface features of the moon, students form its features and color the surface as described by the astronauts. The students discuss how many "times" larger the earth is than the moon!!
2. A stellar body's gravity depends on the body's mass — the greater the mass, the greater the gravitational attraction of a stellar body; our earth weight is different from our moon weight because the moon has 1/6th the mass of the earth.
3. Students discuss the cause of a lunar eclipse.

Organizing the Idea

Brainstorm on: WHAT WE KNOW ABOUT THE MOON

Write sentences on strips of tag board as students provide information on the moon. Then the students organize the information into a report to take home to read to the family.

Students make a list of questions: WHAT WE WANT TO KNOW.

Write questions that students suggest on tag board strips also. Then the students work in pairs or small groups to find the answers. They report to the class, justifying their answers with references and/or observations.

Applying the Idea

Problem Solving

1. Suppose you are an astronaut on the moon. You want to step out of your spaceship to walk around to explore. How much more weight do you have to have on your space suit to equal your weight on earth so that you won't go sailing off into the air?
2. Using pictures of the astronauts and pictures, if possible, of recent departures of new space vehicles, ask students if they would like to travel to the moon. Why was it important for humans to go to the moon?

Closure and Assessment

As an activity to bring closure to this phase of the unit, the students make a lunar chart with information on the moon:

Distance from Earth is 252,710 miles
Its orbit size
The moon's brightness (the sun is 465,000 times brighter than the moon)
Orbits the earth in 29 1/2 days.
Diameter — 2,200 miles
Water — none on the moon
Air — none on the moon
Surface features — craters (dark areas) and smooth areas

The moon always faces the earth in the same position; humans can see only one side of the moon. The students can show how this is possible by using objects to represent the earth and the moon and a light source to represent the sun.

Students discuss their observations of the moon. See **Activity** — Moon Phases and, from Lesson One, **Activity** — Star- and Moon-Gazing.

List of Activities for this Lesson

- Moon Phases
- The Moon Affects the Tides
- Eclipse of the Moon
- My Weight on the Moon

ACTIVITY
Moon Phases

Objective

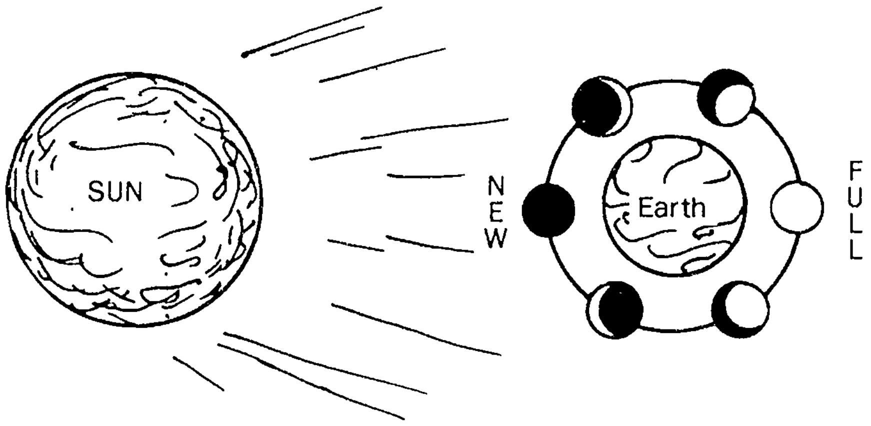
The students demonstrate, using a source of light and models of the earth and moon, how the relative positions of the earth and moon produce the various phases of the moon.

Materials

Two spheres of different diameters, such as two inflated balloons, to represent earth and moon; the smaller balloon has one half covered with aluminum foil
Flashlight or other source of light, such as a lamp, to represent the sun
Copy of a lunar calendar (or transparency)

Procedures

1. The students pantomime the rotation of the moon on its axis and its revolution around the earth. One student holds the flashlight.
2. A second student holds the earth (the larger balloon) between the sun and the moon (the smaller balloon) in the positions shown in the diagram.



Light rays

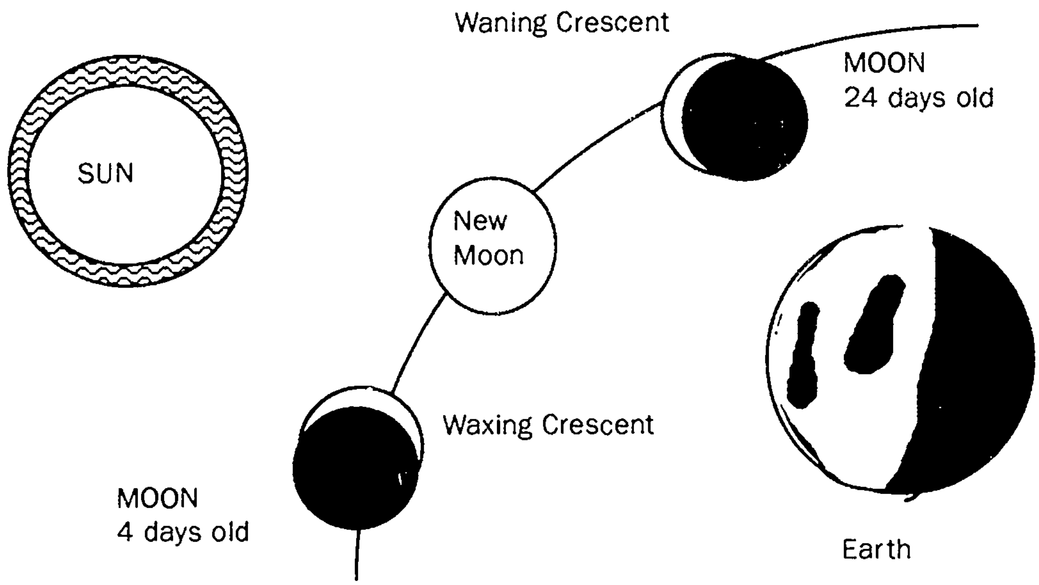
3. The moon revolves around the earth and keeps only one side (the aluminum side) facing the earth.
4. The moon rotates on its axis so that as it revolves around the earth, it keeps the same side always facing the earth.

Discussion

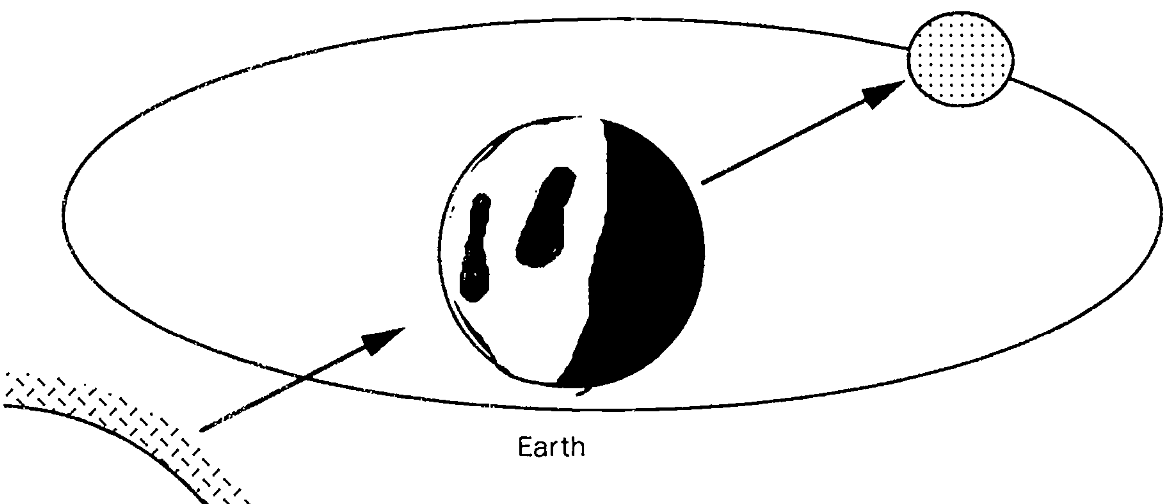
Show students a copy of the lunar calendar. Ask the students to make observations about the chart and about the number of days in the lunar calendar. When does the lunar month begin?

When is the moon full? When is the next full moon? The next new moon? When is the moon in the various positions shown on the lunar calendar?

The New Moon



The Full Moon



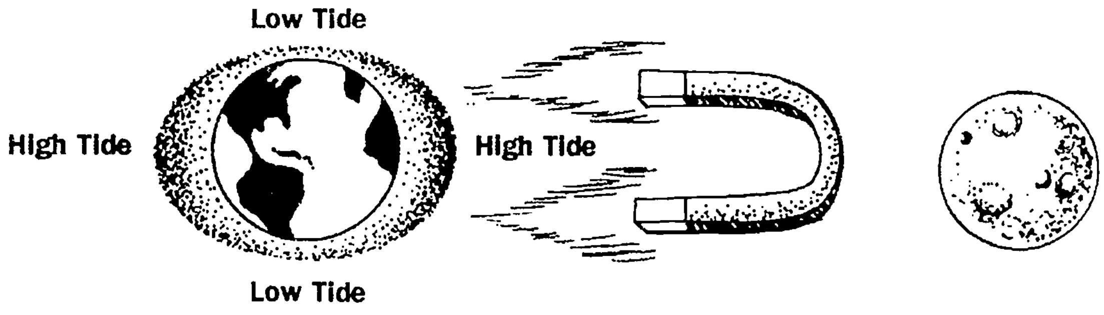
The phase of the moon when it is opposite the sun.
The fully lightd surface faces the earth.

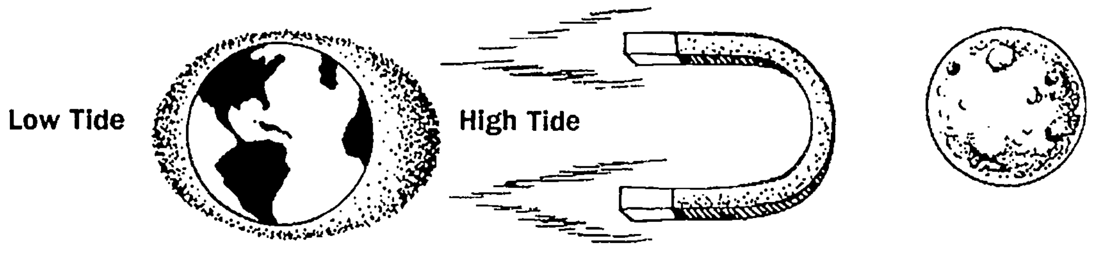
ACTIVITY
The Moon Affects the Tides

Objective
The student demonstrates by using a small dish and a strong horseshoe magnet the way the moon affects the tides on earth.

Materials
Small, round dish containing iron filings
Strong horseshoe magnet

Procedures
1. Review with students the action of a magnet on iron filings. Move the magnet back and forth among the filings to demonstrate how the filings respond to the movement of the magnet.
2. Tell students that the iron filings stand for the water in the ocean on earth, and the magnet represents the moon. Since the moon is a stellar object it effects an attraction on everything on earth, the same way that the earth effects an attraction on other stellar bodies in space.
3. Put iron filings in a small, round dish. Bring the magnet close to the dish, keeping the dish in the center of the horseshoe area of the magnet.
4. The students describe the effect of the magnet on the iron filings.





Discussion
The sun effects an attraction on earth also. Which picture above shows the effect of the sun on the tide? (When the sun is opposite the moon, the sun attracts the water, causing a high tide on its side. When the sun is on the same side as the moon, the high tide reaches its highest point.)

ACTIVITY
Eclipse of the Moon

Objective

The students demonstrate, using a source of light and models of the earth and moon, how the relative positions of the earth and moon produce a partial and total eclipse of the moon.

Materials

Two spheres of different diameters, such as two inflated balloons, to represent earth and moon; smaller balloon has one half covered with aluminum foil—this is the side that faces earth at all times

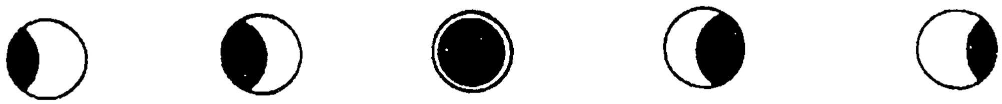
Flashlight or other source of light, such as a lamp, to represent the sun.

Procedures

1. Darken the room as much as possible.
2. The students pantomime the rotation of the moon on its axis and its revolution around the earth. One student holds the flashlight.
3. A second student holds the earth (the larger balloon) between the sun and the moon (the smaller balloon) in the positions shown in the diagrams.

Partial Eclipse

Total Eclipse



4. The students describe the position of the earth in relation to the moon when the earth's shadow can fall on the moon. (Note: The moon is much closer to earth than earth is to the sun.)

ACTIVITY
My Weight on the Moon

Objective

The student says that a person's body weight depends on where he/she weighs himself/ herself and gives his/her body weight on earth and on the moon.

Materials

Surface Gravity chart (from **Activity** — Planet Data, Lesson 5)
Scale

Procedures

1. Students take turns weighing themselves on earth's surface.
2. They calculate how much they would weigh on the moon, given that the moon's surface gravity is only ______ of the earth's.

For example, a person weighing 100 pounds on earth would only weigh ______ pounds on the moon.

	Stellar Body's Surface Gravity
Earth	1
Pluto	1/3 (still in doubt)
Mercury	1/3
Mars	2/5
Venus	1
Neptune	1
Uranus	1
Saturn	1 1/5
Jupiter	2 3/5
Earth's moon	3/5

Discussion

Stellar bodies have different masses that affect the strength of their gravitational attraction. But the mass is not always evenly distributed throughout the body, thus the strength of the gravitational attraction is not the same everywhere. What this means is that your weight will not always be the same everywhere you weigh yourself. Your **mass,** however, remains the same.

We use earth as the standard unit on the chart. With the exception of earth — because its surface gravity is used as the standard unit — all of these other factors are approximations. We can still develop the notion, however, that weight is a property of matter that depends on location — where the weight is measured. Mass is constant — the amount of "stuff" in a piece of matter does not change even though its weight depends on where the "stuff" is weighed.

[1]Note that although the mass of the earth is 6 times greater than the mass of the moon, the moon's **surface** gravity is 3/5th the surface gravity of the earth.
[2]Earth's surface gravity is the standard unit of surface gravity for the other planets in our solar system
[3]A unit is usually assigned the number 1; that unit is used then as the standard by which to make comparisons

LESSON 7 Constellations

BIG IDEAS We see light from faraway stars as reliable patterns called "constellations". These patterns in the sky guide travelers on earth at night and tell astronauts where they are in space.

Whole Group Work

Materials

Books: **The Big Dipper and You** by E.C. Krupp, **Her Seven Brothers** by P. Goble, **Follow the Drinking Gourd** by J. Winter, and **Exploring the Night Sky** by T. Dickinson

Collection of pictures of the constellations; set of dot pictures of the constellations, for example, The Big Dipper: See **Activity** — Major Constellations

Word tags: constellation, zodiac, Greeks, circumpolar, seasonal, gourd

Encountering the Idea

Read the story **The Big Dipper and You** or one of the other stories to the class. As you show pictures of the constellations to the students, discuss the story with them. In their observations of the night sky, have they detected any patterns such as the ones described by the authors in the books? In this lesson, they will study the patterns that appear in the night sky and learn how the patterns have become useful guides for travelers on earth and in space.

Exploring the Idea

At the **Mathematics Center,** the students complete **Activity** — Star Find.

At the **Science Center,** the students

1. complete **Activity** — Finding Our Way
2. complete **Activity** — The Night Sky
3. complete **Activity** — Major Constellations
4. complete **Activity** — Zodiac Data.

Do **Activity** — Use Your Umbrella, as below.

Materials

Large black umbrella; soft white chalk

Procedures

Students open a large black umbrella and draw several of the constellations on the black underside around the shaft of the umbrella, identifying **Polaris** first, then locating various other stars and constellations. They label what they can identify in the constellation.

Getting the Idea

Ask the students if they know what the word "constellation" means. If they break it down into syllables, they may be able to guess. "Con" in Spanish means "with", or "together with." What does the word "stella" suggest? Yes, star. What would the word mean? With other stars, or a grouping of stars. In the activities you have completed, you have learned that there are some consistent patterns in the night sky that we can identify because they suggest familiar objects.

Constellations visible in any part of the sky appear to move easterly each hour because of the earth's rotation. Constellations visible in any part of the sky also appear to move in a westerly direction each month, but this is because of the earth's revolution about the sun. Thus, over a period of a year, each constellation is visible for a period of six months when we observe it, at the same time of the night, moving from an easterly direction to west. These are the **seasonal** constellations.

On the other hand, **circumpolar** constellations are constellations that do not rise or set — in other words, do not appear to move as the others do. These constellations appear to move in a series of circles around **Polaris, the North Star,** thereby termed "circumpolar".

We have learned that the Greeks gave constellations names because if a constellation suggested the figure of a familiar object, it would be easier to find it regularly in the night sky. But does **each of the stars** in a particular constellation have a name? In current times, astronomers throughout the world need a common communication system to talk about stars and constellations. There are so many stars that there has to be a way of identifying them without making a mistake. One common characteristic stars have is their brightness. So, the Greeks ordered the stars by apparent brightness and gave them a prefix of a Greek letter and then the name of the constellation where the star could be found. For example, B, beta, meant the *second brightest* star in a constellation. Look at your **Star Data** chart. You will find some stars labeled alpha (first letter in the Greek alphabet, like A) and others labeled beta (second letter in the Greek alphabet, like B), and so on.

The Greeks not only named the constellations after the figures they imagined they could see in the patterns but also gave the constellations names to commemorate important events. They used letters of the Greek alphabet to name the individual stars within the constellations.

The Greeks designed another stellar coding system called the **Zodiac.** See **Activity** — Zodiac Data. They developed this system on the basis of the position of the sun, rather than the stars. The Greeks believed that the planets had great influence on the lives of people. The Greeks used the word "Zodiac" to name this system, because when they looked for familiar figures in the night sky they were reminded of a **zoo** — a place where we find many animals.

After discussing the ideas presented in the activities, the students may want to consider the following interesting questions.

1. What did you think of the game of finding a star using an ordered pair of numbers? Of course, in space you would have to use additional numbers to actually find a star because, for one, space is three-dimensional.
2. Are there other calendars that other people have developed? For example, the Chinese have their own calendar, as do the Mayans and the Hebrews. Look in your reference books for one or more of these systems and report to your class.

Organizing the Idea

Read or tell stories about the constellations; make and label a zodiac belt around the model solar system. Walk the earth's orbit and make a chart indicating the months when we can view each constellation. Put the charts in the class library.

At the **Writing Center:**

1. Write a class **Newsletter** to include student-authored stories and pictures of planets and constellations, and planet games (Write the rules for the games you make up so that other students can play the games.) Read your newsletter to your family at home.
2. Find your own zodiac sign and those of your friends; follow horoscope predictions that usually appear in the daily newspaper. See and describe in your journal how the predictions relate to the events of the day.

At the **Language Center:**

1. Find other stars on your **Star Chart** that have Greek letters added to them. You may also want to find in your reference book other Greek letters that are similar to English letters, for example, the last letter of the Greek alphabet.

ALPHA	BETA	GAMMA	DELTA	EPSILON
α	β	γ	Δ	ε

2. Look up the word "alphabet" in the dictionary and identify and describe the relation of that word to the Greek letters "alpha" and "beta".
3. Look for the definitions of "astronomer" and "astrologer". How are these two methods of studying stellar bodies the same, and how are they different?

Applying the Idea

1. Do you think the Greeks had a good idea when they decided to group the constellations into specific patterns and give them names of familiar objects or persons? Explain why you think it was a good idea or not. Give your reasons.
2. Would you like to design your own scheme for keeping track of the stars? If so, how would you go about it?
3. Extend the game "Star Find" to a third dimension, or third number, if you would like. You can get one of your friends to help you design the game and then teach it to the other members of the class.

Closure and Assessment

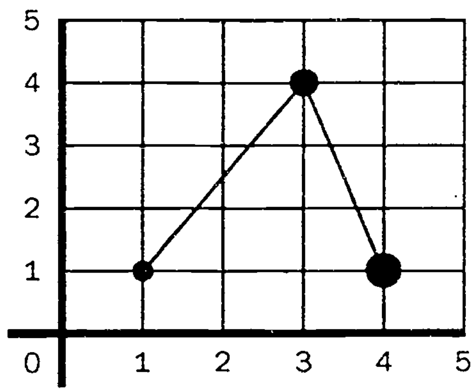
At the end of the lesson, reconvene the children to ask the following questions about **The Big Dipper and You** and **Exploring the Night Sky.**

1. What objects can you see in the night sky?
2. Can you name the planets in our solar system? Which is the largest? Smallest?
3. How are Earth and Venus alike/different?
4. What are black holes/quasars/red dwarfs?
5. What is a constellation?
6. How can the stars in the Big Dipper help guide you?
7. Which star can you see only in the daytime?
8. What are some other names for the North Star? What is the "drinking gourd"?

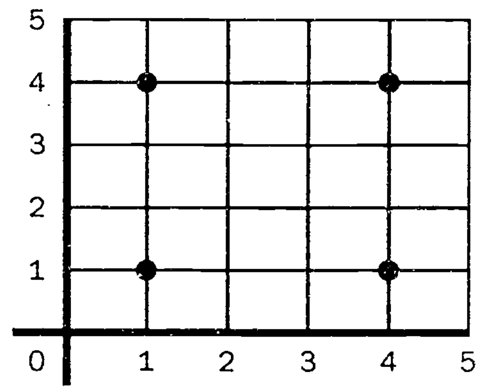
9. Why do the stars seem to move across the night sky?
10. Why is the Big Dipper called by other names in different countries?
11. Do people living at the tip of South America see the same constellations as we see here in the United States?

Finding some Stars

1. Write the coordinates (ordered pairs) of the vertices (corners) forming the triangle on the first grid showing the constellation "Tristellis".
2. Draw a square on the second grid and write the ordered pairs forming the vertices (corners) of the square showing the constellation "Quadristellis".



Tristellis



Quadristellis

3. If you had been a Greek naming the constellations and the stars, how would you have named the stars in the "Constellation Tristellis"? ((4,1) is alpha Tristellis; (3,4) is beta Tristellis; (1,1) is gamma Tristellis; the brightest is alpha, and so on.) In "Constellation Quadristellis"?

List of Activities for this Lesson

- ▲ Star Find
- ▲ Finding Our Way
- ▲ The Night Sky
- ▲ Major Constellations
- ▲ Zodiac Data

ACTIVITY
Star Find

Objective

Students use the concept of an ordered pair of whole numbers on a coordinate plane so that

1. given an ordered pair of a "star location," they can circle the intersection of the ordered pair
2. shown a "star" on a coordinate plane, they can give its location using an ordered pair.

Materials

Coordinate plane drawn on heavy paper and laminated
Erasable markers

Rules

1. The person who gives an ordered pair gives two numbers less than or equal to five, for example, three and one, written (3,1).
2. The first number is the horizontal coordinate to the right, 3 spaces.
3. The second number is the vertical coordinate, up one space. (See the black dot on Fig. 1.)
4. If a student says (1,3), then that is the square on Fig. 1 and it is incorrect.
5. The point (0,0) is the origin.

Procedures

1. Students work in groups of three, taking turns.
2. One is scorekeeper and determines correctness of responses.
3. The second gives the ordered pair.
4. The third locates the star and puts a circle on its location. (Fig. 1.)
5. After students have mastered locating points on the coordinate plane using whole numbers, they suggest ways to locate a star that is **not** on a corner. (Fig. 2.)

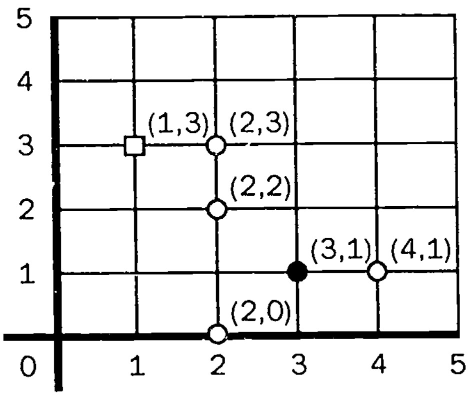


Fig. 1

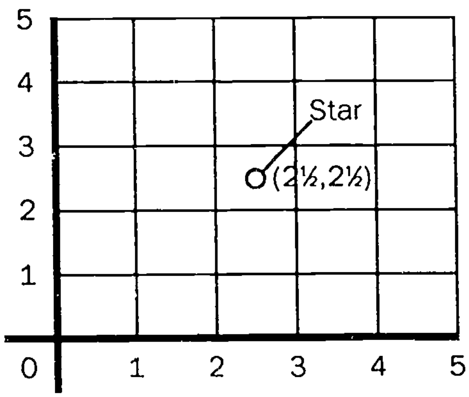


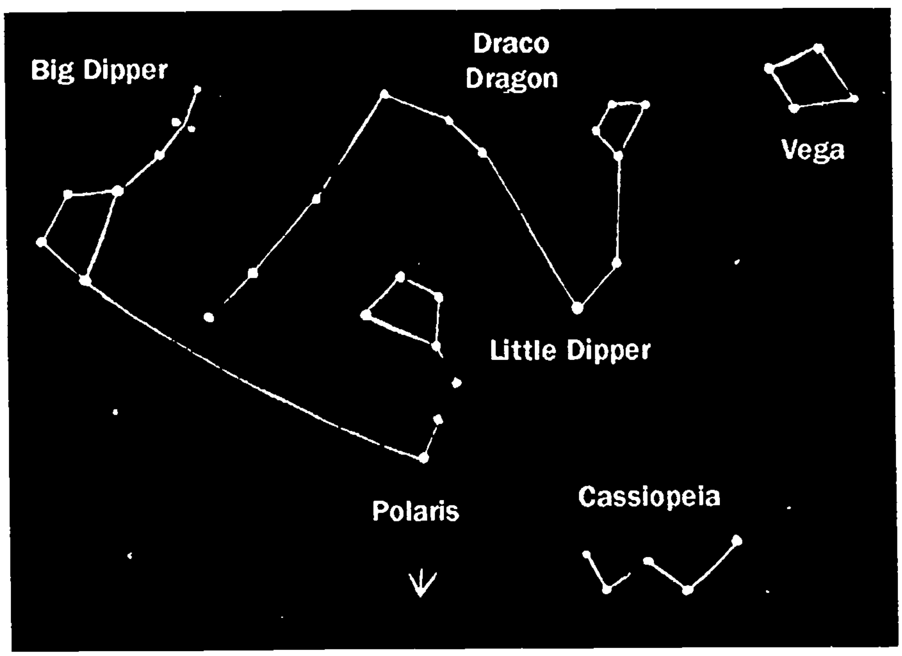
Fig. 2

ACTIVITY
Finding Our Way

Objective
The student finds in the night sky the North Star and at least three constellations, using a star chart and the North Star as guides.

Materials
Copy of the charts below for each student; world globe

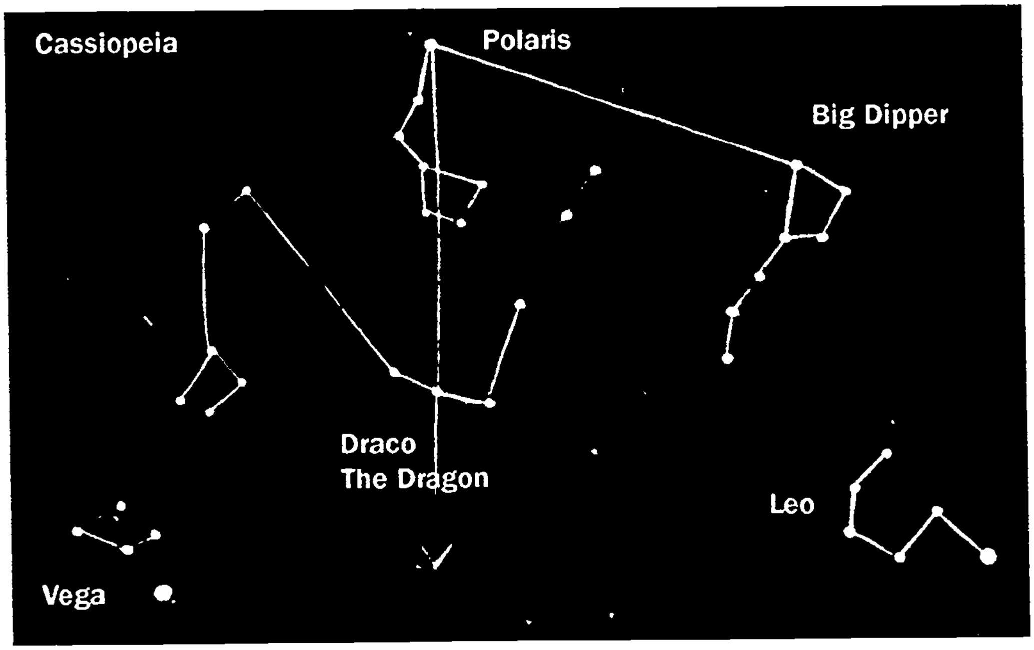
Procedures
1. The first step in orienting yourself on a clear night is to find the North Star, also called Polaris because it is the "North Pole" star.
2. Since Polaris is in the constellation we call the "Big Dipper," you start by looking for the Big Dipper. If you have an idea where north is, you look in a northerly direction.
3. Look for four stars that make a bowl, and three stars that make the handle.
4. The two stars farthest from the handle are the "pointers" to the North Star. Notice that the North Star is at the end of the handle on the Little Dipper.
5. If you draw a perpendicular line from the North Star down to the horizon, true north (for you) is the point where the imaginary line from the North Star intersects with the horizon.
6. The second star in the handle of the Big Dipper (arrow) is not one star, but two stars that appear to be very close. If you have especially good eyesight, you will be able to see the two.
7. Compare the two charts of the stars. How are they alike and how are they different?



Summer Sky

8. Are the constellations shown on the charts **seasonal** or are they **circumpolar**? Explain.

9. To find the star Vega in the summer sky, draw a line from the Big Dipper to Cassiopeia, the constellation that looks like a W, then draw a line perpendicular to the first line but make it go through Polaris. That line will point in the direction of Vega, which is the brightest star in the constellation Lyra.
10. Give directions on how to find Vega in the winter sky.



Winter Sky

Getting the Idea

1. Will Polaris change its position during the year as some of the other stars move from east to west? (No, because this is a star that is **circumpolar.** It goes "around the pole" and stays in the same place throughout the year. That is why the North Star is our reference point, or the point that we begin from, to find our way.)
2. If you were a sailor on a ship out in the middle of the ocean, no sign of land, would you need a compass to help you find north? If not, how would you find north?
3. If you were in a spaceship in outer space, do you think you could find the direction the spaceship was traveling without a compass? How? Would you still look for Polaris to help you find your direction? Why, or why not?
4. Suppose you are millions and millions of miles away from earth in outer space on a very distant star. What would earth look like to you? Where would north be? Would you even care about north out there? (The earth, if it were visible from the distance, would be a mere speck. "North" is a notion that is valuable on earth only and becomes meaningless in outer space. The spaceship navigators use different methods for finding their way, but **they still use the stars!**)
5. Suppose you live in South America, Australia or South Africa (at least 1000 miles below the equator). Would you be able to find Polaris? Use a world globe and explain why. If you were an explorer would you look for north or for south? How would you find south? Would you try to use the stars? **First, you would have to find a point of reference in the south night sky!**

ACTIVITY
The Night Sky

Objective

The student finds at least three constellations in a simulated night sky.

Materials

Copy of the two charts shown in **Activity** -- Finding Our Way.
Black construction paper
Hole punch for larger holes, and pencil and pen points for smaller holes

Prior Preparation

1. The teacher makes a copy of the summer and winter sky maps. Using this as an overlay, punch holes on each of the dots indicating a star.
2. Lay a copy of the summer sky chart on a black sheet of construction paper.
3. Place the chart outlined in black construction paper over an overhead projector.
4. Project the images onto the ceiling.
5. If the ceiling is made of acoustical tile that will interfere with the view of the dots of projected light, so you may want to cover a portion of the ceiling with paper.

Procedures

1. Darken the room as much as possible.
2. Project the chart of the summer sky onto the ceiling with an overhead projector.
3. Ask students to locate the various constellations using the directions from **Activity** — Finding Our Way.
4. Slowly rotate the chart around on the top of the overhead projector, keeping Polaris in a relatively fixed position.
5. The students describe the position of the constellations as the chart rotates.
6. The student hypothesize as to why the constellations appear to rotate in a circle. (These are the circumpolar constellations.)
7. Students practice finding the constellations and Polaris so that at night they will be able to locate them when they go out to make their observations.
8. Working in pairs, the students check each other on finding the constellations.

ACTIVITY
Major Constellations

Objective

The student names and describes at least three major constellations.

Materials

Chart of major constellations and their common names. **Note:** Indicate to students that the lines drawn on the constellations are imaginary, like the equator, and we use them only to show the pattern; these lines are not in the sky.

Procedures

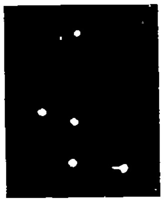
Working in small groups to compare, communicate and share information, the students continue to observe the night sky as often as possible and report on the major constellations they have been able to identify.

1. The students identify **Polaris, The North Star,** as one of their first assignments. This star will help them identify their first constellation (Ursa Minor — the Little Bear) and others, such as the ones shown on the chart as circumpolar.
2. As soon as students identify a constellation, they report to the class, describe and illustrate it in their journals.

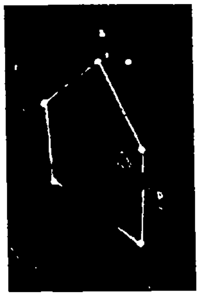
MAJOR CONSTELLATIONS

CIRCUMPOLAR

Name
Cassiopeia —
Lady in the Chair



Name
Cepheus —
The King



Draco —
The Dragon

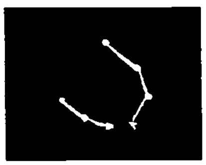
Ursa Major —
The Great Bear

Ursa Minor —
The Little Bear

Andromeda —
The Chained Maiden

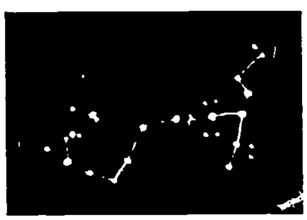
Taurus —
The Bull

Corona Borealis —
The Northern Crown



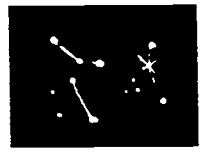
Aguila —
The Eagle

Scorpius —
The Scorpion



SEASONAL

Canis Major —
The Big Dog



Gemini —
The Twins

Leo —
The Lion

Cygnus —
The Swan

Aries —
The Ram

Organizing the Idea

Students record and illustrate at least three major constellations.

I saw constellation	Date Time	Description — Number of Stars; Brightest	Location — I had to look: East, West, North, South

ACTIVITY
Zodiac Data

Objective

The student identifies his/her own Zodiac sign by consulting the zodiac chart.

Materials

Copy of the Zodiac chart for each student group; reference books; students who have the same sign work as a small group

Procedures

Students find their zodiac sign on the chart, read about it and report to the class and/or collaborate to make a Big Book on the Zodiac.

ZODIAC CHART

Sign	*Name*	*Dates related to the Sign*	*Symbol*
ARIES	Ram	March 21- April 20	♈
TAURUS	Bull	April 21 - May 21	♉
GEMINI	Twins	May 22 - June 21	♊
CANCER	Crab	June 22 - July 23	♋
LEO	Lion	July 24 - August 23	♌
VIRGO	Virgin	August 24 - September 23	♍
LIBRA	Balance	September 24 - October 23	♎
SCORPIO	Scorpion	October 24 - November 22	♏
SAGITTARIUS	Archer	November 23 - December 21	♐
CAPRICORN	Horned Goat	December 22 - January 20	♑
AQUARIUS	Water Jug	January 21 - February 19	♒
PISCES	Fish	February 20 - March 20	♓

Discussion

The ancient Greeks were great students of the night sky and developed a system of naming the stars and the constellations in which the stars were grouped. The Greeks divided an imaginary belt in the sky into 12 equal segments and assigned 12 constellations or signs to each section.

Because many ancient people throughout the world assigned great importance to the influence of the stellar bodies on the lives of humans, many of these people were students of what is called **astrology**, or the study of the influence of the "astros", or planets, on the lives of humans. Astrologers also **believed** they could foretell the future by depending on the relative positions of the constellations. Although there is no **scientific data** to support these beliefs, to this modern age many people begin their day by reading their "horoscope", which is a guide to their lives that depends on the influence of the planets on that particular day.

UNIT ASSESSMENT

Designer Planets

For group and/or individual assessment

Design a planet to meet the conditions that the students set. **The Sky is the Limit!**

Alternative 1

Working individually, in pairs or in small groups, students select a planet they would like to visit. They write in their journals about why they would like to visit that planet and what they would expect to find there. They illustrate their report with drawings and/or three-dimensional objects (even using the pop-up kind) and include living organisms, or extraterrestrials, they would expect to find.

Alternative 2

Working individually, in pairs or in small groups, students design a planet in our solar system. Using paper mache or balloons/masking tape, they develop a model of the planet. They select a distance from the sun, size of the planet, its surface features, life and plant forms and other features and characteristics. They show their planet and give an oral report to the class and/or teacher. They write a newsletter to their parents describing their planet.

Oral Assessment

1. Name at least two ways that stars are different from each other.
2. How do we know that there are millions of stars in the universe?
3. Do you think we should continue to explore outer space?
4. Do you think scientists will discover other life forms on other planets in the universe? Explain.
5. Would you like to become an astronaut? Why? Do you know what you have to do to become an astronaut?
6. Would you like to be a moon explorer and live on the moon to investigate it?

Performance Assessment

1. Show how planets reflect light.
2. Draw our solar system and label it.
3. Draw and name five constellations.
4. Describe and/or illustrate how the sun's energy affects the earth.
5. Name and/or illustrate as many different stellar bodies as you can.

Written Assessment

1. How do stars produce light?
2. How do we know how far it is to the moon?
3. How do we know how far it is to Mars? To a faraway star?
4. How many days does it take the moon to orbit the earth?
5. Describe one way in which the moon affects the earth.

References

Children's Annotated Books

Apfel, N. H. (1988). *Nebulae: The birth and death of stars*. New York: Lothrop, Lee & Shepard Books.
An introduction to clouds of interstellar particles and gasses.

Becklake, S. (1987). *El sistema solar*. Barcelona: Editorial Juventud, S.A.
Translated to Spanish by Victor Pozano, this volume contains photographs and illustrations of the sun, Venus, Earth, the moon, etc. It also has a list of special inter-planetary flights.

Berger, M. (1976). *Energy from the sun*. New York: Thomas Y. Crowell Company.
This is a simple explanation of how important the sun is in our lives.

Branley, F. M. (1962). *The big dipper*. New York: Thomas Y. Crowell Company.
An introduction to the composition, mythology, and location of the Big and Little Dippers.

Branley, F. M. (1971). *The planets in our solar system* New York: Harper Collins Children's Books.
This revised edition incorporates our ever-growing information on the solar system.

Branley, F. M. (1981). *The sky is full of stars*. New York: Thomas Y. Crowell
A simple introduction to constellations and star watching.

Branley, F. M. (1985). *Sunshine makes the seasons* (rev. ed.). New York: Thomas Y. Crowell.
Describes seasonal changes caused by the related motions of the sun and the earth.

Branley, F. M. (1986). *Journey into a back hole*. New York: Thomas Y. Crowell .
A comprehensible treatment of the formation of a black hole and its effects on matter.

Branley, F. M. (1986). *What the moon is like* (rev. ed.). New York: Harper Collins Children's Books.
A description of the moon's composition based on information gathered from Apollo space missions.

Branley, F. M. (1988). *Eclipse: Darkness in daytime* (rev. ed.). New York: Thomas Y. Crowell.
Describes a total solar eclipse and the reactions of living things to the daytime darkness.

Branley, F. M. (1988). *The sun: Our nearest star* (rev. ed.). New York: Thomas Y. Crowell.
This revised edition describes the sun and its functions.

Branley, F. M. (1991). *The big dipper* (rev. ed.). New York: Harper Collins Children's Books.
This revised edition explains basic facts about the Big Dipper.

Carle, E. (1986). *Papa, please get the moon for me*. Saxonville, MA: Picture Book Studio.
A story of how a father attempts to get the moon for his daughter. The book contains fold-out pages. Concepts of long, large, and small are introduced/taught from this volume.

Cobb, V. (1988). *Why doesn't the earth fall up? and other not such dumb questions about motion*. New York: E. P. Dutton.
Explores nine questions about motion.

Cruz, A, D. (1987). *The woman who outshone the sun: The legend of Lucía Zenteno. La mujer que brillaba más aún que el sol: La leyenda de Lucia Zenteno*. San Francisco: Children's Book Press.
Based on a poem, this is a Mexican folktale in both English and Spanish. (May have to be read by the teacher.) A woman arrives at a mountain village with an iguana at her side, with hair so glorious, it outshines the sun.

Darling, D. J. (1984). *The sun: Our neighborhood star*. Minneapolis: Dillon Press.
An introduction to our most important star in a series designed to give young readers a sense of Earth's place in the universe.

Dayrell, E. (1968). *Why the sun and the moon live in the sky: An African folktale*. Boston: Houghton Mifflin.
A good story to encounter the ideas of sun and moon. It contains good illustrations.

Dickinson, T. (1987). *Exploring the night sky: the equinox astronomy guide for beginners*. Camden East, Ontario: Camden House.
This has good illustrations about the constellations.

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unit

3 Matter

Prior Knowledge

The student has

1. measured length and area in the English and metric systems
2. measured time
3. added and subtracted with regrouping and renaming
4. used a calculator to find sums and differences
5. estimated sums and differences less than or equal to 100
6. formed arrays to show repeated addition as a model for multiplication
7. separated equivalent groups to show repeated subtraction as a model for division.

Mathematics, Science and Language Objectives

Mathematics

The student will

1. measure volume of gases, liquids and solids in metric and English systems to the 1/2, 1/10, 1/100 units
2. measure weight of gases, liquids and solids in metric and English systems, to the 1/2, 1/10, 1/100 units
3. estimate volume and weight
4. predict results of physical and/or chemical changes
5. find volume of given three-dimensional geometric shapes
6. find sums and differences with addends less than or equal to 500
7. use a calculator to find products of two-digit factors greater than or equal to 20
8. describe differences between objects to include weight and volume as descriptors
9. measure temperature
10. graph data
11. explore inverse operations.

Science

The student will

1. list three forms in which matter exists, i.e., solid, liquid, gas
2. list mass and volume as properties of matter
3. describe two changes through which matter undergoes
4. list at least three examples of a physical change
5. list at least three examples of a chemical change
6. describe composition of substances as mixtures, compounds or elements
7. describe elements as uniform compositions, and give three examples
8. describe compounds as uniform compositions, and give three examples

9. describe mixtures as nonuniform combinations, and give three examples
10. measure volume using a graduated cylinder in standard units of volume
11. measure weight using a scale
12. describe mass of objects using a balance and nonstandard units of weight.

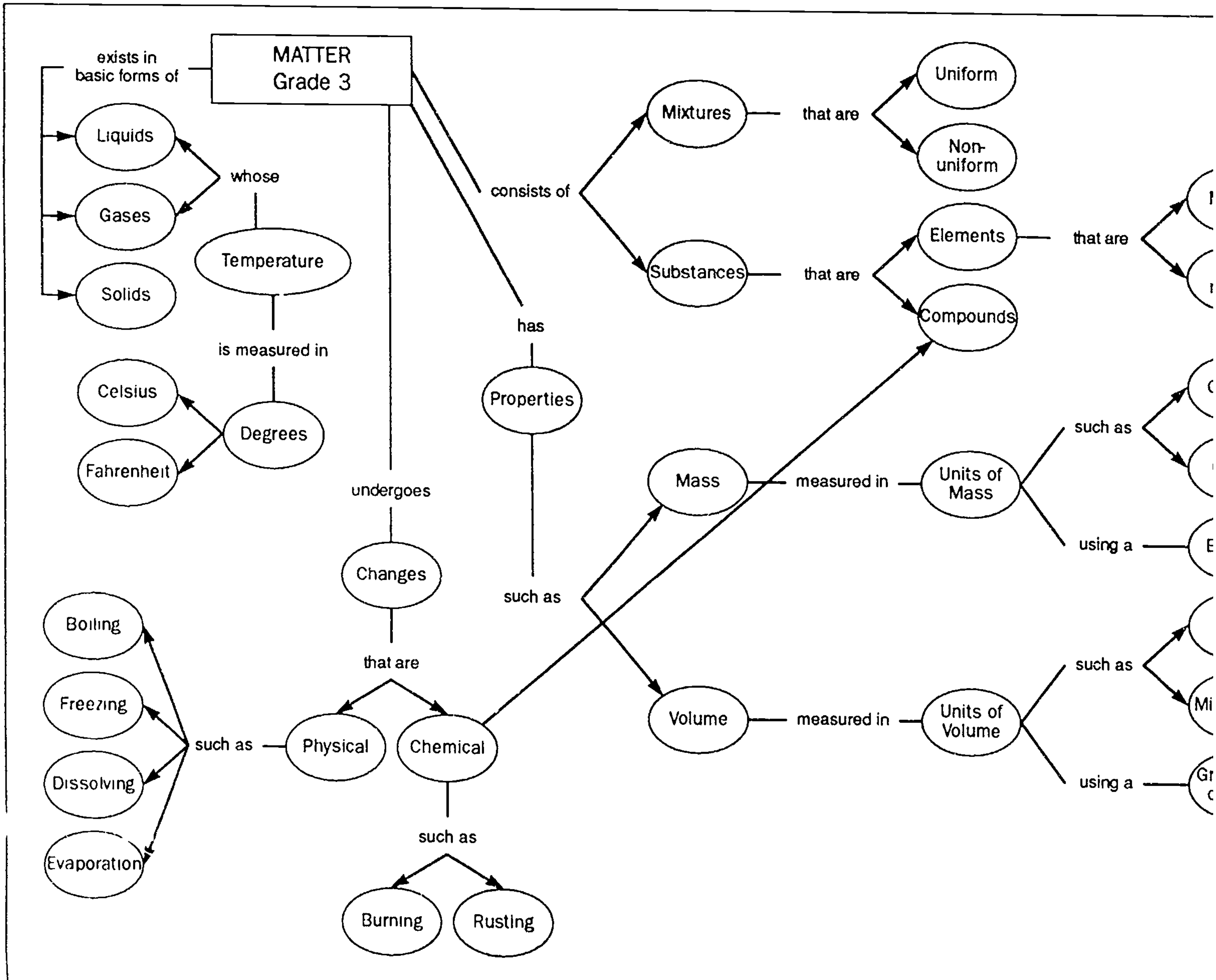
Language

The student will

1. engage in dialogue/discussion
2. record observations about unit activities in a journal
3. identify a main idea in a story
4. create stories using theme-related vocabulary
5. use description in writing
6. narrate events in writing
7. write complete sentences
8. give reasons to persuade
9. summarize
10. organize information/data in writing, charts and graphs.

VOCABULARY

matter materia	liquid líquido	solid sólido	gas gas	change cambio
evaporation evaporación	boil hervir	freeze conjelar	burn quemar	rust oxidar
element elemento	compound combinación	mixture mescla	uniform uniforme	nonuniform desigual
volume volumen	mass masa	balance balanza	grams gramos	graduated cylinder cilindro graduado
weight peso	space espacio	air tight sellado	physical físico	cook cocinar
property propiedad				


MATTER
Grade 3
exists in basic forms of
Liquids
Gases
Solids
whose
Temperature
is measured in
Degrees
Celsius
Fahrenheit
undergoes
Changes
that are
Physical
Chemical
such as
Boiling
Freezing
Dissolving
Evaporation
such as
Burning
Rusting
has
Properties
such as
Mass
measured in
Units of Mass
such as
using a
Volume
measured in
Units of Volume
such as
using a
consists of
Mixtures
that are
Uniform
Non-uniform
Substances
that are
Elements
that are
Compounds

CONCEPT WEB

Prior Preparation for Lesson 6

The teacher and students prepare the following materials and place them in the **Science Center.** The students make and record daily observations on a chart. See **Lesson 6** for a copy of the data chart. Reserve this chart with its data for use in **Lesson 8.**

Materials

several matches
rock
potato cut into several pieces and left uncovered; apple cut into several pieces and left uncovered
Two pieces of steel wool placed in two plastic bags; piece of wet steel wool placed into a plastic bag and sealed
cup of water
inflated balloon

Teacher Background Information ● ● ●

Everything in the universe is composed of matter or energy. Before students study matter, introduce the basic notion of what we mean by "matter". Matter exists in its elemental form, such as carbon, mercury, iron, copper, gold, silver, etc., or in molecular form, such as water, wood, food, clothes, etc. Matter can also exist in the form of mixtures, such as air, which is a mixture of gases in their elemental form (nitrogen, oxygen) and in molecular form (carbon dioxide, water vapor). We call the most fundamental units of matter **atoms.** An atom is the smallest particle of matter that by itself can combine with other like or different particles, or atoms. **Elements** are groups or combinations of like atoms, while **molecules** are combinations of like or different atoms.

Matter has two essential properties — it has **mass** and it has **volume,** it occupies space. Mass is the amount of "stuff" something is made of. Mass has **inertia,** which is the resistance of matter to change in its state of rest or state of motion.

Sometimes mass is referred to as "weight". Weight is a property of matter that changes, depending on where matter is weighed. Large bodies, such as the earth, the sun, the planets and the moon, have their own gravity that attracts anything that is close to them. When we weigh ourselves on earth, we are measuring the attraction of the earth on our body. Our weight does depend on how much "matter" we have, but it changes depending on where we weigh ourselves — on what is attracting our body. For example, our weight would be less if we weighed ourselves on the moon and more if we weighed ourselves on the sun! The mass of our bodies, the stuff we are made of, however, does not change.

All matter is either a solid, a liquid or a gas. Elements exist in any of these three forms — i.e. gold, mercury (liquid form of the element) and oxygen. Matter can change its form, but under normal processes, matter in its elemental form cannot be destroyed. Under a physical change, charcoal (element, carbon) remains a solid even when powdered. Water (in molecular form) has the unusual property of changing easily to any of the three states of matter. Students can see that when water becomes a gas it is invisible.

Substances can also exist as **mixtures,** in which each of the individual components maintains its properties. Milk is a mixture of substances that we can separate into their original form. Cereals, like Fruit Loops or trail mix, are good examples of mixtures, since students can see and easily separate each of the individual components. When an egg breaks or is beaten, however, it is very difficult to see the original components and impossible to separate, but nevertheless this is a mixture because it was changed **physically only.** Breaking an object is one example of physical change.

Elements combine to form various substances in a process that is not only physical, but chemical also. When elements, such as carbon and hydrogen combine with oxygen, for instance, they burn and form **compounds.** Compounds are combinations of elements that have joined through chemical changes. When we cook an egg, for example, the nature of the egg changes. Cooking is an example of chemical change.

When matter changes from one form to another and back, as ice melting to form water and then water freezing back into ice, we have an example of two **inverse operations.**

The notion of inverse operations is a mathematical notion, also. For example, addition and subtraction are inverse operations, because one "undoes" the other. On the other hand, there are some operations that have no inverse operation, for example, cooking an egg. There are other operations that are their own inverses, for example, pressing the power button for "off" and for "on" on a TV set.

LESSON FOCUS

■ LESSON 1 — *Matter Is Everywhere*

BIG IDEA Everything we see and touch is matter. We can describe relations between 2 measurements with a graph.

■ LESSON 2 — *How to Detect Matter*

BIG IDEA If it is matter, it has mass. One way to describe mass is to weigh it and to say where in the universe we weighed it.

■ LESSON 3 — *Another Way to Detect Matter*

BIG IDEA If it is matter, it occupies space. We can measure volume.

■ LESSON 4 — *What Is Matter?*

BIG IDEA Everything in the universe is composed of atoms. Special combinations of atoms, called molecules, help us understand the properties of matter. A small number of elements can join to form many different combinations.

■ LESSON 5 — *Matter Changes in Appearance*

BIG IDEA Matter can change its appearance through a physical change while its weight and volume remain the same. Inverse operations "undo" each other.

■ LESSON 6 — *A Substance Can Change in Mass*

BIG IDEAS Matter can change in its mass through a chemical change. Weight and volume can change through chemical reactions.

■ LESSON 7 — *Compounds and Mixtures*

BIG IDEA Compounds form through chemical change; mixtures are combinations that form through physical alterations only. There are similar mathematical operations; some operations have inverses, other have no inverses and some operations are their own inverses.

■ LESSON 8 — *Science: Counting and Measuring*

BIG IDEA Science tries to answers questions about our world; often, we find the answers by counting, estimating and approximating.

OBJECTIVE GRID

Lessons	1	2	3	4	5	6	7	8
Mathematics Objectives								
1. measure volume of gases , liquids and solids in metric and English systems to the 1/2, 1/10, 1/100 units			•			•	•	
2. measure weight of gases, liquids and solids in metric and English systems, to the 1/2, 1/10, 1/100 units		•			•	•	•	
3. estimate volume and weight		•			•	•	•	•
4. predict results of physical and/or chemical changes					•	•		
5. find volume of given 3-dimensional geometric shapes				•				
6. find sums and differences with addends less than or equal to 500	•	•		•	•	•		•
7. use a calculator to find products of 2-digit factors greater than or equal to 20				•				
8. describe differences between objects to include weight and volume as descriptors		•			•	•		
9. measure temperature	•							
10. graph data	•			•				
11. explore inverse operations.					•		•	
Science Objectives								
1. list 3 forms in which matter exists, i.e., solid, liquid, gas	•	•	•		•	•	•	
2. list mass and volume as properties of matter		•	•	•	•	•	•	
3. describe 2 changes through which matter undergoes					•		•	
4. list at least 3 examples of a physical change					•		•	
5. list at least 3 examples of a chemical change						•	•	
6. describe composition of substances as mixtures, compounds or elements	•			•	•	•	•	

Continued on next page ▶

Lessons	1	2	3	4	5	6	7	8
7. describe elements as uniform compositions, and give 3 examples				•			•	
8. describe compounds as uniform compositions, and give 3 examples							•	
9. describe mixtures as nonuniform combinations, and give 3 examples				•	•		•	
10. measure volume using a graduated cylinder in standard units of volume		•	•					•
11. measure weight using a scale		•			•	•		•
12. describe mass of objects using a balance		•			•	•		•
13. describe one function of science.								•
Language Objectives								
1. engage in dialogue/discussion	•	•	•	•	•	•	•	•
2. record observations about unit activities in a journal	•	•	•	•	•	•	•	•
3. identify a main idea in a story								
4. create stories using theme-related vocabulary								
5. use description in writing	•	•	•	•	•	•	•	•
6. narrate events in writing	•	•	•	•	•	•	•	•
7. write complete sentences	•	•	•	•	•	•	•	•
8. give reasons to persuade	•	•	•	•	•	•	•	•
9. summarize	•	•	•	•	•	•	•	•
10. organize information/data in writing, charts and graphs.	•	•	•	•	•	•	•	•

LESSON 1 Matter Is Everywhere

BIG IDEAS Everything that we see and touch is matter. We can describe relations between two measurements with a graph.

Whole Group Work

Materials

Large chart; bottle of strong-smelling perfume; marble, some other solid object; cup of Kool-aid; ice cube

At least three transparent glass tumblers of different sizes and odd shapes

Word tags: solid, liquid, gas, shape, form

Encountering the Idea

Begin this overview lesson with the question: What is the world made of? As students offer ideas, write them on a chalkboard for later use. If students do not mention air, ask if air should be on the list. What about water? What about our bodies? After the students have offered their suggestions, ask them how some of these things are alike.

Ask students what ice is. Yes, water. What is steam? Yes, that is water also. What is the difference between ice, water and steam? Yes, the temperature — steam is hot, but ice is cold. Water can be hot or cold. We can take the temperature of liquids and gases more easily than that of solids. We are going to explore these ideas more.

Exploring the Idea

Perfume

Before students go to the learning centers, begin this activity:

Students, look at this perfume bottle. I am going to take off the stopper and place the bottle here by the window. As soon as you smell the perfume, raise your hand and tell us that you can smell it and describe the smell. As soon as a student indicates she/he can smell the perfume and describe it, the teacher adds: Some people are holding up their hands. Do you smell the perfume? Why can you smell the perfume if it is far away from you? Who can give me some ideas? (The perfume is a liquid, but it has a smell; the smell is a vapor; a vapor is also a gas; a gas can go all over the room; it doesn't stay in one place.)

Who was able to smell the perfume first? Are you closer to the bottle? Did it take the perfume smell long to travel to the other side of the room? What helped the perfume travel from the bottle to the other side of the room? (Has no shape; won't stay in a container unless it is covered. It goes into the air that takes it everywhere.) Describe the properties of a gas.

If I don't want to smell the perfume, what do I do? (Put the cap on the bottle so the vapor won't go out.)

Kool-Aid

Look at this cup of Kool-Aid. Is Kool-Aid matter? Is it a solid or liquid? What shape is this liquid in? (The shape of the cup.) Now I'm going to pour it into these different tumblers.

What form or shape does it have? Yes, it takes the shape of the tumbler. What can we say about a liquid? (We can see it and feel it, but it doesn't have a definite shape.) What are some other examples of matter that is in liquid form?

Marbles

Look at this marble. This is a solid. Describe it. (Hard, heavy, definite shape, can see it, feel it.) What can we say about matter in the form of a solid? What are some other examples of matter that is in solid form?

Solids, Liquids, Gases

For this activity, we are going to look around the room, again, and see if we can list things that are either solid, liquid or gas. As we name these things, we'll put them up on this chart under the words: Solid, Liquid or Gas.

Things the world is made of

Solids (hard, heavy)	Liquids (have to have it in bottle)	Gases (can't see it)
rocks	water	air
wood	milk	oxygen
people	juice	carbon dioxide
paper	rain	cooking gas
pencils	Kool-Aid	
clock		

At the **Science Center**, the students complete **Activity** — Solids, Liquids and Gases.

At the **Mathematics Center**, the students complete **Activity** — Temperature. For review, students can do **Activity** — Using a Thermometer, from **Unit 2: Sun and Stars.**

Getting the Idea

Tell the students that everything we see and touch is **matter.** Our bodies are made of matter, the water we drink is made of matter, as is the air around us. (There is little that we can see and feel that is not matter.) Sometimes we can see matter and feel it, but sometimes we can't. Even if we cannot see it or feel it, as with air, it is still matter. Matter exists as a solid, a liquid or a gas.

How can you describe a solid? (It's hard; it's heavy; can't see through it; you can't go through it; you can feel it and see it; it has a specific shape.) **Note:** If a student names light as matter, you may respond that the world does receive light from the sun and that light is energy, but we will not study energy until a later unit.

How can you describe a liquid? (You have to put it in something; it doesn't have a specific form; it takes the form of its container; it doesn't have a shape.)

How can we describe a gas? (It goes everywhere; it doesn't have a shape; it doesn't stay in an uncovered container; sometimes you can't see it; it goes everywhere in the room.)

Organizing the Idea

1. Students write about matter in their journals — what it looks like, what it feels like.
2. Students draw a picture of matter; what does matter look like?
3. Students make a checklist of things to look for in matter to be able to say whether it is in solid, liquid or gas form.

Applying the Idea

Problem Solving

1. What is jello? Solid or liquid? For your answer, select either solid or liquid and convince your partner or your teacher of the answer you chose. Can both answers be correct? Why?
2. Is temperature related to the form that water is in? Explain.
3. Do you think that the temperature of matter is related to whether it is in solid, liquid or gas form? Why do you think that might be true?

Closure and Assessment

Paper and Pencil

1. A __(gas)__ has no shape and sometimes we can't __(see)__ it or __(feel)__ it.
2. A solid is __(heavy)__, has a __(shape)__ and we can see it and __(feel)__ it.
3. A __(liquid)__ has no shape, but it takes the __(form)__ of the container it's in.
4. How many forms does matter have? Name them and describe at least two properties of each.

List of Activities for this Lesson

▲ Solids, Liquids and Gases

▲ Temperature

ACTIVITY
Solids, Liquids and Gases

Objective

Student says that matter exists as a solid, liquid or gas and can change from one form to the other.

Materials

Hammer; ice cubes; dish; thermometer; paper towel; charcoal briquette or small piece of coal

Procedures

1. Put the ice cube in the dish and the pieces of coal on the towel.
2. Examine and describe the charcoal and the ice cube. How are they alike? How are they different?
3. Crush the piece of charcoal with the hammer.
4. Examine the charcoal again. In what ways is it the same as it was before? How is it different? Is it a solid, liquid or gas?
5. Let the ice cube remain in the dish. Examine and describe it including its temperature after a few minutes, after an hour and after a day. Each time, decide whether it is a solid, a liquid or a gas.
6. After the last observation, again compare the charcoal and the ice cube. How did they respond differently when left undisturbed? Why do you think this happened?
7. Place the water from the melted ice cubes in a pan and heat it until it begins to boil and produces steam. Take the temperature of the steam. Describe the water in this form.

Problem Solving

1. What is the temperature of the piece of coal? How could you take its temperature?
2. What is the temperature of the water that has been left in the room for several hours, or several days? (It has the same temperature as the air in the room.)
3. What do you think that "at room temperature" means?

Getting the Idea

In this activity we saw that matter exists as a solid, a liquid or a gas. But we saw something else — matter can change its form from solid, to liquid, to gas and then back. Matter cannot be destroyed — only changed in form.

ACTIVITY
Temperature

Note
Conduct this activity **with the whole group,** the students working in pairs. The teacher **strictly monitors** the activity since it will require using boiling water. It is important that the teacher conduct the discussion as indicated.

BIG IDEAS We can measure the temperature of liquids in degrees Celsius or degrees Fahrenheit. We can show the relation between degrees Celsius and degrees Fahrenheit on a linear graph.

Materials
Hot plate to boil water; ice cubes to put into a cup of water

Graph paper, or a paper marked with a grid. On the grid paper draw a coordinate system such as the one in Fig. 3; label one axis degrees Celsius and the other degrees Fahrenheit.

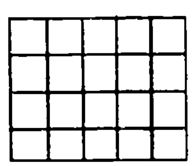
One thermometer, marked in both Celsius and Fahrenheit units, for each student pair

One thermometer for the classroom, marked in both Celsius and Fahrenheit units, to remain at room temperature for the entire activity and easily available to all the working groups

One thermometer, marked in both Celsius and Fahrenheit units; place outdoors early in the day, away from direct sunlight, for students to take the outdoor temperature

Procedures
1. Students examine the thermometers and describe them.
2. Students put the thermometer in boiling water and record the temperature to the nearest 1/2 unit, using both scales.
3. Students put the thermometer in the freezing water and record the temperature to the nearest 1/2 unit, using both scales. The students repeat their measurements two or three times, after allowing the thermometer to cool or warm depending on the observation they want to make.
4. Each student pair report their results and observations.
5. After students report their results, they discuss why there were differences in their observations, i.e. did everyone report that water boiled at exactly 100°C or 212°.

[1]Draw a grid to graph a relation several times on a single sheet of paper and duplicate for students' use. Draw in the axes and the scale later.



	Celsius	Fahrenheit
Boiling water	100°	212°
Freezing water	0°	32°

Fig. 1

Discussion

Why were the temperatures we observed and recorded not **exactly** the same? (Measurements are never exact.)

When you read the temperatures on the Celsius side of the thermometer and then on the Fahrenheit side of the thermometer, why are the readings (the numbers) different? Yes, because we are using two different scales.

Are both scales standard scales? Yes.

Compare the first Celsius reading with the first Fahrenheit reading.

Compare the second Celsius reading with the second Fahrenheit reading. What do you notice about the readings? (For each observation the Fahrenheit reading is larger than the Celsius reading.) Do you think this will always be true? Why?

1. Students record the room temperature using both scales to the nearest 1/2 unit. Was your prediction true? Was the Fahrenheit reading larger than the Celsius reading?
2. Students record the outdoors temperature and predict the relationship between the Celsius and Fahrenheit readings again.
3. Students state a rule about the temperature readings in Celsius and Fahrenheit. (The C reading will always be less than the F reading, or the F reading will always be greater than the C reading.)
4. Does this mean that the temperatures are different? No, the temperature is the same. What, **then,** is different? Yes, the size of the units is different.
5. We use the temperatures at which water freezes and at which it boils to make the two scales. Which unit is larger **in size**? Celsius is larger, so you need fewer units to go from freezing to boiling. Fahrenheit is smaller, so you have to have more units.

	Celsius	Fahrenheit
Room air	25°	78°
Outside air	10°	50°
Boiling water	100°	212°
Freezing water	0°	32°

Fig. 2

We can plot the relationship between the two temperature scales on a line graph using the four points (the origin) we found with the four thermometer readings.

6. On the coordinate system find the point (0, 32) on the graph. Since the graph shows the Celsius scale represented on the horizontal axis, and the Fahrenheit on the vertical axis, remember to use the C reading to the right, and the F reading to the top. Find the points (0,0), (100, 212), (10, 50), (25, 28), (0,32).
7. What do you get if you connect all four points in increasing order for C?
8. Because the graph of the C readings and the F reading forms a line, we say that the Celsius scale and the Fahrenheit scale have a **linear relation.**

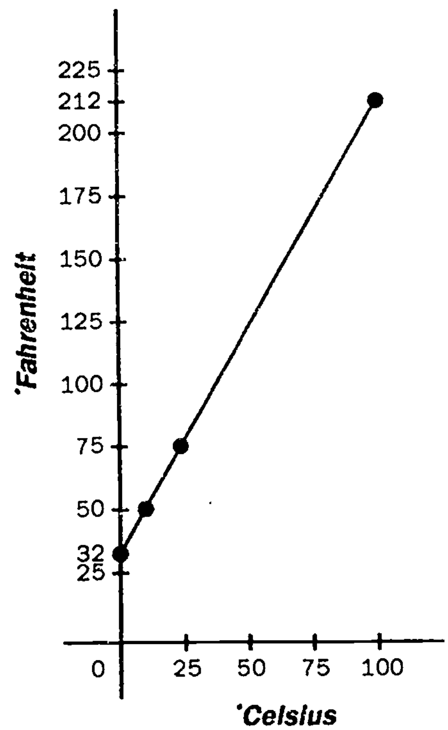


Fig. 3

Applying the Idea

You can use the graph we constructed above to find the temperature in degrees Celsius if you know it in degrees Fahrenheit. You can also do the inverse. Given the degrees Fahrenheit, you can find the degrees Celsius. Can you do it?

1. Suppose the outside temperature in the summer is 100° F. What is it in C? You can approximate your answers. Be sure you have a reason for your answer Share it with other student groups.
2. Suppose the room temperature is 16° C. What is it F?
3. Just by looking at the graph can you tell that the F reading will always be

LESSON 2 How to Detect Matter

BIG IDEAS If it is matter, it has mass. One way to describe mass is to weigh it and to say where in the universe we weighed it.

Whole Group Work

Materials

For each student team

Place the following items in a box for student use: ping pong balls in a plastic bag; a marble; a paperweight or a large stone; several cotton balls in a plastic bag; two balloons

Balances to mass various objects, and nonstandard weights to mass the objects, such as washers and/or other objects

Several different pictures of astronauts in a space capsule floating inside the capsule

Gallon can or plastic bottle

Nail and hammer

Several rubber bands; small plastic bags with ties; balloons; sponges; water and Kool-Aid; cups; a meter stick; a 12-inch piece of string

Word tags: weight, mass, matter

Encountering the Idea

Ask the students to review the following: In what forms does matter exist? Matter exists as a **solid,** as a **liquid** or as a **gas.** We can usually see and feel matter when it is in the form of a solid or a liquid, but if it is a gas, we may not be able to see it, smell it or even feel it. If that is true, how do we know matter is there? (Pause for possible suggestions.) Write some of the suggestions on a chart or chalkboard for later consideration. We are going to perform some experiments in the **Science Center** that will help us discover answers to this question: If we can't see matter, feel it or smell it, how can we detect it?

Exploring the Idea

At the **Mathematics Center,** the students complete **Activity** — Water Weight.

At the **Science Center,** the students work in teams of four each.

1. Using the balances, the students mass the following objects and record the number of washers or other objects used in balancing the objects: a marble; plastic bags filled with cotton balls; ping pong balls, a plastic bag partially filled with water and sealed with a tie to keep the water from spilling

   After the students have had an opportunity to mass these objects, discuss what they observed and recorded.

   - They balanced one mass, the ping pong balls, with another mass, the washers.
   - The two masses "balanced" meaning that the two masses, one on each side, were equal.
   - They found that solids (the balls, the cotton, the marble) have mass.
   - They found that water (the water in the bag) has mass.

2. Ask students to find a method by which to mass air, using any of the materials available in the classroom. (Suggest they might look in the box for materials they might use.) As soon as a group thinks they have found a way to mass air, the students explain their idea to the class.

Getting the Idea

Complete the following sentences for the experiment on the weight of a liquid.

The weight of the ______ minus ________ of the _______ equals ___________.

The weight of the ______ plus ________ of the _______ equals ___________.

Answer the following question: Can we find the weight of all liquids in this manner? (Usually, yes, but there may be liquids that we can't handle as easily as water, or alcohol, milk, etc.)

One important property of matter is **mass.** Mass is the "stuff" things are made of. In these experiments we were able to see that **all matter has mass** when we picked up objects such as this marble or paperweight. It is not as easy when we pick up this ping pong ball or this cotton ball to feel that they are heavy. We need a balance to help us see that these things have weight.

We describe mass in matter by saying that it has weight. Weight tells us how much earth's gravity is pulling on something. If there were no gravity, then we would not weigh any amount, **but we would still have the same amount of mass.** Weight only describes how much gravity is pulling on matter, and it is a way of describing matter.

Does all matter have weight? How do we know? Do solids have weight? Do liquids? What can we say about air? (Air has weight, because air is matter.) Even though we can't see air, we know it is there because we can mass it, or we can weigh it. Gases have mass, and we can weigh them also.

What is the answer to our question: If we can't see matter, smell it or feel it, **how do we know it is there?** Write and illustrate the answer in your journals.

Organizing the Idea

The activities conducted during the exploration phase of the lesson include strategies for organizing the idea.

Applying the Idea

Answer these questions after studying the pictures of the astronauts inside the space capsule:

1. What would happen to you if there were no gravity on earth? (Float off into space; couldn't keep my feet on the ground; couldn't weigh myself; **but** I would still have the same amount of **mass.**)
2. Why do the astronauts float around the space capsule, turn upside down and sideways? (There is no gravity in outer space; the astronauts then have **no weight!** But, they **do have the same mass they had on earth.**)

Closure and Assessment

1. Students, working in small groups, state and/or illustrate their own definition of matter, mass and weight.
2. Students use these words to complete the following paragraph: mass, matter, weight, gravity, container, invisible, outer space.

All __(matter)__ has __(mass)__. Solids are __(heavy)__, and __(we can't see through them)__, are __(hard)__ and have __(mass)__. Liquids __(have to be put in a container)__ and have __(mass)__. Gases usually __(can't be seen, are invisible)__, __(have to be put in a container)__ and have __(mass)__. Matter does not have weight when it is __(in outer space where there is no gravity)__.

What can you say about weighing liquids and gases? (They cannot be weighed directly; we must use an indirect method to weigh them. We need to put both liquids and gases into containers; we need to place a gas, however, into a **closed** container.)

List of Activities for this Lesson

▲ Water Weight

▲ Finding the Weight of Solids, Liquids and Gases

ACTIVITY
Water Weight

Objective
Students use subtraction and addition to compare two quantities to find a difference.

Materials
At least two different liquids, paper cup, scale to weigh the cup, a sponge

Procedures
1. Weigh a cup without water, then weigh it again with water. Record the weights.
2. What is the difference in the weights? What does the difference show?
3. Weigh the sponge. Next, wet the sponge and shake some of the water off of it. Now, weigh it again. Record both weights of the sponge. What is the difference in the weights?
4. What can you say about matter in the form of liquids? (It has weight.)

Cup/Sponge	Water	Alcohol (or other liquid)
with without		
difference		

Getting the Idea

1. Why did we use subtraction in finding the weight of water (alcohol)?
2. Rewrite the subtraction sentence as an addition sentence.

3 ounces, weight of paper cup 7 ounces, weight of water
10 ounces, total weight of cup and water

3. Why can we rewrite the subtraction sentence as an addition sentence? (Addition "undoes" subtraction and subtraction "undoes" addition.)
The weight of the ____________ minus the weight of the ____________ equals the weight of the ____________.

Organizing the Idea

Write subtraction and addition sentences and draw illustrations that say what we did in this experiment.

ACTIVITY
Finding the Weight of Solids, Liquids and Gases

BIG IDEAS We can weigh solids directly; we must place liquids and gases in containers to weigh them, using subtraction.

Materials

a rock; balloons; water in a container; scales for each student group
a cup for water for each student group
several cups available for student use, as needed

Procedures

1. Students find the weight of the rock. Ask students what they had to do to find the weight of the rock.
2. Show students the container with water (or some other liquid). Tell the students that their group assignment is to find the weight of the water. What is the problem that they must be solve to find the weight of the water? (Students cannot weigh the water directly on the scale because it spills over. They have to weigh the water in a container.) Provide each group of students with a cup of water; they must find the weight of the water only.
3. The students, working in small groups, decide how to weigh the water in the cup assigned to them. After each group has had an opportunity to work on the problem, ask them to report the results to the class.

Getting the Idea

1. What was the problem that you had to solve before you could find the weight of the water? (How to contain the water.)
2. If you had to put the water into a container in order to weigh it, did that bring in a new problem? How did you solve that problem?

   Yes, you had to use subtraction. Why did we use the mathematics operation of subtraction?

   Yes, we use subtraction to find differences.

(Container plus water) Sum - part (container) = difference (water),
or
Sum - one part = the other part

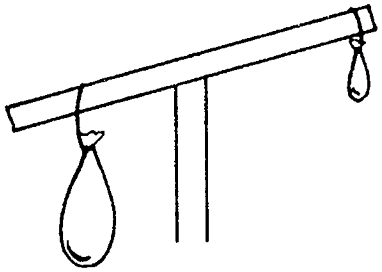
Applying the Idea

Tell the students that now that they have solved the problem of finding the weight of a liquid, they need to apply what they have learned to try to find the way to weigh a gas. For example, how can we weigh air?

Give them time to consider the solution. Hint: Air, since it is a gas, needs to be placed in a container. The problem is, how can you weigh the container without the air being inside it to begin with?

Let them brainstorm about what containers they could use. Hint: It doesn't have to be a glass container — it could be made of something else, like a balloon.

After the students have thought about using balloons to weigh air, let them explore in a manner similar to the one below.



Materials
Two meter sticks; two balloons; two six-inch pieces of string

Procedures
1. Have the students put one meter stick on the end of another meter stick to form a balance.
2. Attach one uninflated balloon on each end of the top stick with string. Place the meter stick with the balloons attached on the vertical stick and adjust until the two balloons balance. Mark the point of balance on the horizontal stick.
3. Inflate one balloon and replace it exactly where it was before.
4. Have students observe and describe what happened.

Discussion
What can we say is inside the balloon? (We blew air into it.)

Are the two balloons the same before and after the experiment? (No, one balloon has air, and it is heavier after we blew air into it.)

What happened to the meter stick? (Or what happened to the balance?) (The meter stick is leaning to the heavier side.)

What does it mean if the stick tilts down to one side? (The heavier balloon goes down.)

Which side is heavier? (The one with the inflated balloon.)

What can we say about air? (It has weight. A gas has weight.)

Why do you suppose we tied the other balloon with the string even though it did not have air in it? (The string has weight, and the two balloons have to be the same if we are going to compare them.)

Did we use subtraction in this method of finding the air's weight in the balloon?

LESSON 3 Another Way to Detect Matter

BIG IDEAS If it is matter, it occupies space. We can measure volume.

Whole Group Work

Materials

An empty box, cubic centimeter cubes, one-inch cubes, or other units of volume; a graduated cylinder or a measuring cup in ounces and milliliters; a cup of Kool-Aid or juice; Ziplock Baggies and the Baggie box; a bowl half-filled with water; several dry, shriveled sponges; a transparent glass tumbler

Word tags: space, volume, capacity

Encountering the Idea

Introduce the relation between matter and volume by asking students to look at: the marble they weighed earlier; one of the centimeter cubes; the inflated balloon; the bowl with water in it. What do all these things have in common? Let the students suggest some ideas. (They are matter; they have mass that is shown as weight.) What other thing do they have in common? (Pause. Allow students to make suggestions.) Tell students that they will discover some answers to the question.

We are now going to perform some experiments in the **Science Center** that will help you answer the question: **What's another way to detect matter?**

Exploring the Idea

Let's look at this glass of Kool-Aid. If we pour it into a graduated cylinder, we see that the Kool-Aid takes up ____ milliliters (or ______ cubic centimeters) of space.

Here is another demonstration: I take this empty Baggie, open it, and swing it hard, and then without flattening it, close the zipper. The Baggie is now expanded, stretched, and when I squeeze it, it remains expanded. The Baggie now takes up more space. I can't put it back into its original box. It has gotten too big and takes up too much room.

Look at this box. We can fill this box with these cubes. We easily see that this box takes up ____ milliliters (or _____ cubic centimeters) of space or room.

At the **Mathematics Center,** students complete **Activity** — Volume of Solids, Liquids and Gases.

Getting the Idea

In order for scientist to discover answers to questions about matter, it is very important that they have the appropriate tools to help them make their observations. One such tool is the graduated cylinder. It is a cylinder in shape — round and three-dimensional. It is also narrow and long. Why do you think it's tall? (Pause for student suggestions.) It is tall to make the liquid rise high and give a more accurate reading. The more narrow the tube, the more it looks like a "line" that could be measured with a measuring tape. The tube has marks in "grades" or steps for easy reading. It is an important tool for scientists.

Ask the students what solids, liquids and gases have in common. Let the students make suggestions. Yes, these things all take up space; they take up room; they have **capacity,** or **volume.** We say that the box has **capacity.** We can measure its **volume,** or the space it takes up, by using this standard cubic inch or this standard milliliter.

What's another way to detect matter? Another way to detect matter is to note that it takes up room. What's the other way? To note that it has mass and can be weighed.

Gases conform to the shape of a container and always fill it up completely. That is one difference between liquids and gases. Although liquids must be put into a container and they conform to the shape of the container, in other words take its shape, they don't expand to cover the entire container. Gases also conform to the shape of the container, but the container must be **a closed container,** otherwise the gas will escape. The gas takes the shape of **the entire** container; gases keep expanding unless we close them off.

Organizing the Idea

1. Students write a paragraph and illustrate the property of matter we call volume.
2. Students explain how to find the volume of a solid, of a liquid and of a gas.

Applying the Idea

Problem Solving

1. Of which form of matter — solid, liquid, or gas — is it the easiest to find the volume? Illustrate your answers, if you can.
2. Solve the following problem. Working in teams, design a **different** demonstration that will show that air takes up room; in other words that air, which is a gas, takes up space. Use any of the materials in this box to make your demonstration. (The following is one solution. The students may suggest different ones. If we blow up a balloon with air, we see that the balloon gets big and takes up space. If we release the opening of the balloon we can feel the air come out as the balloon deflates.)

Closure and Assessment

1. The first team who is ready will demonstrate to the class why they think that air has volume; they will tell you what materials they used for the demonstration and why. The other students listen and discuss whether they agree or not.
2. Matter exists in the form of a solid, a liquid or a gas. It is easy to see that matter takes up space when it is in the form of a solid or liquid. Discuss why it is more difficult to measure the volume of a liquid or a gas.
3. Two very important properties of matter are that matter has mass and that it occupies space, or in other words has volume. By these two properties, you can detect matter.

In these activities, we experimented with the properties of matter: matter has mass and it occupies space. Draw and write in your journals about matter.

List of Activities for this Lesson

- ▲ Volume of Solids, Liquids and Gases

ACTIVITY

Volume of Solids, Liquids, and Gases

Objective

Students see that they can measure the volume of a solid, liquid or gas.

Materials

For each student group:

A small box; a rough, irregular rock or some other object; any book; a chalkboard eraser

Enough centimeter cubes to completely fill the small box (the cubes must stack with no spaces between them)

Pieces of wood, such as unifix cubes, Cuisenaire rods or other materials that have the same volume and that can be placed into the small box so as to fill it

Procedures

Students can do the activity on three separate days, one part per day.

Part I: Solids

1. Ask the students to look at the piece of wood. Describe it. (Color, odor, takes up space, has mass, etc.) If students don't mention it, tell them that the piece of wood takes up room, takes up space, or has volume. Can we measure volume? How can I find the volume of this piece of wood? How can we measure volume? Allow students sufficient time to think about it and to offer suggestions.
   Hint: How do we measure length? (With units of length called "inches", "centimeters" or "feet".)
   How do we measure area? (With units of area called "square inches" or "square centimeters.")
   How do we measure volume? (With units of volume.)
   What can we use to measure the volume of this box? (Pause for suggestions.) I can take these smaller cubes and put them into the box until all the space in it is used up. By finding the number of cubes it took to fill the box, I will know its capacity, or volume. Centimeter blocks (or whatever unit of volume was used) can be the standard unit of volume to fill up the box because they take up room, have volume.
2. Your first assignment is to find the volume of the box. You can also find the volume of this chalkboard eraser, this book, and this rock. Record the information on this chart. The object is the solid of which you are measuring the volume; the method describes what you did to find the volume; and the volume you give in the units you used.

Object	Method Used	Volume (unit)

3. After completing the assignment, the students report to other groups or to the class.

4. What method did you use to find the volume of the shoe box? The eraser? The rock? Explain why you selected the different methods. (If the students are not able to find a reasonable estimate of the volume of the rock, leave this question unanswered until after the student have completed Part III of the activity. At that time someone may suggest placing the rock into a large measuring cup and using the rise in water volume as the measure of the volume of the rock.

Part II—Liquids

Materials

For each student group:
A graduated cylinder; a soda pop can
Three milk containers — 1/2 pint, 1/2 gallon and one-gallon

1. Students, look at this cup of water. Does the water take up space or room? Does it have volume? What is the volume of the water? How can we find the volume of a liquid? (Since a liquid takes the shape of its container and does not have a definite shape, we have to put it into a container before measuring its volume.)
2. What is the volume of the milk container? (1/2 gallon. How do you know? It says on the label.) And this one? ("One gallon" is on the label.). We say that a gallon is a standard unit of **liquid volume.** Examine the milk **container.** The container often shows the content in other standard units. What are they? (Liters and fluid ounces.)
3. Your assignment is to find the volume of the water in your cup. Find the volume of the milk you drink when you use the milk containers in the cafeteria. Find the volume of soda pop in the can. (Should be listed fl. oz. and ml.)
4. After completing the assignment, the students report to other groups or to the class.
5. What method did you use to find the volume of the milk carton? The can? Explain why you selected that method. Liquids take the shape of the container but gravity causes filling from the bottom up.
6. What units do we use to give the volume of a liquid? (Fluid ounce, pint, gallon, milliliter, liter, cubic centimeter.) Why do you suppose there are so many **different units** to say what the volume of a liquid is?

Part III—Gases

Materials

For each student group:
A measuring cup; a large container with water

1. Students, look at this empty measuring cup. What is its capacity? How much liquid can we put into it, if we fill it up to this mark at the top? Yes, one cup. On the other scale it reads _____ milliliters. What is inside the cup, now? Yes, air. But we can't see it. How do we know it is there?
2. We are going to use the large container that has water in it. Take the cup and submerge it into the water in the large container **without turning it sideways.** Describe to your team members what happens.
3. What is in the cup that prevents the water from filling the cup completely? Is it hard to keep the cup from turning sideways? Can you tell how much volume the air is occupying in the cup? Read it to your team members.

4. What can you say about the volume of a gas? (We can measure it.)
5. What units do we use to measure the volume of a gas? Are they the same as the units we use for liquids? All of them except the fluid ounces. Why do you think that we can measure the volume of a gas using the same units? (Since a gas does not have a definite shape, it needs to be put into a container, as does a liquid.)
6. How can you find the volume of this rock? (Can submerge it in the measuring cup and record the change in the volume of the water.)
7. In your journal, write your conclusions about the most important thing about measuring the volume of solids, liquids and gases.

Alternative to finding the volume of a gas.
Ask the students for suggestions for other ways to find the volume of a gas. Remind them that a gas not only conforms to the shape of its container, it also **fills the container completely;** therefore the container must not only be a closed container, but it must be **airtight.**

1. Put water into a large measuring cup with water, but do not fill it. Record the volume of the water.
2. Blow air into a **small** balloon and submerge it completely into the measuring cup. (Students will have to decide how to submerge the balloon completely without putting their hands or some other object into the water. The students explain why they have to take this precaution.)
3. Read the change in the volume of the water.
4. The students may want to discuss whether the balloon itself affected the reading of the volume, and if so, what needs to be done about that.

LESSON 4

What Is Matter?

BIG IDEAS Everything in the universe is composed of atoms. Special combinations of atoms, called molecules, help us understand the properties of matter. A small number of different elements can join to form many different combinations.

Whole Group Work

Materials

Small piece of coal or charcoal
Small square of aluminum foil
Hammer
Have for demonstration pictures of a diamond, gold and silver jewelry, or pictures of objects made of brass, steel, copper
Word tags: atom, molecule, element, combination

Encountering the Idea

In our previous lessons we have talked about the forms that matter takes, for example, solids, liquids and gases. We also talked about matter having special properties — it has mass and we can weigh it, and it has volume, or takes up space. But have we actually said what matter is? This is one of the most important questions that scientists are trying to answer. What we think that matter is today has been handed down to us by scientists who have tried to find out about matter. In the following activities we are going to try to discover some new things about matter.

Exploring the Idea

Show students the piece of coal. Ask what it is. This is pure carbon, or coal. What happens if I hit it over and over with the hammer? Yes, it breaks into very small pieces. Is it still coal, or carbon? (It looks like it; breaking only changes its appearance.) How long do I have to hammer this coal until it is not coal anymore? Yes, that's right, you can't change it by just breaking it. What about this piece of aluminum foil? It is pure aluminum, and when I cut it into very small pieces is it still aluminum? Can you change the aluminum foil just by making it into small pieces? No.

Many hundreds of years ago, the Greeks asked the same question. Can we continue cutting the carbon into smaller and smaller pieces forever, or is there a very small piece that we can no longer cut into smaller pieces? The Greeks solved their problem like this: the smallest piece that matter can be cut into without changing the matter into something else, they called — and to this day we call — **an atom.** All matter, then, is made up of these small units that cannot be cut into smaller units using ordinary processes. A collection of the same kind of atoms is called an **element.** Groups of atoms, sometimes of the same kind and sometimes of different kinds of elements, that cling together like tiny magnets are called **molecules.**

Matter usually does not exist in its pure form as an element, like carbon or gold. Matter exists in the form of molecules. These particles that we have named, atoms and molecules, are so very small that we cannot see them, not even with a microscope. Thus, we group these molecules into the forms of matter we call solids, liquids and gases.

In the following activities we are going to try to discover some of the properties of molecules. The first activity will help us see that molecules are combinations of atoms, the second that molecules are in constant motion and the third that a small number of different types of atoms can combine to form many different combinations that are the molecules.

At the **Mathematics Center**, students do **Activity** — Molecules Combine.

At the **Science Center**, the students

1. do **Activity** — Sweet Molecules
2. do **Activity** — Molecule Can Move Through Solids
3. as a whole group do **Activity** — Molecule Speed, as below.

Materials

Two glasses of hot and cold water; food coloring; medicine dropper

Procedures

1. Get a glass of very cold water and one of very hot water (not boiling).
2. Put a drop of food coloring in each glass.
3. Students describe what happened.

Getting the Idea

We know some substances in their pure form such as carbon, coal, charcoal or graphite. Other substances that we usually see in their pure form as **elements** are diamonds, which are also carbon but in the form of crystals. Gold is another element. Usually, when we use gold for jewelry, it is not in its purest form because gold is very soft. It has to mix with other metals for it to be hard. We can see silver in its pure form, usually as jewelry. Other metals such as aluminum (foil), copper and zinc exist as elements. These are examples of matter in its element and in its solid form.

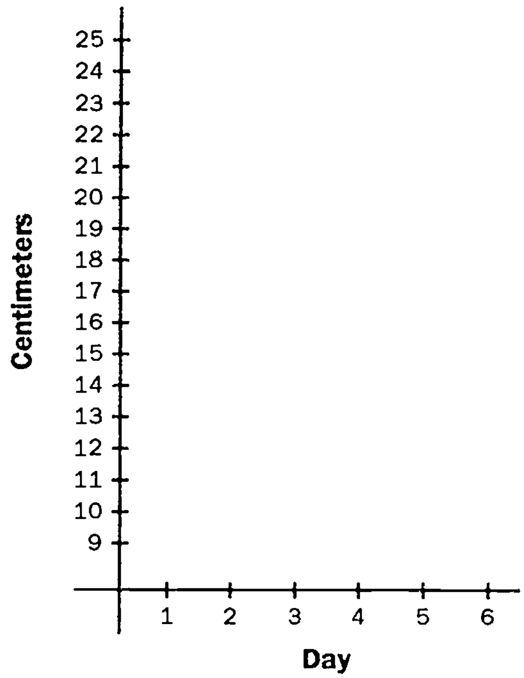
Matter also exists in a liquid form as an element, but this is very unusual. One metal, mercury, exists in its pure form as a liquid. It goes into its vapor state very easily and is very poisonous as a gas. We will not show that to you except in this mercury thermometer. The mercury is sealed into this tube and cannot escape.

Matter in the form of a gas exists as an element too. These gases are hard to see because they are usually colorless. Oxygen in the air is in its element form, as is nitrogen. However, carbon dioxide, which is included in the air we breathe out, is also a colorless and odorless gas, but it is not an element. It exists in the form of a **compound.** Compounds are **substances** composed of two or more elements that have joined as a result of a chemical change. Water, for example, is a compound composed of two gases — oxygen and hydrogen.

In one of our experiments we said that hot water molecules were moving faster than cold water molecules. How did we reach that conclusion? (Pause; allow students time to give opinions.) A drop of food coloring will mix much more rapidly in hot water than in cold water, because as liquids heat up the molecules in them move faster. The movement of the molecules "stirs" the water and causes the food coloring to mix at a faster rate. Water does not compress, but it will expand and contract due to changes in temperature.

Organizing the Idea

1. To expand on the idea that molecules can move through solids, students make a chart showing the length of a string every time they measure the circumference of a balloon. From the chart they draw a graph.



2. Students make a drawing showing how atoms, elements and molecules are different from each other.

Applying the Idea

1. If you wanted something, like jello, to dissolve rapidly in water, what would you do to the water you were going to make it in? Explain why. (Heat for jello to dissolve faster or stir quickly, or both.)
2. You have two atoms of carbon, two of hydrogen and one of oxygen. Make as many **different** molecules as you can using **all** five of the atoms at the same time. Make the molecules with gumdrops to check yourself.

```
H - C - C - H - O; H - C - C - H; C - H - H - C - O; C - H  H - C; H - C - H - C - O;
                            |                                |
                            O                                O
O - H - C - H - C; H - C - H - C;
                       |
                       O
```

3. Check with your partner to see if she/he had different ones.

List of Activities for this Lesson

▲ Molecules Combine

▲ Sweet Molecules

▲ Molecules Can Move Through Solids

ACTIVITY

Molecules Combine

Objective

Given a set of elements, the student counts all possible combinations of the members of the set.

Materials

Felt or cardboard cutouts of ice cream cones and ice cream scoops; gumdrops

Procedures

1. Janie works in an ice cream store. The flavors sold are {vanilla, chocolate}. Although there are only two flavors the store sells, how many possible combinations can Janie make from these two flavors, alone, for a double-scoop cone? (Remember, some people might like a double vanilla or double chocolate.) Use the ice cream cutouts to help you solve the problem. Record your results on a chart. (3.)
2. The store introduced a new flavor: strawberry. How many combinations can Janie now make for a double-dip cone? Use the cutouts to help you see the solution. ((v,v) (v,c) (v, s) (c,c) (c,s) (s,s).) (**Hint:** Try using gumdrops to show the ice cream cones and then count them.)
3. The store is having an ice cream sale and is reducing the price of a triple-dip (three scoops) cone. How many combinations of a triple-dip cone can Janie make? Let's let a vanilla, vanilla, chocolate cone be the same as a vanilla, chocolate, vanilla cone. In other words, the order in which you put the scoops on is not important — just the number of scoops of each flavor.

   ((v, v, v) (c, c, c) (s, s, s)
   (v, v, c) (v,v, s)
   (c, c, v) (c, c, s)
   (s, s, v) (s, s, c)
   (v, c, s)
4. The store now begins to offer 31 flavors to its customers. The customers can ask for a single, a double or a triple-dip cone. Can you make a guess about how many different combinations there can be? How did you come up with this estimate?
5. Instead of making combinations of flavors for ice cream cones, you are going to make combinations of different elements to make molecules. How many **different molecules** could you make if you had two different elements {krypton, selenium} and combined them two atoms at a time? Remember, molecules can form from combinations of the same element, as well as from different elements.
6. How many **different molecules** do you estimate you could make if you had three different elements and could combine them in groups of two molecules and then three molecules? Select three colors of gumdrops and make some molecules and count them. Combine your information with the rest of your group's information and report to the class.

Discussion

What can you say about this idea: A small number of different elements can combine to form many, many different kinds of molecules.

ACTIVITY
Sweet Molecules

Objective

Students construct molecules of common compounds with color-coded gumdrops (or some other colored, soft candy).

Materials

Package of different-color gumdrops; toothpicks; baking cups; a copy of the color chart.

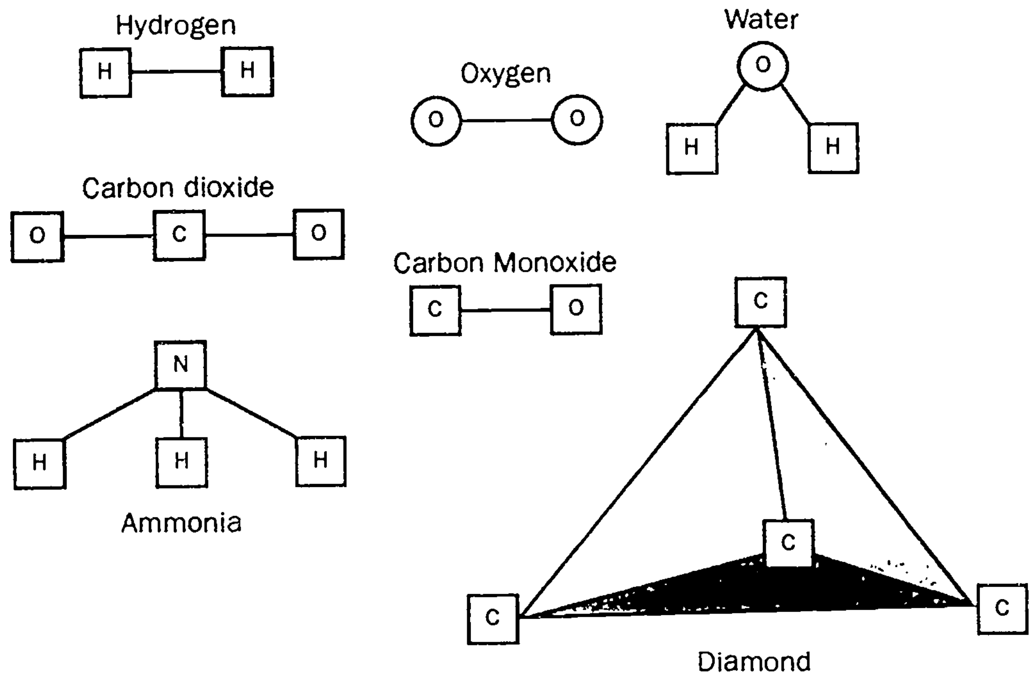
1. 30 gumdrops or other colored candy (at least five different colors); class has determined and assigned colors for each element
2. 30 toothpicks
3. Copy of the chart depicting molecules of water, oxygen, hydrogen, ammonia, carbon dioxide, carbon monoxide
4. five to six paper cups (baking cups)

Procedures

1. Students receive the gumdrops, sort them by color and put them in the labeled paper cups.
2. Using the candies, the students construct each of the molecules shown on the chart depicting molecules of water, etc..
3. Once they construct the molecules, the students copy the models into their journals, coloring the atoms with the assigned color.

Symbol	Color	Atom
H	red	Hydrogen
O	white	Oxygen
C	______	Carbon
N	______	Nitrogen
Ca	______	Calcium

4. Have students describe the molecules, saying how many red atoms and how many white atoms make a molecule of water.



Getting the Idea

1. You made some representations of molecules in this activity; what do the different pieces of candy represent? (Each gumdrop represents an atom. The different colors of the gumdrops help us see how many **different elements** go into each molecule.)
2. What do the toothpicks represent? (We said that molecules are groups of atoms that hold together like little magnets that hold to each other. The toothpicks represent the magnetic forces that keep the atoms together, thus forming the molecule. Without these magnetic forces, the molecules would fly apart.)
2. How many different types of atoms make one molecule of hydrogen? (Only one type — both of the atoms that make up that molecule are hydrogen atoms.)
3. Describe the molecule of water. (Has three atoms, and two kinds of elements — hydrogen and oxygen only.)
4. What is the difference between the molecules of carbon dioxide and carbon monoxide? What is the difference between these two gases in real life? (Humans breathe out carbon dioxide and also breathe in carbon dioxide with the regular air we breathe. Carbon dioxide exists in regular air in only a small percent. But carbon monoxide, on the other hand, is a very deadly gas. Humans cannot breathe it for more than a few minutes and live.)

ACTIVITY
Molecules Can Move Through Solids

Objective

Materials

Balloon; string; marker; paper and pencil

Procedures

1. Blow up a balloon and tie it.
2. Measure the size of the balloon by wrapping the string around the balloon along its largest circumference at the largest point. Mark and record the length of the string.
3. Place the balloon where it will not be disturbed. Try to keep it away from heaters or drafts and record the size of the balloon twice a day, in the morning and in the afternoon.
4. At the end of three days, describe your observations.
5. Explain any changes you noted to the class.

Getting the Idea

After three days, ask students what their observations have been and what their interpretation is of the data.

Note: You might check to see that the balloon is tied tightly so air cannot leak through the opening. You can do this by submerging it in water to check for air bubbles. As the balloon sits, air molecules actually permeate the balloon walls, and it will lose air slowly even though air is not escaping by any observable means. For the duration of this activity the air temperature should remain as constant as possible. If air temperature changes, the balloon will expand or contract (in warmer and cooler air, respectively) and that will nullify the results.

LESSON 5 Matter Changes in Appearance

BIG IDEAS Matter can change its appearance through a physical change while its weight and volume remain the same. Inverse operations "undo" each other.

Whole Group Work

Materials

Ice cube; potato cut into several pieces; broken glass bottle; empty can of hair spray

Word tags: change, physical, permanent, temporary, form, appearance, operation, inverse

Encountering the Idea

We have been studying about matter for several days now. We know that matter exists in three forms — liquid, gas and solid — and that it has mass and takes up space. Now, we are going to explore another question: What can we **do** to matter? Can we change it? This is one of the most important questions that scientists have asked. Many hundreds of years ago, **alchemists** were some of the early scientists. They were looking for ways to change matter. For example, they wanted to change iron, copper or lead, which can be easily found, to gold. Their efforts helped science take its early steps. We are going to explore these questions: What can we **do** to matter? And, can we change matter?

Look at this apple. I'm going to cut the apple into small pieces. Take one of these pieces. What does it look like? What does it smell like? What does it taste like? What is it? Yes, it is apple. What is the only thing that has changed about the apple? Yes, only its size, its shape, or form. We can take the pieces and put them together again, like a puzzle, and it will look like an apple again.

In this little demonstration we saw that we can change matter. What did we change in the apple — its shape, its appearance, its form. When matter changes, in what ways does it change? We know that matter has two important properties. What are they? Yes, matter has mass that we can try to change. What experiments do you think we could design to help us see how matter changes? (Pause for suggestions and, if feasible, try some of them.)

Exploring the Idea

Let's look at this ice cube. Is it a solid or a liquid? Yes, it's a solid. What is ice? Yes, it is water, but we said that water is a liquid. So what is it — solid or liquid? Can anyone explain this to the class? Yes, when water gets very cold it freezes, and when the ice gets warmer it melts into a liquid, but it is still water. What happens when we heat the water? Yes, it turns into steam. But, is it still water? How do you know? Yes, it is still water because the steam, or water vapor, will condense back into water. In this type of change from ice to water to steam and then back to water, the change is not permanent. We can go back and forth changing from one to the other. **In what ways does matter change?**

At the **Science Center,** the students complete **Activity** — Mass and Physical Change.

At the **Mathematics Center,** the students complete **Activity** — Inverse Operations.

Getting the Idea

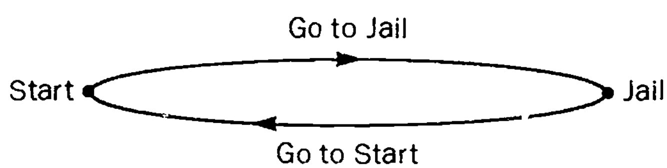
Matter can undergo change. Matter can change its form. That means that matter can change its **appearance.** This is called a **physical change.** For example, we can break a piece of glass, but each piece is still a smaller piece of glass. We can cut up an apple, but each piece is still a smaller piece of apple. Only its size or form changes.

Are physical changes permanent? Explain this to the class. (When ice turns to water and then freezes again, the changes from ice to water and back are not permanent changes. If you break a piece of glass, however, it is a physical change, but unless you have a glass factory, you won't be able to put the pieces back together exactly as they were before. This means that we can't say if a change is a physical change just by looking at whether that change is permanent or not.)

We use mass and volume to demonstrate that physical changes only change the **appearance of** matter and not its mass. We were able to see in an activity that mass, as described by the weight of the rocks after they were broken, remains the same.

We can use the idea of **inverse operations** in mathematics to think about events that follow each other in such a way that performing one operation after the other takes us back to the place where we started. two very important inverse operations are addition and subtraction, as we learned in **Lesson 2.**

We can show the results of performing inverse operations — "Go to Jail/Go to Start" one after the other — by thinking about them as a map. One step followed by the other takes you to the point where you began.



Organizing the Idea

Write a paragraph about and/or illustrate physical change of matter in your journal.

Applying the Idea

1. Suppose you are a carpenter and bought some wood to make a bookshelf. The bookshelf will have six shelves. Each shelf is 15 inches wide and six feet long. You calculate you will need 36 feet of 15-inch wide wood planks. You telephone in your order, and the company sends you three 15-inch wide wood planks that are 12 feet long each. Can you make the bookshelf with these pieces of wood? If so, how? Show a picture of the bookshelf and label the dimensions. (three planks 12 feet long are the same as six shelves six feet

long; cutting the planks into smaller pieces is only a physical change and you have the same amount (mass) of wood that you ordered.)

2. Read the warning label on a can of spray paint or hair spray. Why do you think the label says that you should not dispose of the can by putting it in a fire. What do you think would happen if you did? Why do you think that would happen?

Closure and Assessment

Problem Solving

At the **Science Center**, take several pieces of banana and smash them with a fork. Write and complete these sentences:

Smashing pieces of banana with a fork is an example of __________ change. My reasons for saying this are: ________________________________ .

Burning a match __(is, or is not)__ an example of a physical change. My reasons for saying this are: __________ .

Report to the class and explain your reasons.

List of Activities for this Lesson

- ▲ Mass and Physical Change
- ▲ Inverse Operations

ACTIVITY

Mass and Physical Change

Objective

The student observes and can say that the mass of an object doesn't change in a physical change.

Materials

Rock; hammer; large piece of ice or several ice cubes; scale

Procedures

1. Weigh the rock and record its weight.
2. Break the rock into several pieces.
3. Again, record the weight, being sure to weigh all the pieces.
4. Place the ice cubes in a pan and weigh them. Record the weight. Keep a lid on the pan. If you weigh the pan with the lid on, keep the lid on whenever you weigh the pan again.
5. Let the ice melt and then weigh the pan with the water in it, again.

Discussion

1. What happened when we crushed the rock? Did its appearance change? Did it change color? Did it smell any different? (The only way the rock changed was that instead of keeping it all in one piece, we broke it into many smaller pieces, but that was all that changed.)
2. Did its mass change? How do you know? (The pieces all weighed the same as the rock did before it was crushed.)
3. What happened when the ice melted? Did the color change? Did the shape change? Did the odor change? (The only way the ice changed was that it changed its form from solid to liquid.)
4. Did the mass of the ice change? (No, the water weighed the same as the ice.)
5. When you weighed the ice and then weighed the water from the melted ice, why didn't you weigh the pan separately? (Since we weighed both the ice and the water **in the same pan** the weight of the pan was not important.)
6. Why did you put a lid on the pan when you melted the ice? (To make sure that the water did not evaporate before we had a chance to weigh it.)
7. What conclusions can we draw from this experiment? How can we summarize this experiment?

ACTIVITY
Inverse Operations

Objective

The student understands the concept of inverse operation so that
1. given an operation that has an inverse, the student can give its inverse
2. given an operation, the student can say if it has no inverse and can explain why.

Materials

Lamp that lights by turning a knob to the right and that turns off the same way
A rusted knife or a rusted scouring pad

Procedures

1. Turn on the light in the classroom and say: I'm performing the operation "turn on the light" by flicking the switch up. How can I "undo" what I did? (Pause for the students to have opportunity to think and respond.) How can I get the classroom to be as it was before? Yes, I can perform the operation "turn off the light" by flicking the switch down. The actions "turn on the light" and "turn off the light" we call **inverse operations.** One operation — "turn off the light" undoes what the other one does — "turn on the light." If I start with one operation, I can go back to where I started by performing its inverse operation.
   - Close the door and say: I'm performing the operation "close the door." What is its inverse operation? Yes, "open the door" is its inverse; it takes the door back to where it was originally.
   - Inhale and say: I'm inhaling. What is the inverse of inhaling? Yes, letting your breath out, or exhaling.
   - Give other examples such as putting on your shoe and taking off your shoe.
   - Students give their own examples. They explain how an operation followed by its inverse takes them back to where they originally started.
2. Turn on the lamp by turning the knob to the right and say: I'm performing the operation "turn on the light" by turning the round knob to the right. How can I "undo" what I did? (Pause and let the students examine the knob before they attempt to answer.) Do you turn off the lamp by turning the knob to the left, since you turned the lamp on by turning to the right? No, that unscrews the bulb, so what do you do? Yes, you have to turn the knob to the right again, to turn off the light. On this lamp, what is the inverse operation of "turn the knob to the right"? Yes, it is the same — turn the knob to the right. What can you say about this operation? Yes, it is its own inverse. Are there other operations that are their own inverses?
   - The power on/power off button on television sets and VCRs.
   - Can the students think of other operations that are their own inverses? They can give new examples to the class whenever they come across them.
3. Tell the students you are going to give them a new example. They are to try to think of what this nursery rhyme tells them about operations.
   Humpty Dumpty sat on a wall.
   Humpty Dumpty had a great fall.
   All the King's horses and all the King's men,
   Couldn't put Humpty Dumpty back together again.

What does this rhyme tell us? Yes, that there are some operations that have no inverse — you can't get back to the place where you originally started. Let's look at some other examples of operations that have no inverse operation.

- Burn a match. Ask students if "burning a match" has an inverse operation.
- Take a small bottle and break it. Does "break a bottle" have an inverse operation? The students may want to discuss the notion that you could glue the pieces back together; but would that be putting the bottle back to its original condition?

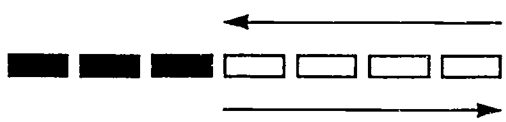
Application

1. Place four ice cubes in a pan; heat the pan only until the ice melts. Ask: What is the inverse of "melting ice"? Yes, freezing water. What is the inverse of "freezing water"? Yes, melting ice. How are these two operations related? (Inverse operations.)
2. Dissolve salt in water. Ask: What is the inverse operation of dissolving salt in water? Yes, getting the salt back, but how? (Heat the water until it evaporates, leaving the salt in the pan.)
3. Show the students the rusted scouring pad. Ask: What can we do to "undo" the process of rusting? We can't reverse it. Rusting is also called an irreversible process — it has no inverse.

Assessment

Students say whether a given operation has an inverse and, if so, what it is. If the operation does not have an inverse, say why.

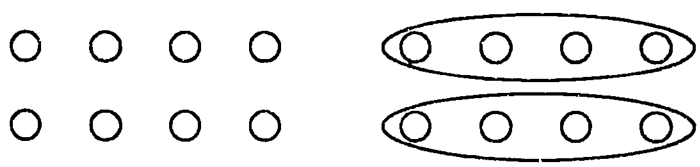
1. Climb up a mountain/ climb down a mountain.
2. Scratch my head.
3. Be a baby.
4. Write with a pencil/erase it.
5. Go to school/go home.
6. Say something (you can't un-say it).
7. Adding four to a number/subtracting four from the sum.
   ex. 3 (the number) + 4 = 7; 7 - 4 = 3 (back to the original number)
   You can show this relation with locking cubes:



8. Multiplying a number by two/dividing the product by two.
   ex. 4 (the number) x 2 = 8; 8 ÷ 2 = 4 (back to the original number)
   You can show this relation with arrays:

4 times 2 is 8.

8 divided into 2 groups equals 4 in each group.



9. Finding a number greater than a given number has no inverse.
   ex. Using the counting numbers, you start with five; nine is greater than five. If you start with the result nine, how do you get back to the original five? If you select "finding a number that is less than nine" then eight, seven, six, five, four, three, two, one and zero are also less than nine. Which one will you pick? Since the rule "finding a number less than nine" does not say which of the numbers that are all less than nine has to be selected, there is no way to get back to the number five.

LESSON 6 A Substance Can Change in Mass

BIG IDEAS Matter can change in its mass through a chemical change. Weight and volume can change through chemical reactions.

Whole Group Work

Materials

Several matches; a rock; a candle; an inflated balloon: an appla and a potato; three pieces of steel wool; small plastic bags; measuring cup; glass of water

Advance Preparation

Four days before beginning the lesson:

1. Cut an apple and a potato into several pieces, place on a plate and leave uncovered in the **Science Center.**
2. Put one piece of steel wool in a plastic bag, put three tablespoons of water in the bag, seal the bag and place in the **Science Center.**
3. Put another piece of steel wool in a bag, put three tablespoons of water in the bag but leave the bag unopened.
4. Put the third piece of steel wool in the **Science Center** where it won't get wet or be disturbed.
5. Measure the circumference of the balloon every day and record it.
6. Fill the measuring cup with one cup of water. Measure its volume every day and record it.
7. Place the rock in the **Science Center**.

Encountering the Idea

In the lesson we just finished, we learned that matter can change its form — that is, it can change how it looks, but it continues being what it was originally. Let's name some examples: ice turns to water or steam and back; we can cut an apple into pieces and it is still an apple. Now, I want you to look at this match. I light the match and what happens? Is this a physical change? How do you know? We had this question as a problem-solving assignment. Let's let the groups report on their answers.

Yes, those of you who said that burning a match is **not** a physical change are correct. What happened to the match? Did it look the same, feel the same, smell the same after it burned? No. What happened to it? That is what we are going to investigate in the following activities.

Exploring the Idea

A few days ago, we put this piece of steel wool into this bag with a little bit of water in it **but left the bag open.** We left it here for several days in the **Science Center.** In the other bag, we put other piece of steel wool, but we did not put water in it. We left this piece of steel wool dry. We put this apple on this plate and left it uncovered for a few days. We did the same thing with this potato. The inflated balloon has been hanging here for several days, and we measured its circumference. We put this rock here in this corner. Your assignment is to come by every day and see if you notice a difference in each of these items. What is happening to them? As you come by to see what is happening to these items, make a chart of what you see and write a description in your journal of what you think is going on. If you want to add other items to test for change, you may do so, but add them to the chart to make sure that you record all your observations.

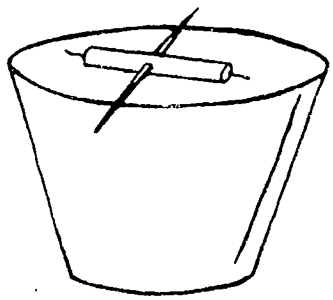
Before you go to the learning centers, let's complete this **Activity** — Burning A Candle, as below.

Materials

Candle or long taper; match; toothpicks; water glasses

Procedures

1. Prepare a candle so you may light the wick at both ends.
2. Stick round toothpicks into the candle and balance it on the water glasses as shown in the illustration. It doesn't have to balance perfectly.
3. Light both ends of the candle. Observe for several minutes. Describe what happens.



4. Using what you know about matter and how matter changes, explain how this happens.
   Students complete **Activity** — Chemical Changes.

Getting the Idea

A burning match is an example of matter changing from a solid piece of wood to a gas — to smoke, and to ashes — other solids. A burned match is different from the match we started with. If we watch closely as the match burns, we can see some liquid close to the flame. This liquid is part of the match that has vaporized because it got so hot that it turned to liquid before it turned to smoke. This change of a burning match to vapor and then to ashes is called a chemical change. When matter goes through a **chemical change,** we have no way, using ordinary processes, to change it back to what it was before the change. In this example, there is no way we can capture the vapor and put it back into the ashes to make a wooden match again.

We studied other examples of chemical changes. What happened to the dry steel wool? Nothing — no change. Why did the wet steel wool change? What was the only difference in the two pieces of steel wool? One piece of steel wool was wet and placed in a baggie and sealed. It got no air. The other piece of steel wool was wet, placed in a baggie, but left unsealed — open. It got air. The iron in the open baggie rusted. Rust is a substance made of iron and oxygen. Rust molecules have atoms of iron and of oxygen, with water molecules attached. When these elements — iron, oxygen and water — come together, a chemical change takes place — iron turns to rust.

All of you have had an opportunity to observe the changes in the potato, the apple, the steel wool, the balloon and the water. Why do you think that some of these changes are physical, while others are chemical? (The potato and the apple rotted; they got green or they changed color; they are not the same anymore. The wool rusted and became flaky. The water only evaporated. The balloon didn't change; it is still a balloon; it just got limp.)

Rotting and rusting are examples of chemical change. Evaporation is a physical change. Matter, however, **can change** its form and its attributes in ways that are permanent. We see this happening all the time. We can find evidence that a chemical change has occured from one or a combination of the following: a change in mass, shown by a change in weight; heat is generated (the burning match); the color of the substance changes (apple and potato); a gas is generated (bubbles when mystery powder (baking soda) and mystery liquid (vinegar) were combined); the substance changes in nature (the egg white became elastic, and Elmer's Glue and liquid starch became Silly Putty).

Organizing the Idea

1. Make a chart to help you record observations about changes in matter. This chart is designed to help you decide whether the change was a physical or chemical change. You may want to weigh the items you are investigating. What would a change in weight suggest?
2. After you have completed the chart on your observations of change, make a chart listing the differences between physical and chemical changes, as you observe them.

Physical or Chemical Changes?

	Day 1	Day 2	Day 3	Day 4	Day 5
potato					
apple					
steel wool (dry, placed anywhere)					
steel wool (wet, uncovered baggie)					
steel wool (wet, sealed baggie)					
cup of water					
rock					
inflated balloon					

Applying the Idea

1. **Activity** — Secret Message, as below.

Materials

Small jar; white paper; milk (only a few drops); lamp with light bulb; toothpick; lemon juice

Procedures

- Dip the toothpick into the lemon juice and use it as a pen to write a message on the paper. Let the juice dry.
- What happened to your message?
- Hold the paper close to a burning lightbulb. Describe what absorbed heat from the lightbulb. What can you say about this?
- Repeat with milk.

Teacher Information

As the liquid dries, the residue blends with the paper and becomes invisible. When we apply heat, a chemical change takes place in the residue, turning it dark and making it easily visible against the white paper.

2. Read about alchemy in a reference book. Answer this question: Have scientists been successful in changing lead into gold?

Closure and Assessment

Problem Solving

1. Does a physical change always go along with a chemical change?
2. Does a chemical change always go along with a physical change? Demonstrate and explain your answers to the class.

List of Activities for this Lesson

▲ Chemical Change

ACTIVITY
Chemical Change

Objective
Student gives an example of a chemical change and gives two reasons for saying that it is a chemical change.

Activity — Dissolve the Egg

Materials
One hardboiled egg; one fresh egg; 600 ml vinegar

Procedures
Soak a hardboiled egg overnight in 300 ml of vinegar (also soak a fresh egg in 300 ml of vinegar). The egg shell will completely dissolve into the vinegar leaving:
1. fresh egg — yolk and white surrounded totally by a thin membrane
2. boiled egg — white becomes rubbery and can bounce.

Activity — Silly Putty

Materials
One cup prepared (store-bought) liquid starch and one cup Elmer's Glue.

Procedures
Pour both liquids in a large Zip-lock bag (one qt. or larger). Make sure to close the bag securely. Knead the mixture thoroughly. Pour off watery liquid and discard. Wow! Silly Putty.

You can pull it slow and it stretches; pull it hard and it breaks. Press it on comics to copy the print. Make exciting models. Keep it stored in the bag to keep it fresh and soft.

Activity — Mysterious Reaction Baking Soda & Vinegar

Materials
Mystery Liquid = Vinegar (50 ml); 500 ml beaker; baking soda
Mystery Powder = Baking Soda

Procedures
(Do not tell the students that they are working with vinegar and baking soda — let them discover it.)

Observe mystery powder and mystery liquid.

Put 50 ml of vinegar in a 400ml beaker, drop one gram baking soda into liquid. What happened? Where did the bubbles come from? Was this a physical or chemical change?

LESSON 7 Compounds and Mixtures

BIG IDEAS Compounds form through chemical change; mixtures are combinations that form through physical alterations only. There are similar mathematical operations; some operations have inverses, others have no inverses and some operations are their own inverses.

Whole Group Work

Materials

Have in a box for demonstration:

picture of a diamond; gold and silver jewelry or pictures of the jewelry; objects made of brass, steel, copper; labeled container with water; plastic, ceramic, glass objects; bread; fruit; one plastic bag of **Lucky Charms** cereal; trail Mix; Rice Krispies

Additional materials listed below

Encountering the Idea

Combine the following ingredients as you talk to the students. Some of these combinations the class has already made and discussed; but in this lesson the class will identify the combinations as being either compounds or mixtures, depending on whether the combinations are undergoing a physical or chemical change.

- baking soda and vinegar
- Elmer's Glue and liquid starch
- egg and vinegar
- milk and pudding
- bits of rock and bits of grass
- trail mix with Rice Krispies or some other cereal

Make each of the combinations above. After making each combination, ask the students: What happened when I mixed the ______ with the ___________? What was the result? The students make observations and examine the results.

Exploring the Idea

Review the concepts of physical and chemical change before the students go to the learning centers. Light a match, then ask students to describe what they see as the match burns. Review the possible results of chemical changes: change in color; production of light, heat, gas or liquid that was not there before and not the result of melting, as with the ice/water activity; change in mass.

Students complete **Activity** — What Are Mixtures and Solutions?

Getting the Idea

Review the notions of the composition of matter. The smallest units matter exists in are called **atoms.** When matter exists in a combination of two or more elements, it is called a **compound** or a **mixture**.

Every object in the universe is composed of matter, either as a pure element or as a compound or a mixture. Elements combine to form compounds or to form mixtures. When a mixture forms, it is the result of a physical change — the individual components or parts that went into the mixture are often visible. The individual parts maintain all of their original properties, and we can separate them into their original form with relatively little effort, for example, trail mix. Look at this bag of **Lucky Charms** cereal. This is a mixture. In a mixture, you can sometimes see the different parts. It has marshmallows, stars, cereal. If you spill it on a table, you can separate all the different pieces out. This is not true of water, for example. You cannot easily separate the oxygen and hydrogen gases of which it is made.

A solution is also a mixture. If you dissolve sugar in water, this is a physical change. You can always evaporate the water and get the sugar back. In the case of solutions, you can't see the different parts like you can in **Lucky Charms.**

On the other hand, when two or more elements combine to form a compound, an exchange of energy occurs. At times, heat is given off. Light and gas are also products of the union of elements to form compounds. An explosion, for example, is the byproduct of the formation of new substances, as when dynamite is detonated.

Organizing the Idea

1. The students tabulate on a chart their observations of the combinations made earlier. They discuss how the original substances looked before and after the class combined them.

Substances	Type of changes	Description: (Before & After) Compound/Mix
Baking soda & vinegar		
Elmer's Glue and liquid starch		
Egg & vinegar		
Milk & pudding		
Bits of rock & grass		
Trail mix with Rice Krispies		

2. We are going to classify each object in this box in two ways—first, if it is a solid, liquid or a gas, and then we are going to guess to see if it is an element, a compound, or a mixture. When you finish, show and explain your work to the teacher. When all the groups have had an opportunity to classify these materials, we will discuss them.

Form	Substances		Mixture
	Element	Compound	
Solid	carbon silver, gold copper	wood, bread glass plastic	steel brass trail mix
Liquid	mercury	water alcohol	milk Kool-Aid
Gas	oxygen helium nitrogen ozone	carbon dioxide carbon monoxide	air scents natural gas cooking

Applying the Idea

Problem Solving

How do you get salt out of pepper?

Materials

For each student team:

a plastic bag with one teaspoon of pepper mixed with 1/2 cup salt

Procedures

Working in teams, the students design as many activities as they can to solve the problem of removing the pepper from the salt. There is no one correct answer to the problem. After they have solved the problem, they explain to the class. Then they write the activity in their journals.

Closure and Assessment

1. Dissolve some salt in a cup of water; describe what happened. Tell me if there was a chemical or a physical change with the salt and water. Tell me your reasons.
2. If you think it was a physical change, what can you do to get the salt back?
3. Make a chart or state a rule to explain how elements, compounds, mixtures and solutions are alike, and how they are different.

List of Activities for this Lesson

▲ What Are Mixtures and Solutions?

ACTIVITY

What Are Mixtures and Solutions?

Objective

Students say that a solution is a mixture, but in liquid form.

Materials

Two glass jars; paper clips; spoons; toothpicks; sugar; bits of paper; water; paper and pencil; marbles or small rocks; bottle of soda pop

Procedures

1. Fill each jar about half full of water.
2. Put the marbles, paper clips, toothpicks and bits of paper in one jar and a spoonful of sugar in the other jar.
3. Stir both jars and observe what happens to the materials in the water.
4. Shake the bottle of soda pop.
5. Compare the results in the three containers.
6. Try other substances in water, such as sand, Jello or powdered chocolate.

Teacher Information

A mixture consists of two or more substance that retain their separate identities when mixed together. Solutions result when the substance mixed in a liquid seems to become part of the liquid. A solution is really a special kind of mixture — one in which the particles are all molecular in size.

Discussion

1. What are marbles made of? (Molecules.)
2. What is water made of? (Molecules of water.)
3. Explain why some things dissolve and some do not. (Clips, sugar.) Why did gas come out of the soda pop?

LESSON 8 Science: Counting and Measuring

BIG IDEA Science tries to answers questions about our world; often, we find the answers by counting, estimating and approximating.

Whole Group Work

Encountering the Idea

Begin by telling students that in this unit we have studied about matter. People who study about matter — what it is, what its properties are — are called scientists. Scientists ask questions not only about matter but about many other things about our world and the way it works. Scientists look for answers to these questions by collecting data in ways that are similar to the ways we have collected data.

How have we collected data? As students respond, write answers on the chalk board. Yes, we collect data by **counting** and by **measuring.** What kinds of things have we counted? In taking surveys, for example, we count the number of people in the class who like different kinds of ice cream to see which is the class favorite. As another example, in studying nature, we count the number of body parts, three, and the number of legs, six, insects have, and we are able to compare them with spiders that are arachnids, that have only two body parts but have eight legs. (Students give examples of other things they have counted to collect data for experiments.)

We count things we can see; but suppose we are scientists and need to count something that is very small, for example, the number of cells in the human body. We can't count them because we can't see the cells that are very small. What can we do? This is one of the questions we are going to explore.

Let's talk about the other method we use to collect data. We said we measure things. We have measured the length of objects; we have measured the temperature of water and its weight. All of these measurements are data also. However, in order to measure something, weight for example, we need to use an instrument, such as a scale, and a standard unit of weight, such as an ounce, gram or pound. To measure the temperature of water, we need a thermometer and a unit of temperature such as degrees Fahrenheit or degrees Celsius. To measure the length of a box, we need a ruler and a unit of length such as an inch, centimeter or foot.

In addition to needing these instruments for measurement, we also need to know how to use these instruments. How do scientists make sure they use their instruments correctly? Have you had to learn to use a ruler? A thermometer? Yes, we have to develop these skills to collect data that is reliable, that we can trust. We will work in the **Science** and **Mathematics Centers** to explore some of these ideas.

Exploring the Idea

At the **Mathematics** and **Science Centers**, the students

1. complete **Activity** — How Many Beans?
2. complete **Activity** — Linear and Square Measure.

Getting the Idea

What do you think scientists do if they cannot actually count or measure something in order to collect data to answer a question? Yes, they estimate! We do the same thing; if we can't actually count something, we try to estimate the number. To **estimate** means to make a guess by using clues that help us get as close as we can to the actual number we are looking for. When you estimated the number of beans in the jar, what clues did you look for to help you guess a number?

The first time you guessed? (Just guessed, tried counting some of them, looked at the size of the jar, etc.)

The second time you made a guess? (Guessed again; if the beans were bigger, then I guessed fewer beans, had more experience in estimating beans in a jar, and my guesses were closer.)

The third time?

Sometimes scientists have to estimate also. For example, astronomers tell us that the distance from the earth to the sun is 93 million miles. How do they know? They don't; scientists have estimated the distance using different clues — just like you did. Since astronauts have traveled to the moon, they have been able to measure the distance from earth to the moon. They know now that the clues they were using to estimate distance in space were valid — that the clues they used were really helping them measure distance in space.

Let's think about some of the data we have collected in the experiment on chemical change. Look at our data chart. On the chart we show that the potato and the apple got wrinkled, turned brown, smelled bad and rotted, or just dried up. Is there any way we can measure **how much** the potato rotted? Can we measure how bad it smelled? Why can't we measure that? We don't have an instrument or a standard unit to measure how much food rots or smells. We can only estimate that each day the potato looked more rotten and smelled worse than the day before.

What about the water? Could we measure the amount of change? Could we tell how much water evaporated each day? Yes, because we put the water in a measuring cup and could read the scale to see how much was left. What else could we measure in that experiment? After students have given the question some thought, ask: Could we measure how much air escaped from the balloon? Yes, because we measured the circumference of the balloon every day.

What about the rock? Did it change in appearance? Did its mass change? How do you know?

Organizing the Idea

1. The students make a chart listing things that they can count and those things that they cannot count and and have to estimate.

Can be Counted	Have to be Estimated
Students enrolled in our school The number of times I have been absent from school Number of elements in a compound; ex. table salt has 2 — sodium and chlorine The amount of money I have in my savings bank	Students enrolled in 3rd grade in the U.S. Number of molecules in a grain of sand Number of stars in the Milky Way How much the earth weighs

2. The students write and/or illustrate the difference between counting, estimating and approximating.

Applying the Idea

Problem Solving

What is the population of the United States? Look in a reference book in your school library to read about the "census". What is it? How is it done? Is the population of the United States an estimate? Is it an approximation? Report your ideas to your group and then to your class.

Closure and Assessment

Assess each of the activities included in the lesson for student level of participation and degree of completion.

List of Activities for this Lesson

▲ How Many Beans?

▲ Linear and Square Measure

ACTIVITY
How Many Beans?

Objective

Students give an example of an estimate, an approximation and an actual count.

Materials

Three jars (two-cup capacity) labeled as "1," "2," and "3," filled with beans of different sizes (pinto, navy, large lima beans)

Three charts to record the beans estimated and then counted

Procedures

1. How many beans are there in Jar 1? Do you think there are 1000? (Pause for responses.) What about 500? Well, then, if you still think that is too many, what is your best guess? Each student, working alone, makes an estimate.
2. Students, working in groups, share their individual estimates with the group and develop a strategy to get "as close" to the actual number as possible. They make a group estimate and record the estimates on a chart. Each group explains why they used a particular strategy.

Discussion

- What do we mean when we make a "best guess". When I asked if you thought there were 100 beans, you said that was too high. You also said that 500 was also too high. Why did you think that? Then you made a "best guess," which we also call an **estimate.**
- Did you change your guess after you heard other people's estimates and their reasons for making those estimates? Why?
- Some groups counted 173 beans, one group counted 171 and another counted 193. Can this be right? Why? What do we do? Yes, maybe the correct count is 173 because three groups got that number. Let's recount. Now that we agree that there are 173 beans, let's examine the strategies that may have been more effective — the strategies that got "closer" to the actual count.

Jar I (Pinto beans)

	1	2	3	4	5
Estimate					
Approximation					
Count					

Students work in groups with Jars 2 and 3.

3. Here is Jar 2 with the same volume but different size beans. Let's write down some estimates. Why did you estimate a greater (smaller) number? Because the beans were smaller (bigger).
4. Students work in groups to develop a strategy to get "as close to" the actual count as they can.
5. Students count the beans.
6. Repeat the steps with Jar 3.

Discussion

- The first number you guessed we call an "estimate". Notice that the differences among these estimates was large.
- The next number you found when you tried to get "as close to" the actual count as possible. This time you used a strategy. It appears that some strategies worked better than others; some helped you get a closer count.
- The second time that you guessed, that you estimated the number of beans, did your guesses show that you considered the size of the beans and the capacity, or size, of the jars? Did you change your strategy to get a better approximation? Why?
- The third time you guessed, or estimated, did you make your best guess in a different way? Why? How about the approximation?

Assessment

1. What is the most important difference between an estimate and an approximation? (An estimate is made on general standards or clues, such as appearance, apparent size or past or personal experience; an approximation is also a guess, but we make it by using measurments, which are also clues, or by actual counting.)
2. When would you use an estimate? (When you have only a general ideas of the measurement.)
3. When would you use an approximation? (When you can use measuring instruments.)
4. When would you count? (When things are separate like beans, chairs, people, and when the numbers are small enough that you can count—otherwise you estimate.)

ACTIVITY

Linear and Square Measure

Objective

The students measure lines or areas to the nearest subunit of the measuring instrument they use.

Materials

Copy of the figures to measure for each student
Tape to measure in inches, subdivided into eighths
Tape to measure in centimeters
Inch-square grid and centimeter-square grid, each on a transparency

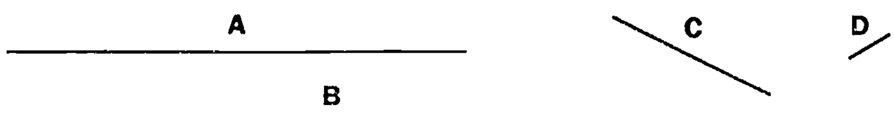
Procedures

Part 1

1. Students measure the length of the lines shown below, recording the inches and 1/8th inches and also recording the number of centimeters and 1/10th centimeters, or millimeters.
2. After the students have measured the lines, they discuss problems they had in measuring the lines, if any.

Discussion

1. Did you have a problem measuring line D with the inch unit? Why?
2. Did you have to "round" your measurement to the nearest 1/8 inch or to the nearest millimeter (mm.)?
3. When you were measuring the lines were you able to "get closer to" the "exact end of the line" with the inch and eighths of an inch marks or with the centimeter and tenths of a centimeter (also called a millimeter) marks? Why?
4. Look for two objects in your classroom and measure their lengths. Record the lengths in inches and eighths of an inch and in centimeters and millimeters.
5. Make a rule about when to use inches and when to use centimeters.



Line	Inches 1/8 in.	Centimeters 1/10 cm. (mm.)
A		
B		
C		
D		

Part 2

1. Using the transparencies of the grids in square inches and square centimeters, the students measure the areas of the figures shown below, recording the area in square inches and in square centimeters.

2. After the students have measured the lines, they discuss problems they had in measuring the lines, if any.

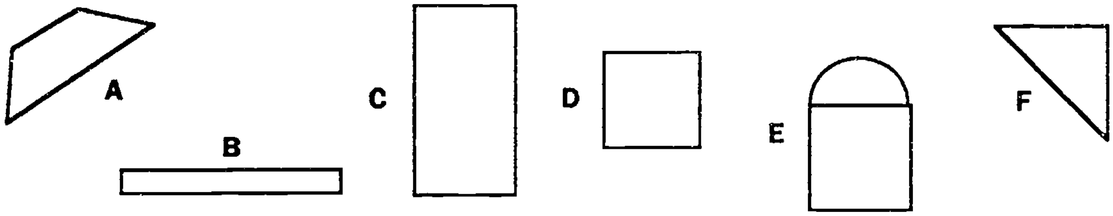
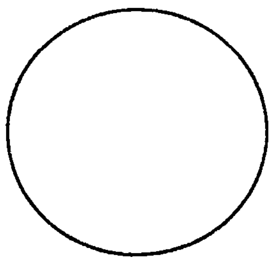


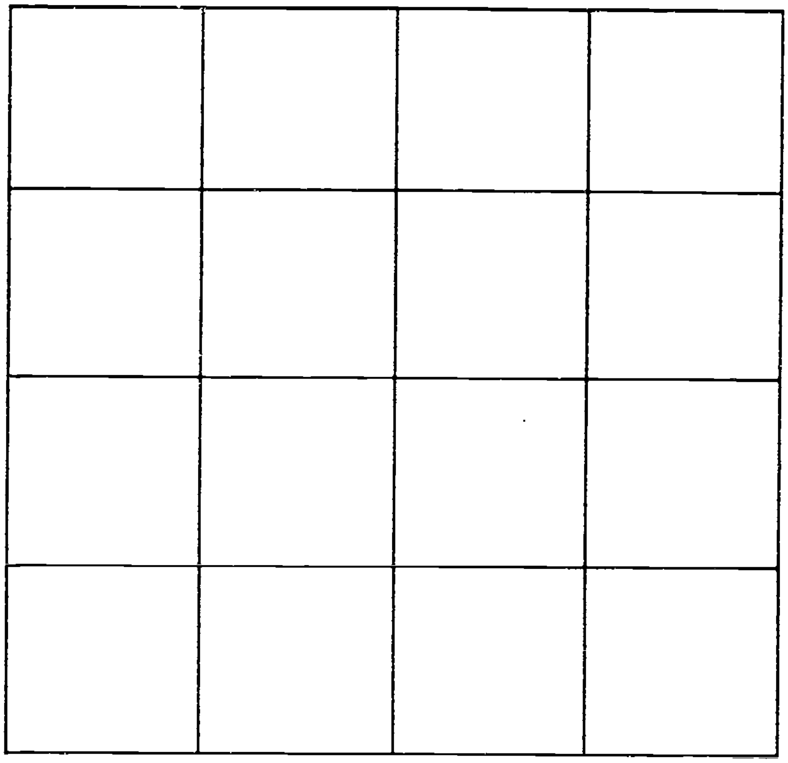
Figure	Square Inches	Square Centimeters
A		
B		
C		
D		
E		
F		

Discussion

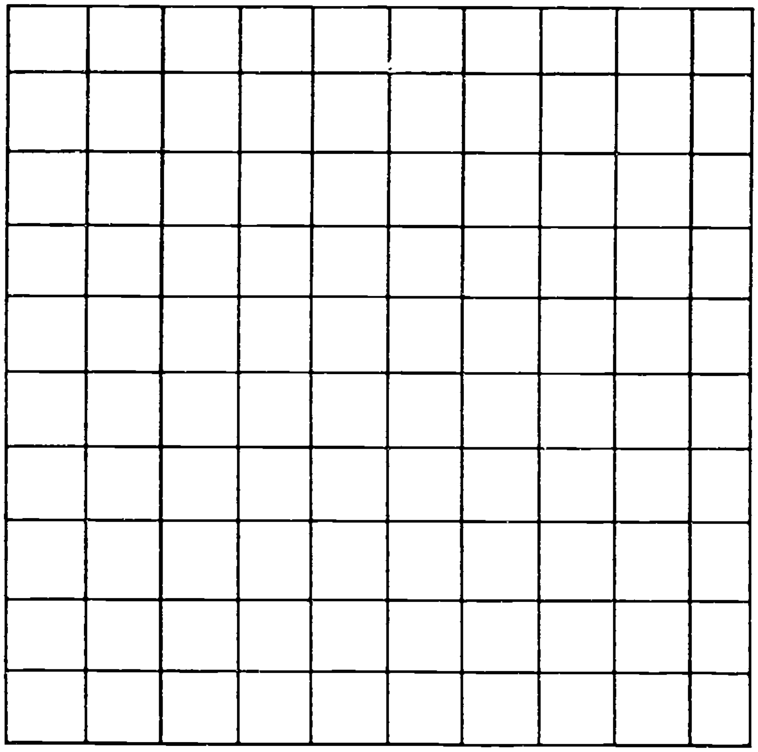
1. Did you have a problem measuring figure B with the square inch unit? Why?
2. Did you have to "round" your measurement to the nearest square inch or to the nearest square centimeter? Why?
3. When you were measuring the figures were you able to "get closer to" the "exact area" with the square inch or with the square centimeter? Why?
4. Look for two objects in your classroom and measure their areas. Record the areas in square inches and in square centimeters.
5. Make a rule about when to use square inches and when to use square centimeters.
6. Suppose we marked the square centimeter grid into square millimeters. Could you get "closer" to the exact area of figure E? Why?
7. What is the closest you can get to measuring the area of this figure:



Square Inch Grid



Square Centimeter Grid



UNIT ASSESSMENT

1. Is temperature related to the form that water is in? Explain.
2. Do you think the temperature of matter relates to whether it is in a solid, liquid or gas form? Why do you think that might be true?
3. Look at the chart you completed in **Lesson 6** on Physical and/or Chemical Changes. Did the cup of water change its weight during the days you observed it? Does a change in weight of the water mean that the water changed? (No, since the water evaporated, the cup of water would weigh less, but the water changed only in form.)
4. How can you keep the tools to fix your house or car — like screwdrivers, hammers and other steel tools — from rusting?
5. How can you keep fruits and vegetables from rotting?

Annotated Children's Books

Ardley, N. (1984). *Making things move.* New York: Franklin Watts.

The properties of friction, inertia, and gravity are explored.

Branley, F. M. (1972). *Weight and weightlessness.* New York: Crowell Collier Press, Division of Macmillan Publishing Co., Inc.

This book provides everyday examples of gravity and weightlessness.

Gramatky, H. (1939). *Little toot.* New York: G. P. Putnam's Sons.

This is a colorful, illustrated story about a tugboat and his adventures on the river where he lived.

Laithwaite, E. (1986). *Force: The power behind movement.* New York: Franklin Watts.

The principles of force are explained by demonstrating its applications.

Mitgutsch, A. (1985). *From swamp to coal.* Minneapolis, MN: Carolrhoda Books.

Much information is simply explained in this account of how coal is formed.

Walpole, B. (1987). *Fun with science: Movement.* New York: Franklin Watts.

An introduction to movement enhanced by photos and illustrations.

White, J. R. (1987). *The hidden world of forces.* New York: Dodd, Mead & Company.

Discusses some of the forces at work in the universe, such as electromagnetism, gravitation, surface tension, and frictions.

Whyman, K. (1986). *Forces in action.* New York: Gloucester Press.

Such forces as elasticity, gravity, and friction are explained in a simple pictorial approach.

unit

3 Sound

Prior Knowledge

The student has

1. worked with examples of at least two forms of energy, such as light and heat
2. had an opportunity to experience or talk about an echo
3. measured length in inches, feet and centimeters
4. worked with forms of matter such as a solids, liquids and gases
5. multiplied and divided single- and double-digit numbers
6. added and subtracted two- and three-digit numbers with re-naming and regrouping
7. interpreted data and summarized it on a graph.

Mathematics, Science and Language Objectives

Mathematics

The student will

1. multiply and divide two- and three-digit numbers
2. solve rate problems related to speed and frequency
3. use fractions to describe parts of a graph.

Science

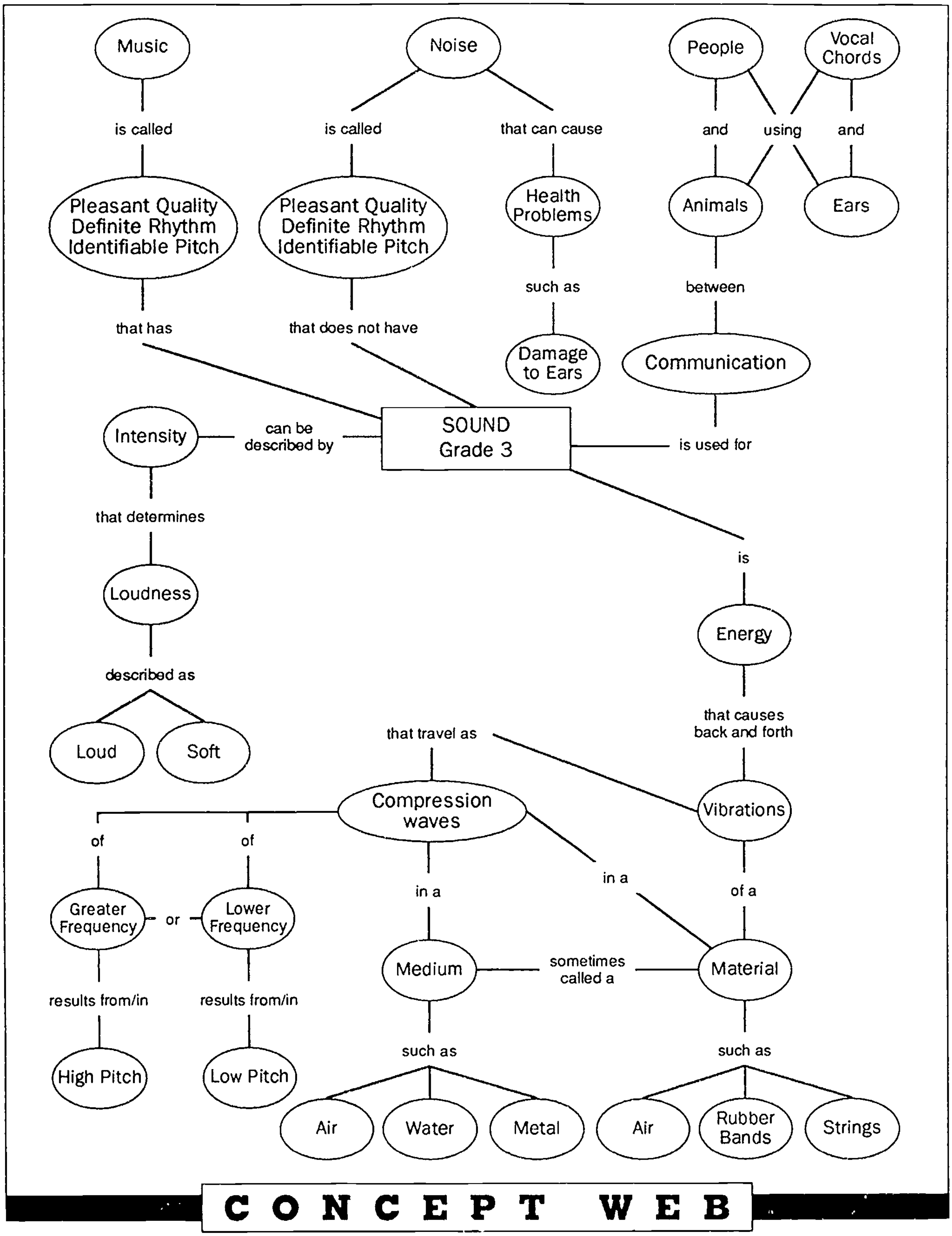
The student will

1. give the location of a sound
2. describe source of sound as the vibration of matter, including air
3. describe and demonstrate with vibrating objects how sound travels through substances by wave motion
4. compare and contrast music and noise using concepts of rhythm, pitch and volume related to wave motion
5. describe the human voice range as related to frequency
6. identify the resonators in the human body that produce the voice
7. describe radiators and resonators.

Language

The student will

1. find needed information in an appropriate reference book
2. follow oral and written multistep directions
3. predict outcome of a story
4. make oral and written inferences and draw conclusions from an activity
5. write poetry related to sound concepts
6. communicate the solution to problems in oral and written form
7. create pattern reports.


Music
is called
Pleasant Quality
Definite Rhythm
Identifiable Pitch
that has
Noise
is called
Pleasant Quality
Definite Rhythm
Identifiable Pitch
that does not have
that can cause
Health Problems
such as
Damage to Ears
People
and
Animals
using
Vocal Chords
and
Ears
between
Communication
is used for
SOUND
Grade 3
Intensity
can be described by
that determines
Loudness
described as
Loud
Soft
is
Energy
that causes back and forth
Vibrations
that travel as
Compression waves
of
Greater Frequency
or
Lower Frequency
results from/in
High Pitch
results from/in
Low Pitch
in a
Medium
sometimes called a
in a
of a
Material
such as
Air
Water
Metal
such as
Air
Rubber Bands
Strings
CONCEPT WEB

VOCABULARY

sound sonido	vibrations vibraciones	synonyms sinónimos	volume volumen	tuning fork diapasón
noise ruido	energy energía	medium mediano	thickness grueso	hum tararear, zumbar canturrear
length longitud, largo	pluck plectro, pulsar puntear	reflect reflejar	observe observar	pitch tono, entonar
resonate resonar	note nota	stereophonic esterofónico	transfer transferir	amplify amplificar
rhythm ritmo	quality calidad	vocal chords cuerdas vocales	ear oido	radiator radiador
material material	communicators comunicadores	communication comunicación	solid sólido	intensity intensidad
verbal verbal	wave onda	loud alto, fuerte	pleasant agradable	soft silencioso, bajo
cell célula	neuron neurona	rubber band liga, goma	compression wave onda de compresión	
thesaurus diccionario ideólogico				

Teacher Background Information

Much of what we learn about our world comes to us through our sense of hearing. Hearing is important not only for learning about the world, but also for communicating with other humans and with animals. The human voice is unique in its ability to express abstract ideas.

Sounds give animals a lot of information, warning them of danger and informing them that possible prey is around. Sounds tell animals and humans about the weather in the form of thunder and the quality of the sound (for example, sounds on a cold, clear night are different from sounds on a hot, muggy evening), or the blowing of the wind. We inform each other as to time with the lunch whistle, danger with the fire alarm or the police whistle, happiness or sadness with music, and so on.

Doctors can listen to their patients' heartbeat, their lungs and their stomachs to help in the diagnosis of illness. We can listen to engines or motors to tell us if we need to repair them. We can identify people by the unique sound of their voices or the sound of their footsteps. We can identify animals by their sounds: birds calling, lions roaring, insects buzzing, and so on. We can all learn from the sounds we hear, and our sense of hearing helps us in learning of the world around us.

Students can learn many technical concepts related to sound by conducting the experiments and activities in the unit. Students can learn concepts of pitch and volume, sound radiation and resonance by playing with objects that vibrate and by making them vibrate in different ways. As students learn to change variables in an experiment and to observe the consequences of the changes, they will begin to develop an approach to problem-solving that will lead them to appreciate the scientific method.

Vibrations, or sound energy, can be felt as a pulsation. The scientists who study these vibrations interpret them as sound waves and picture them on graphs. Students can use these new concepts of energy traveling as waves through a medium to understand the essential notions of sound. We can explain pitch, volume, rhythm, music and noise by looking at graphs of sound waves. Although the production of sound and the ability of humans to detect, analyze and identify sounds are complex, the students can understand the fundamental notions if they are able to experiment with objects in order to become familiar with the ideas.

Sound travels better through solid objects because the molecules pack more tightly and don't have to move a great distance to bump against each other and transmit the vibrations. Sound will travel a greater distance through materials for the same reason. The exception, of course, is specially designed acoustic material that appears to be solid but is designed with spaces to "trap" vibrations.

We can hear the tapping on the desk and the ticking of the clock more clearly when we have an ear against the solid object.

In studying pitch, or the frequency of vibrations per second, children should be aware that the human ear cannot detect the frequency of very high (fast) and very low (slow) vibrations. Dog whistles are too high-pitched for people to hear them, but dogs and some other animals can hear them.

Sound is a very important part of our lives. It is one of the first stimuli to which newborn infants react, and it affects us throughout our lives.

A study of sound can extend greatly to include listening skills. Music can be integrated through a discussion of musical sounds and musical instruments and through producing music by electronic means.

Throughout the unit, encourage children to bring and demonstrate their own musical instruments. Children naturally seem to enjoy music and making music. Music can be used as a motivation for the study of sound. Parents and friends who play musical instruments can be invited to participate in the unit. Architects, doctors (audiologists) and persons with hearing handicaps can also be invited to participate in the unit.

Many children are familiar with the use of electronics to produce sound. They know about electronic musical instruments, radar, sonar and television. All of these methods can be studied through a study of sound waves.

The aesthetics of sound can also be considered. When is a sound pleasant and when does it annoy? Sound has affected how we communicate with each other and entertain each other. Everyone can appreciate the importance of sound in our daily lives.

LESSON FOCUS

■ **LESSON 1**

What Is Sound?

BIG IDEAS

Sounds develop in many ways as they travel through matter. The speed of sound is 770 miles per hour in air.

■ **LESSON 2**

Sound Travels in Waves

BIG IDEAS

A medium such as air, water or metal is necessary for sound waves to travel. A graph shows the characteristics of a sound wave.

■ **LESSON 3**

High/Low and Loud/Soft Vibrations

BIG IDEAS

We hear sound as changes in the frequency and height of sound waves. We hear the frequency of sound waves as pitch, and we hear the height of sound waves as volume, or amplitude.

■ **LESSON 4**

Radiators and Resonance

BIG IDEAS

Radiators are vibrating objects that send out sound energy. Resonators vibrate at the same frequency as the radiators but with different volume (loudness).

■ **LESSON 5**

The Human Voice

BIG IDEAS

The human voice comes from the larynx, the lungs, and the resonators in the mouth, nose and throat. The frequency of the sound waves of the human voice is between 80 and 400 cycles per second.

■ **LESSON 6**

What Is Music? What Is Noise?

BIG IDEAS

Music is sound that has rhythm, pitch and volume and that is pleasant to the ear; noise has none of these but is irregular sound.

■ **LESSON 7**

Sound Is Important in Communication

BIG IDEAS

Sound allows communication among people and between people and animals through the use of vocal chords and ears. Humans can hear sounds that have a frequency between 15 cycles per second to about 20,000 cycles per second.

OBJECTIVE GRID

Lessons	1	2	3	4	5	6	7
Mathematics Objectives							
1. multiply and divide 2- and 3-digit numbers	•					•	
2. solve rate problems related to speed and frequency			•				
3. use fractions to describe parts of a graph.		•	•				
Science Objectives							
1. give the location of a sound.	•		•	•	•	•	•
2. describe source of sound as the vibration of matter, including air		•	•	•	•	•	•
3. describe and demonstrate with vibrating objects how sound travels through substances by wave motion	•	•	•	•	•	•	•
4. compare and contrast music and noise using concepts of rhythm, pitch and volume related to wave motion					•		
5. describe the human voice range as related to frequency					•		
6. identify the resonators in the human body that produce the voice					•		
7. describe radiators and resonators.				•	•	•	
Language Objectives							
1. find needed information from an appropriate source					•		•
2. follow oral and written multistep directions	•	•	•	•	•	•	•
3. predict outcome of a story	•	•	•	•	•	•	•
4. make oral and written inferences and draw conclusions from an activity	•	•	•	•	•	•	•
5. write poetry related to sound concepts						•	
6. communicate the solution to problems in oral and written form	•	•	•	•	•	•	•
7. create pattern reports.				•	•		•

LESSON 1 What Is Sound?

BIG IDEAS Sounds develop in many ways as they travel through matter. The speed of sound is 770 miles per hour in air.

Whole Group Work

Materials

Book: **An Upside-down Day** by J. Scheer
Animal whistle
Meter stick
Tuning fork
Puffed rice, puffed wheat
Cellophane or a balloon
8 1/2 x 11 piece of cardboard or heavy paper
Salt or oatmeal box with ends cut out; cover the box at one end with cellophane stretched tightly and secured in place with a rubber band.
Cassette tape: "Wonderful World of Sounds," Lakeshore or a teacher-made one
Word tags: vibrations, sound

Encountering the Idea

Ask students to predict what an "upside-down day" would be like. Write answers on a chart: the car breaks down, the alarm clock does not go off, etc. Read the simple text, pointing at pictures. At the conclusion, ask if the world will be quiet on upside-down days. What would happen if there were no sounds at all?

The lesson begins with a teacher demonstration of **Cereal Vibrations.** Place the cereal on the cellophane on top of the box. Tap the cellophane lightly to make the cereal jump. Ask the students what makes the cereal move. What is needed to make matter move? (Energy.) Where is the energy coming from to make the cereal move? What is making the sound? What is sound? We'll try to discover the answers to all these questions in our exploration activities.

Exploring the Idea

These three activities will help us examine vibrations, how sounds develop and characteristics of sounds.

At the **Science Center,** the students

1. strike a tuning fork and then put it on their hands to sense the vibrations. The students try to discover how to make the tone louder. Ask students if they think they can change the tone. The students describe the tuning fork as they felt it on their hands.
2. place a meter stick with one end extending at least 15 cm. over a table and hold it firmly on the table with one hand. Students pluck the protruding end of the meter stick to make a sound. They determine what the meter stick is doing as it makes a sound.
3. experiment with the meter stick, trying to make high and low and loud and soft sounds. They record their observations for future use.

4. complete **Activity** — Sounds Develop in Many Ways
5. complete **Activity** — Bell in a Jar
6. complete **Activity** — Sound Characteristics.

At the **Art Center,** the students draw the tuning fork as they felt it on their hands.

Getting the Idea

Ask students to tell what they think sound is. Sound develops when something is **vibrating** — when it is moving back and forth. Hold a loose rubber band between your finger and thumb and pluck it gently. Ask the students: Is it making a sound? Why not? You are right. It has to move back and forth — vibrate very fast — for us to hear the sound. Now, pull the rubber band tight and pluck. What happens?

Show the animal whistle to the students and blow it. Can you hear it? Let the students try blowing the whistle to determine whether the whistle is vibrating. Why can't we hear it? There are some vibrations that are so slow, like the loose rubber band, or so fast, like the animal whistle, that the human ear cannot hear them.

The vibration of matter causes all sounds. Sound is very important in our lives. Sound can make us happy, as with music, dancing or playing a musical instrument. However, sound can be harmful when it is too loud. Sounds can also warn us of danger, as with a fire siren. Sometimes when we are home alone, the sound of the radio or television can give us comfort.

Discuss each activity with the students, stressing that sounds develop in many ways as vibrations in matter.

Organizing the Idea

Students choose several or all of the following activities:

At the **Listening Center,** students play a tape containing various sounds. (Animals, water, city, metal.) Students identify and write as many sounds as they can. The student group that makes the longest, justifiable list gets a sticker (recognition). Play the tape again; as students listen, they write down the name of the sounds. Students can use the list in the **Poetry Center.**

At the **Poetry Center,** the students close their eyes and are very quiet for three minutes. They listen carefully to the sounds around them. Each student writes a poem or Haiku to describe "how being quiet makes me feel."

At the **Music Center,** the students listen to a tape of classical music and then to a tape of rock music. They write a paragraph or a story about how the two kinds of music make them feel.

At the **Language Center,** the students

1. make a "thesaurus" to find different words to describe sounds. In the center of a wheel, write one sound word. Students fill in each spoke of the wheel with related words.
2. make a list of "quiet words." They combine this activity with the activity in which the class makes a "thesaurus" for sound words.
3. write and illustrate what happens on their upside-down days for a class Big Book.

Applying the Idea

At the **Mathematics Center,** students working in small groups of four,

1. work on the following problem and then report to the class during **Closure.**

   Students in the third grade are going to use some music tapes at a class party. The length of the tapes are the following: three tapes are eight minutes each; four tapes are 10 1/2 minutes each; and two tapes are nine minutes each.

   The music is to play for 30 minutes during the party, and then there is to be a 10-minute intermission, followed by 20 more minutes of party and music time. How can Disk Jockey Elena and Disk Jockey Rick play the tapes so that the music ends **exactly on time** for the intermission and ends **exactly on time** at the end of the party?
2. work on the **Activity** — Speed of Sound.

Ask students to consider the question, again. How can you change the tone (pitch) of the tuning fork? (You can't change the pitch unless you change the length of the tines on the fork.)

Closure and Assessment

In their logs, students write and illustrate how sound is a form of energy causing vibrations in matter.

List of Activities for this Lesson

- ▲ Sounds Develop in Many Ways
- ▲ Bell in a Jar
- ▲ Sound Characteristics
- ▲ Speed of Sound

ACTIVITY
Sounds Develop in Many Ways

Objective

Students produce sounds in different ways.

Materials

Peg board; wide rubber band; two 3 x 5 index cards; small bottle with a mouth; Tuning fork; one-hole rubber stopper; pencil; paper soda straw; small wad of paper; thread; masking tape; one wire coat hanger per student; two pieces of string 50 cm. long

Procedures

1. Stretch a wide rubber band between two support nails on the edge of a peg board. Stretch the rubber band as far as possible without breaking it. Pull only the top strand of the rubber band with your finger and then release it. Describe and record what you observe.
2. Hold the edges of two slightly curved index cards between your fingers. Place the two index cards between your lips. Blow hard enough to produce a sound.
3. Describe what happens to the prongs of the tuning fork after you strike it. Explain what is making the sound.
4. Attach the ball of paper to the thread with a piece of masking tape. Strike the tuning fork with the rubber hammer and let the fork touch the suspended ball. Predict and then describe what happens.
5. Pinch one end of a paper soda straw until it is almost flat. Close your lips gently around the end of the straw and blow air through it. What do you think is producing the sound in this case?
6. Tie the strings to the wide ends of the coat hanger.
7. Hold the ends of the strings stretched tight and hit the hanger against a solid object. Listen to the sound it makes.
8. Wrap the ends of the string twice around each of your index fingers. Put your fingers in your ears and get a partner to tap the hanger on the solid object again.
9. What happened? What can you say about this?

Getting the Idea

Tell students that sound is produced when an object vibrates. Ask the students to
1. identify the object that vibrated in each part of the activity above, and
2. identify what made the object begin to vibrate.

ACTIVITY
Bell in a Jar

Note
Teacher demonstration to ensure that students do not touch the hot water or its container.

Objective
Students say that air is necessary for sound waves to travel.

Materials
Four-to-eight ounce glass jar with tight-fitting lid; piece of string; hot (not boiling) water; small bell; tape

Procedures
1. Suspend the bell to the inside of the jar lid with the string and tape. The bell should not touch the sides or bottom of the jar.
2. Put the lid on the jar and close it tightly.
3. Gently shake the jar and listen to the bell.
4. Remove the lid with the bell attached and carefully pour about two to three cm. (one in.) of hot water into the jar.
5. Allow the jar to stand for about 30 seconds and then replace the lid tightly. Be sure the bell does not touch the water or the sides.
6. Gently shake the jar again and listen to the bell.
7. The students describe what they heard the first time and compare it to the second time.
8. What made the sound change?

Getting the Idea

Before hot water is poured into the jar, the students will hear the bell clearly. Hot water in the jar will cause the air to expand and force some of the molecules out. With fewer air molecules in the bottle, sound vibrations will not travel as easily, so the bell will not sound as loud. If there were no air on earth, could we hear sounds by talking to each other? What could we do to communicate if there were no air for sound waves to travel on?

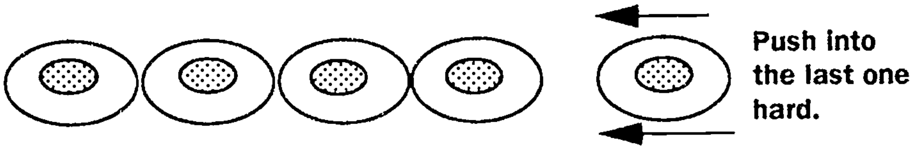
Discuss the problem of communications on the moon or any other place that has no air.

ACTIVITY
Sound Characteristics

Objective
The student demonstrates that energy, such as sound energy, can travel through matter.

Materials
Six metal washers; tuning fork; wooden block; one-hole rubber stopper; pencil; metric ruler; wide rubber band

Procedures
1. Arrange five metal washers in a straight line so that each is touching the other. Place four fingers of your left hand firmly on four of the washers. Place another washer about six cm from the end of the line of washers. With the forefinger of your right hand, flip the washer sharply against the row of washers.
2. Predict what will happen.



3. Describe what you feel.
4. Now place only three of your fingers on the first three washers. Do not touch the last one on the left. Make sure that the last washer is touching the other washer.
5. Again, with the forefinger of your right hand flip the washer sharply against the row of washers. What happened?
6. Place one end of a block of wood against your ear. Strike a tuning fork with a rubber hammer. Touch the other end of the block with the handle of the tuning fork.
7. Predict what will happen.

Discussion
1. What happened when you pushed the washer into the others?
2. Can energy travel through matter? How do you know?

ACTIVITY
Speed of Sound

Objective

The students solve problems using division as repeated subtraction. Students works in groups of three and four to solve this problem.

Problem

Sound travels about 1200 **kilometers per hour** in air. How far does sound travel per minute?

Before students begin to work in their groups ask them if

1. they understand what their task is: tell me in your own words what you are to find.
2. they have all the information they may need to solve the problem.

Give students an opportunity to work on this problem. These are two examples of student work in solving this problem.

Student Group 1 gave this solution: There are 60 minutes in every hour, so we have to divide up the 1200 kilometers into 60 minutes. We made a chart to show that we put 100 kilometers into each 10 minutes because we want to show 60 minutes divided into 10 minute periods. We subtracted 600 first and then 600 again, because 100 x 6 = 600. Then we had 600 more to go.

10 min	10 min	10 min	10 min	10 min	10 min		
100K 100K 200K	100K 100K	100K 100K	100K 100K	100K 100K	100K 100K	600K 600K	1200K in 60 min.

Sound travels at 1200 kilometers per hour, which is the same as 200 kilometers in 10 minutes. If we put 200 kilometers into groups of 10, then each minute gets 20 kilometers. Then: Sound travels at 20 kilometers per minute.

Sound travels about _________ **kilometers per minute.**

Student Group 2 gave this solution: We used colored chips to show the speed of sound. We used 120 red chips because each chip is worth 10 because we couldn't get 1200 chips. Then we put the chips into stacks of 10 each. That gave us 12 chips in each stack. But we didn't understand that so then we put the chips into stacks of 12 and that gave us 10 stacks. Finally we put the 120 chips into six stacks because there are 60 minutes in one hour. Each stack has 20 chips. We got the same answer, but we only used six stacks for the 60 minutes. We think using the chart is easier to understand, even though we got the same answer.

Problem

If sound travels 770 miles per hour in air, how far does it travel in one minute?

Give students an opportunity to solve this problem in groups.

One solution:

10 min	10 min	10 min	10 min	10 min	10 min		
100K	100K	100K	100K	100K	100K	600K	770 miles in 1 hour
10K	10K	10K	10K	10K	10K	60K	
10K	10K	10K	10K	10K	10K	60K	774 miles
9K	9K	9K	9K	9K	9K	54K	in 1 hour
129K							

We started with 100K because 100 is an easy number. 100K × 6 = 600K.

Sound travels at 770 miles per hour, which is the same as 129 miles in 10 minutes. If we put 129 miles into groups of 10, then each minute gets almost 13 miles. Then: Sound travels at about 13 miles per minute.

Assessment

1. If a jet goes at the speed of sound in air, what is the jet's speed in miles per hour?
2. If the jet is going at 26 miles per minute, what is the jet's speed in miles per hour?
3. Is the jet traveling faster than the speed of sound? Compare the two speeds.

LESSON 2 Sound Travels in Waves

BIG IDEAS A medium such as air, water or metal is necessary for sound waves to travel. A graph shows the characteristics of a sound wave.

Whole Group Work

Materials

"Slinky" for each student group; a tuning fork for each student group

Large pan 1/2 filled with water; another pan with bottom covered with two inches of sand

Encountering the Idea

How do we know that sound travels? Students suggest reasons. Yes, because I can call you from one end of the hall, and you can hear me at the other end. I can also call you on the telephone, and I can be very far away, and you can still hear me. How does sound travel through a telephone?

Sound does not always travel. Who has heard of a "soundproof" room? What does that mean? Students give descriptions. For example, if you want to practice a musical instrument in the band room, you practice in a soundproof room so that you won't hear outside noises, and students and teachers outside the room won't be disturbed by your practicing.

Before going to the learning centers, let's try a few things and see what you think about them. Here is a large pan that has water in it. A students strikes the tuning fork and puts it in the water in the center of the pan. The students describe what happens. (Making waves; as the waves hit the sides of the pan, they return and hit the others; the waves go out in circles.) Now, strike the tuning fork harder and place it in the water again. What happened to the waves? (They moved faster and they got bigger; they hit the sides harder.) Are the waves traveling in only one direction? No, they are going out in circles. Follow the same procedures when striking the tuning fork and placing it into the sand.

Let's try something different now. We are going to go to the playground. Let's see what you think is happening when we perform these experiments outside. The students go into a large gymnasium, to the cafeteria or into the playground. They yell or hit an instrument (triangle). Go back into the classroom, designate one person to yell. Ask the children to explain the difference between the sounds. After the students have had an opportunity to express their opinions, tell them that they will discover how sound travels.

Exploring the Idea

At the **Science Center,** the students

1. work with a "Slinky" to discover how a "wave" moves. Tell the students that the slinky is showing a wave motion. Working in pairs, the students draw a

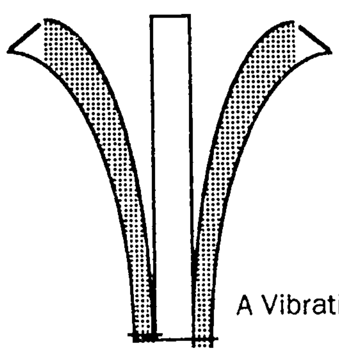
picture of how they think a wave moves and explain it to the class; then the students investigate how sound waves travel by completing **Activity** — Sound Travels in a Medium.

- make a telephone using styrofoam cups, tin cans, plastics with thread, string, yarn, to see that sound waves travel through styrofoam and thread by completing **Activity** — Phone Call

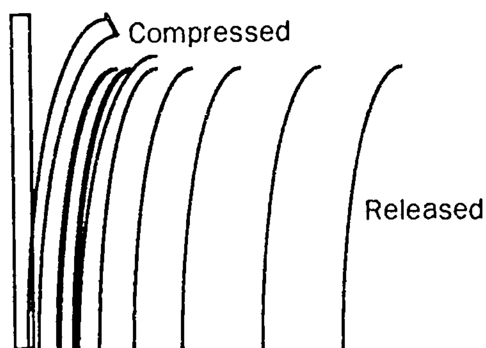
2. experiment with bottles and other objects to understand that sound waves can be reflected or absorbed, depending on the materials with which they come into contact, by
   - completing **Activity** — Musical Bottles
   - completing **Activity** — Reflected or Absorbed?
   - completing **Activity** — Phone Call.

Getting the Idea

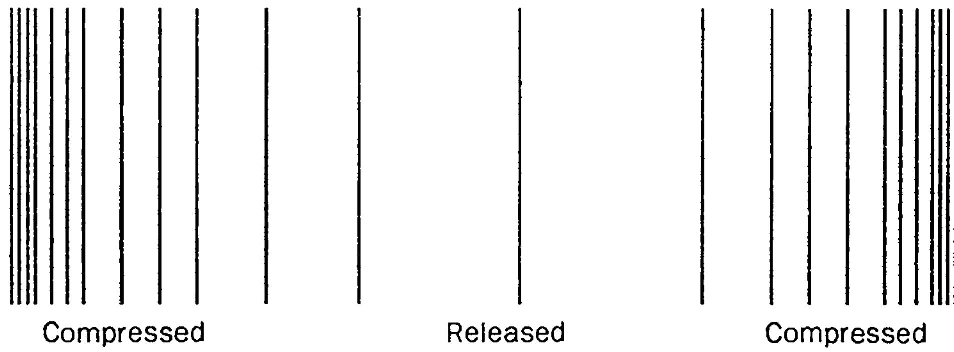
Ask students how they think sound travels. What was alike about the motion of the water and sand waves made by the tuning fork and the motion of the slinky? When we struck the vibrating tuning fork, it made waves in the water, or in the sand, and the waves traveled to the sides of the pan. When the waves hit the sides, they bounced off and hit the new waves coming in. If we had waited a few minutes, we would have seen that the water eventually stopped moving and became calm — there were no more waves. The tuning fork also made waves in the air — that is why we could hear the hum of the tuning fork. Sound needs a medium, such as air, in order to travel. You were able to see the wave motion on the slinky because the slinky was the medium for the wave.



A Vibrating Meter Stick



The vibrations push together and then push back, beginning a back and forth motion.



Is this how a slinky moves? Demonstrate it.

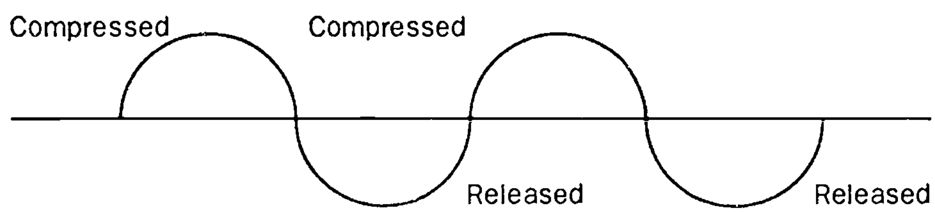
Introduce the words **reflected** and **absorbed.** Ask students to strike a tuning fork and then feel it with their hands. Can they feel the vibrations? Ask students to place a hand on top of a radio as it plays. What can they feel? What is vibrating? What is causing the sound?

Ask students to explain what an echo is, if sound travels in waves? An echo is reflected sound. It strikes matter that is hard and smooth and reflects the sound — bounces it back.

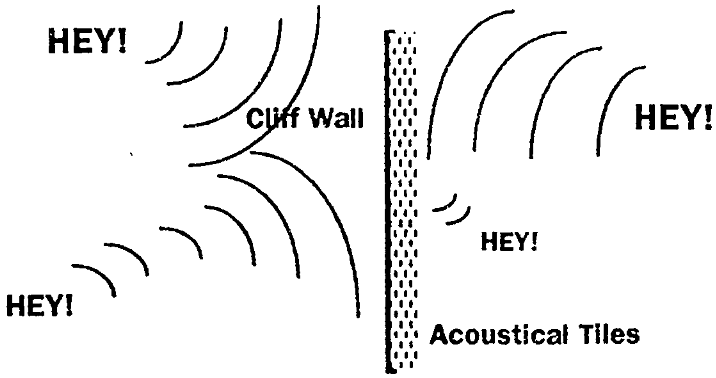
What happens in a carpeted room? What happens in a soundproof room? The walls or floors have materials that are not hard and smooth — they are soft and rough — like carpet, velvet or wool. These materials absorb the sound waves.

Organizing the Idea

1. At the **Mathematics Center,** students draw wave motion as a graph that shows matter being compressed and then being released. The top of the graph, the part above the line, shows that the air, or the medium, is being compressed. The bottom part of the graph, the part below the line, shows that the air, or the medium, is being released. The pattern — compressed, released, compressed, released — we feel as a sensation we call sound.



2. Discuss echos that students have heard (mountains, empty rooms, caves). Students can write a story about an echo, or about a sound that should have been heard but was not because it was absorbed, or a story about a sound wave and its travels.
3. Students can draw an echo (as is shown in cartoons) as a reflection of the waves.



Applying the Idea

Problem Solving
You are an architect and want to build an auditorium for a musical performance. What type of materials are you going to use to build it? Explain your answer.

You are an architect and want to build a new wing in the hospital. What type of materials are you going to use to build it? Explain your answer.

Closure and Assessment

1. Draw a picture to show how sound travels through a medium (air, liquid or solid).
2. Explain or draw a picture to show how an echo develops.
3. Show how sound is reflected or absorbed.
4. Complete a pattern report. The first line begins with:

The important thing about __(topic)__ is __(student's opinion)__. Three to five statements expand on the topic. The final sentence repeats the first: The important thing about _______ is _____________.

Example: The important thing about sound is that I use it to communicate with my friends. It travels in waves. It can be reflected. It can be absorbed. But the important thing about sound is that I use it to talk.

List of Activities for this Lesson

▲ Sound Travels in a Medium

▲ Musical Bottles

▲ Reflected or Absorbed?

▲ Phone Call

▲ Speed of Sound and Light (Alternative Activity)

ACTIVITY
Sound Travels Through a Medium

Objective

The student demonstrates that sound travels through a medium.

Materials

Windup clock; meter stick; balloon

Procedures

Students work in small groups.

1. Place the clock on your desk. Stand 20 cm away and listen for the ticking.
2. Have your partner hold the clock at the 20-cm mark on the meter stick. Place your ear at the end of the meter stick and listen.
3. Fill a balloon with water and seal it.
4. Have your partner hold the clock against one side of the balloon. Listen to the clock at the opposite side of the balloon.

Answer the following questions:

1. Through what kinds of matter did you hear the clock? (Solid (meter stick), liquid (balloon), gas (air)).
2. Through which type of matter did sound travel best?

Applying the Idea

1. Explain why you may never be in a place where there are no sounds.
2. Suppose you are trying to study for a test and don't want sounds to disturb you. Name at least three ways to reduce the sound level in your room so that you can study.

ACTIVITY
Musical Bottles

Objective
Students say that vibrating air makes a sound when we blow across the mouth of a bottle.

Materials
Bottles of various sizes and shapes; water; worksheets; pencils

Procedures
1. Fill 1/4 of a bottle with water; mark the water level.
2. Blow across the top of the bottle until you make a sound. Call this sound the "first" or "reference" sound.
3. Create other sounds by blowing into bottles filled with different amounts of water. Record the water level of each bottle and the sound it makes in relation to the first (reference) sound.
4. Put the bottles in order from highest to lowest pitch.
5. Take the long, narrow bottle and fill it 1/4 full of water. First, predict if you will get a higher or lower pitch and record your prediction. Blow across the top of the bottle and compare to the reference bottle. Record your observation.
6. Take a small bottle and put all the water from the first bottle (the reference bottle) into the smaller bottle. First, predict whether the pitch will be higher or lower and record your prediction. Blow across the top of the bottle and compare to the reference bottle. Record your observation.

Getting the Idea

1. What was vibrating to cause the sound — the bottles, the air in the bottles, or the water? Explain your answer.
2. Which bottle had the highest-pitched sound? The lowest?
3. What happened when you took the first bottle and poured the water into a smaller bottle? When you blew on it, did it make the same sound or a different sound? Was your prediction correct? Explain your answer.
4. What happened when you poured the water into a longer, narrow bottle filled to the same level as the reference bottle? When you blew on it did it make the same sound or a different sound? Was your prediction correct? Explain your answer.

ACTIVITY
Reflected or Absorbed?

Objective

The student names at least two types of materials that will reflect sound and two types that will absorb sound.

Materials

Windup clock; cloth; shoe box; cotton; pieces of wood; carpet scraps; aluminum foil; floor tile

Procedures

1. Make a hole in one end of the shoe box with a pencil.
2. Put the windup clock in the box. Place your ear next to the hole and listen for the ticking sound.
3. Cover the inside of the shoe box with each of the materials listed above. Listen for the ticking sound each time.

Answer the following questions based on your observations.

1. What material was in the box when the clock was loudest?
2. What material was in the box when it was hardest to hear the clock?

Applying the Idea

1. Which materials would you use inside an auditorium if you wanted to invite a music group to play there? Explain your ideas. (Do you want the sound reflected or absorbed?)
2. Which materials would you use on the inside of a hospital room? Why?

ACTIVITY
Phone Call

Objective

Students describe how sound travels through a solid.

Materials

String, at least 200 cm. (two yards) long; nail (to make hole); paper cups; scissors; paper clips (or washers)

Procedures

1. Make a small hole in the bottom of two paper cups.
2. Thread the string through the holes; tie each end to a washer so the string won't slip through.
3. Have a friend hold one cup; you hold the other. Gently pull the string until it's tight. Take turns talking into the cup and listening. Be sure that you keep the string taut. Why do you think these phones work?
4. Work with another pair of students and use two phone sets. Cross the lines by looping one over the other. Describe to your partner what you think is happening and why. Then, report to the class.
5. How is the sound traveling?

Applying the Idea

1. Which do you think would make better "telephone wire," thicker string or thinner string? Why?
2. Why doesn't your telephone work when you let the string hang loosely?
3. What are some other things you could use for a receiver instead of a paper cup?

ALTERNATE ACTIVITY
Speed of Sound and Light

Objective

Students describe how we can tell that light travels faster than sound.

Materials

Drum, cymbals, large metal lid or something else that will make a loud sound when visibly struck; stick to strike object

Procedures

1. Take your drum or other object out on the school grounds. Ask another member of the class to go with you.
2. Move at least 100 meters (approximately 105 yards) away from the other students.
3. Strike the object several times so your partner can see the movement of your arm and hear the sound.
4. Remember, when you see an object move at a distance you are seeing reflected light travel. When you hear the sound you are hearing sound vibrations.
5. Have the students tell you what they observed. What can you say about the speed of light and the speed of sound?
6. Discuss these questions:
   a. Would altitude affect the speed of sound?
   b. Would sound travel more easily during the day or night?
   c. Would sound travel better on a cold or a hot day?

Getting the Idea

Light travels very rapidly, at over 186,000 miles a second. By comparison, sound is a slowpoke, moving at about 770 miles per hour at sea level. (The temperature and density of the air affect the speed of sound. The speed range at sea level is about 740 to 780 as the temperature ranges from freezing to 75 degrees Fahrenheit.) Even at the short distance of 100 meters, a student will be able to see another student strike the drum before he/she hears the sound. Children who have been to athletic events in a large stadium may have noticed that they see sounds made in the playing field by athletes or bands before they hear them. Airplanes, especially fast jets, are sometimes difficult to locate in the sky by their sound because the sound is traveling so much more slowly that by the time it arrives, the plane has moved to a new position.

Children should be able to answer the questions in Step 6 if they remember that sound travels better in air when there are more molecules. Higher altitudes have **thinner air,** fewer molecules per cubic centimeter. Cold air contains more molecules and is **more dense.** Therefore, sound travels better at night or on a cold day.

LESSON 3 High/Low and Loud/Soft Vibrations

BIG IDEAS We hear sound as changes in the frequency and height of sound waves. We hear the frequency of sound waves as pitch, and we hear the height of sound waves as volume, or amplitude.

Whole Group Work

Materials

Book: **If I Were a Bird** by G. Conkin
The shoe box as described in **Activity** — Rubber Band Band
Small drum; triangle from the rhythm band
Word tags: pitch, tone, volume (sound), compress

Encountering the Idea

The teacher demonstrates change in pitch by stretching and releasing the rubber bands in the shoe box from the Alternative Activity in **Activity** — Rubber Band Band, and asks the students what changes they hear in the tones of the shoe box guitar. (Yes, the tone goes higher or lower depending on how much we stretch the rubber band.) Now, pluck the rubber bands harder. Ask the students what they hear. Now, demonstrating with the small drum, strike the drum and ask the students what you need to do to make it sound louder. (Yes, hit it harder.)

What can you do to make the drum sound higher in tone, or pitch, or sound lower? Let the students give suggestions. Is it always possible to change the tone of something that is vibrating? Follow the same procedure with a rhythm band triangle. Ask the same questions.

Tell students that they will discover what changes the pitch or tone of a sound, and also what will make it loud or soft.

Exploring the Idea

At the **Sound Center**, the students

1. complete **Activity** — Rubber Band Band
2. complete **Activity** — Musical String Instruments
3. complete **Activity** — Wave Frequency
4. complete all or several of the following:
   Activity — Pitch It High
   Activity — Who Likes It Loud?
   Activity — Musical Straws.

Getting the Idea

Reading Conklin's **If I Were a Bird.** Show students the musical charts pointing out high and low sounds. Musical charts are like graphs. They show pitch or frequency. We can change pitch by changing the frequency. But change in volume does not change pitch.

Tell the students that they have been exploring ways to change the tone, or the pitch of a sound. The pitch tells you how high or how low a tone is. We change the loudness by plucking or striking a note harder. The sound waves change with the pitch — the vibrations are faster for high sounds, and slower for low sounds. The sound waves also change when we make an object vibrate with taller sound waves. We learned how to tell these changes one from the other in the **Mathematics Center.**

1. In sequencing the rubber bands in the shoe box experiment, did you notice a pattern on the rubber bands. What was it? Can you make a rule that connects the size of the rubber bands to the sound they make?
2. In teaching your partner the tune you learned to play on your shoe box guitar, did you use the colored rubber bands to help you? What do the different colors help you see on your guitar? (The colors show that the pitch is different from one rubber band to the other.) How?
3. What did you do to make a louder or softer sound on your guitar? Why?

Organizing the Idea

At the **Mathematics Center,** the students continue showing sound waves with graphs.

Applying the Idea

1. Use your mouth and throat to make high- and low-pitched sounds like you did with the musical bottles. What do you have to do to your mouth and throat to make a low-pitched sound? A high-pitched sound?
2. Use your mouth and throat to make loud and soft sounds like you did with the musical bottles. What do you have to do to make a loud sound? A soft sound?

Closure and Assessment

Oral Assessment

The student briefly explains how fast or slow vibrations change the tone in sound waves, and how the size of the sound waves makes the sound loud or soft.

Performance Assessment

1. The student demonstrates how to change the pitch on a musical instrument, a bottle or a shoe box guitar.
2. The student demonstrates how to change the volume on a musical instrument, a bottle or a shoe box guitar.
3. Given several foot rulers and tongue depressors, the student places them one at a time over the edge of a table and plucks each with one hand while holding it firmly on the table with the other hand. The student makes sounds of different pitch and orders the rulers and tongue depressors from low to high tones.

Written Assessment

1. Given a graph, the student draws another graph showing that the pitch of the tone has changed to a higher or lower tone.

2. Given a graph, the student draws another graph showing that the volume of a sound has changed to louder or softer.
3. Select the frequency that is the same as six waves per second by circling it: 12 waves per two seconds, six waves per six seconds, or three waves per two seconds. Draw the frequency's graph.

List of Activities for this Lesson

- ▲ Rubber Band Band
- ▲ Musical String Instruments
- ▲ Wave Frequency
- ▲ Pitch It High
- ▲ Who Likes It Loud?
- ▲ Musical Straws

ACTIVITY
Rubber Band Band

Objective

The student demonstrates how to make high- or low-pitched sounds using rubber bands.

Materials

Several peg boards and pegs; shoe box with lid; different lengths and **only** two thicknesses of rubber bands, each one labeled for identification

Procedures

1. Taking one rubber band at a time, stretch it (not too far), record the distance between two pegs on the peg board and whether the rubber band is thick or thin, and record the sound it makes — whether high-pitched or low.
2. Using the same rubber band, stretch it **tightly** between two pegs and again, record your observations.
3. Do the same thing with several of the other rubber bands.
4. After summarizing your data on your chart, make a rule about how to make a high-pitched or a low-pitched sound. Explain your rule to the class.

Rubber Band	Wide/Narrow	Amount of stretch (distance between pegs)	High/Low Pitch
A	wide	5 cm	low
B	narrow	4½ cm	higher

Alternate Activity

1. Stretch four or five rubber bands of different thicknesses and lengths around a shoe box without its lid. Pluck the rubber bands and describe what you see and hear.
2. Put the lid on the box and repeat the activity.
3. Sequence the rubber bands from the lowest sounding to the highest sounding. Using colored markers, mark the rubber bands, or use colored rubber bands.
4. Play a tune; teach it to your partner.

ACTIVITY

Musical String Instruments

Objective

Students listen to and describe sounds according to their pitch and loudness (volume, intensity); students adjust the sound source to create a different pitch.

Materials

Plastic cups; worksheets; boxes (without lids); pencils; rubber bands (various lengths and thicknesses)

Procedures

1. Put a rubber band around a box or cup. Pluck the rubber band. What do you hear?
2. Try this with different rubber bands. Which ones make the highest or lowest sound? Put the rubber bands in order from highest to lowest sound. Sound is made by vibration. Fast vibration makes a high sound; slow vibration makes a low sound.
3. Try to transfer the vibration of the rubber band to a piece of paper. What happened? Why? How did you do it?
4. Try to change the pitch of the rubber band. How did you do it? Listen to music made by different string instruments.

Getting the Idea

1. Which rubber bands vibrate faster? Slower? How can you tell?
2. Can you think of some ways to change the sound your instrument makes? (Use other objects to stretch the rubber bands. Instead of a cardboard box, try wood. Instead of a glass cup, try styrofoam.)

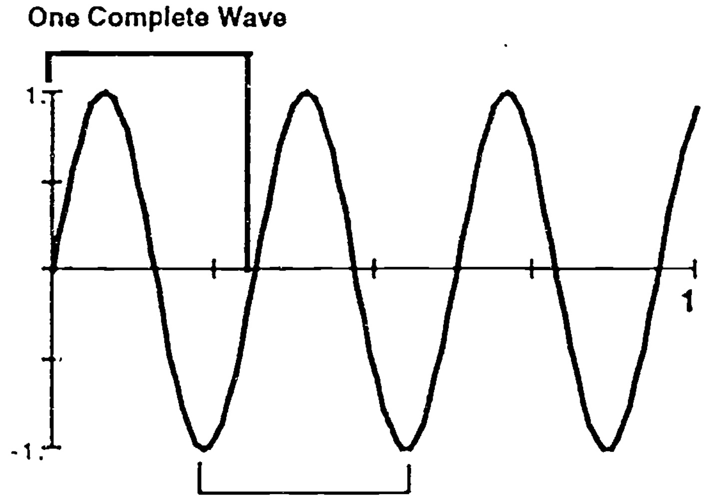
ACTIVITY
Wave Frequency

Objective
The student says that if a wave has a frequency of 10 cycles (waves) per second, the wave completes 10 vibrations every second.

Materials
Pictures of sound waves and blank graphs

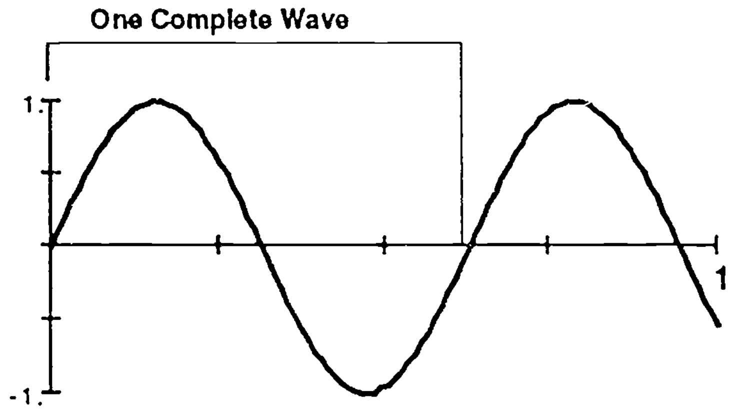
Procedures
Students describe the waves by counting the number of complete waves between 0 and one second. Give the frequency of the wave as the number of waves per second. We cannot always express wave frequency in whole numbers. Estimate fractions of a wave such as 1/2, 1/4, 3/4 of a wave, or if it is difficult to estimate using fractions, then "about" three or "almost" seven can serve as an estimate.

Frequency of Sound Waves



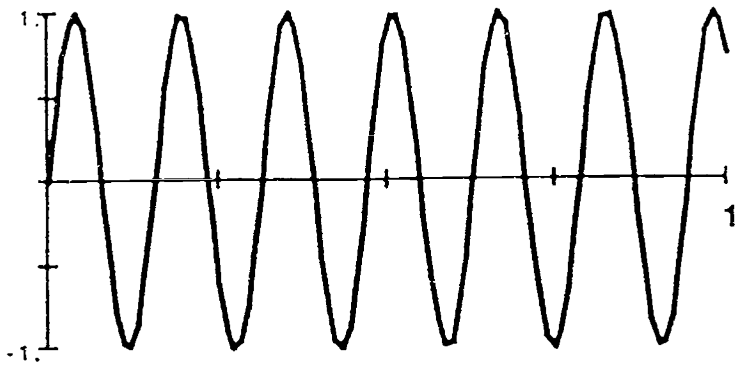
Three and ¼ complete waves in 1 second

Frequency of Sound Waves

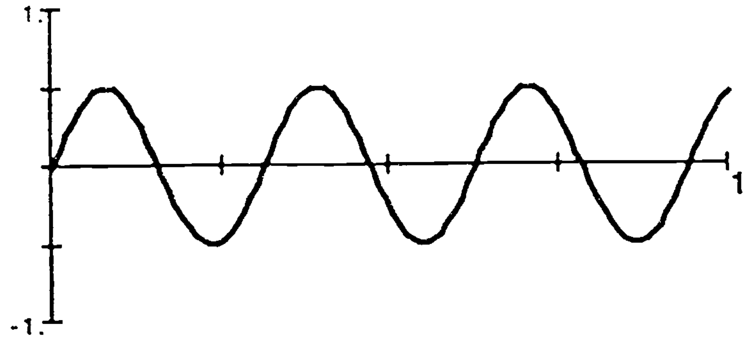


About 1½ waves per second

Frequency of Sound Waves

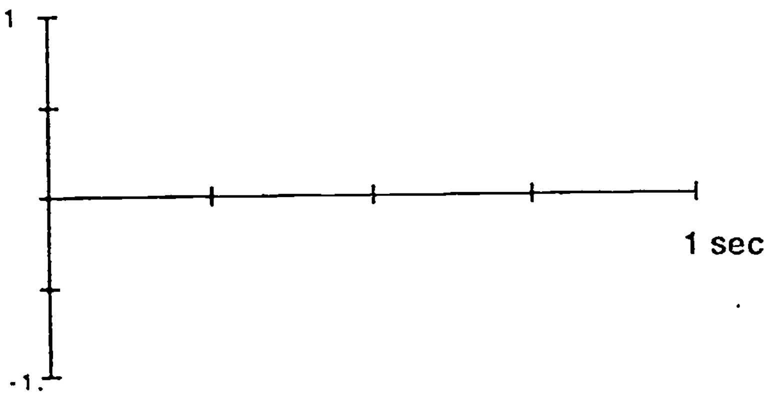


Frequency of Sound Waves

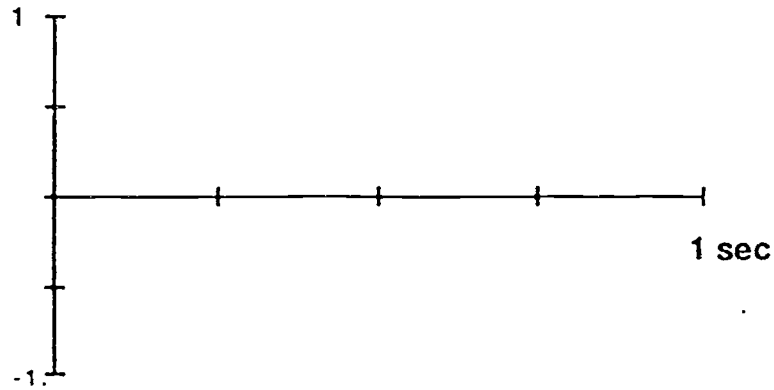


On the blank graphs, draw your own sound waves and tell the frequency of each.

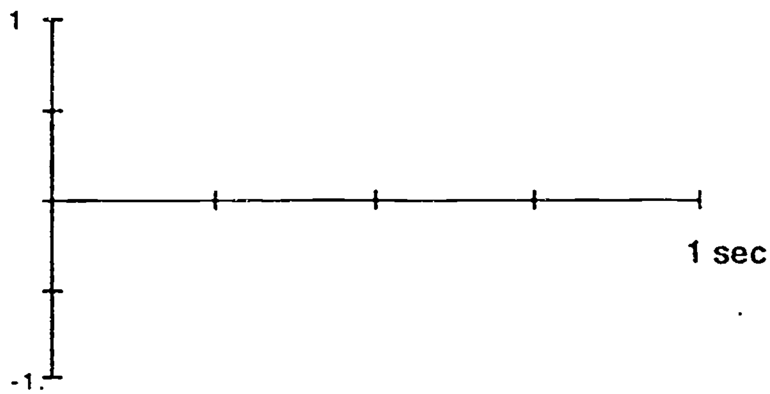
Frequency of Sound Waves



Frequency of Sound Waves

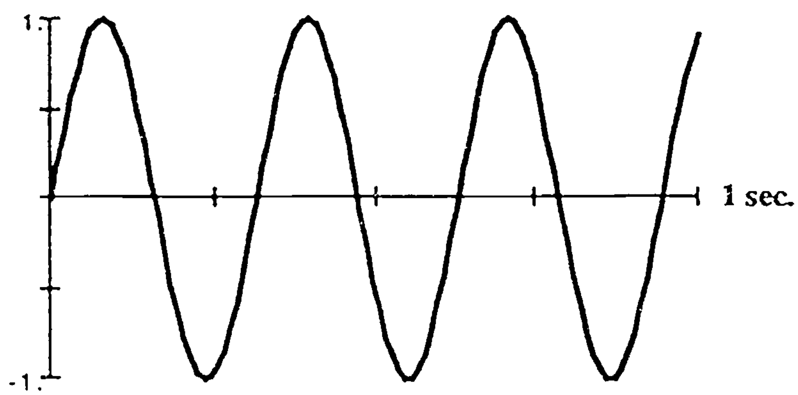


Frequency of Sound Waves

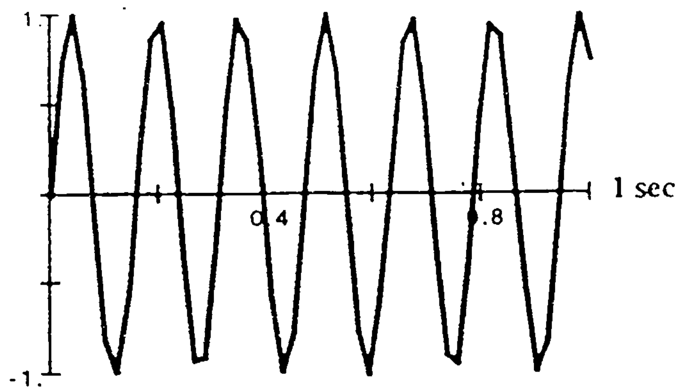


The following are some examples the students might draw freehand.

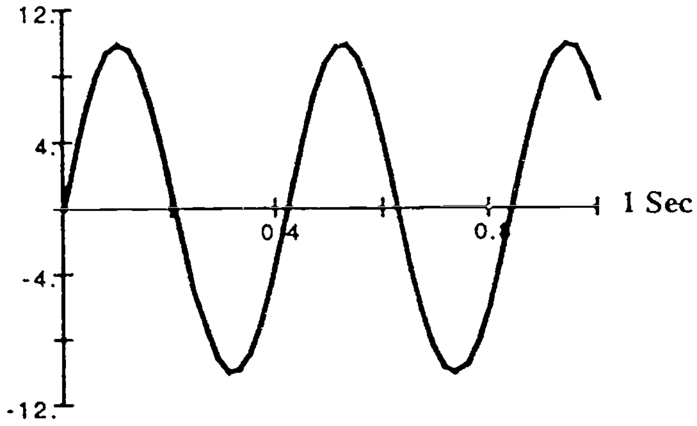
Frequency of Sound Waves



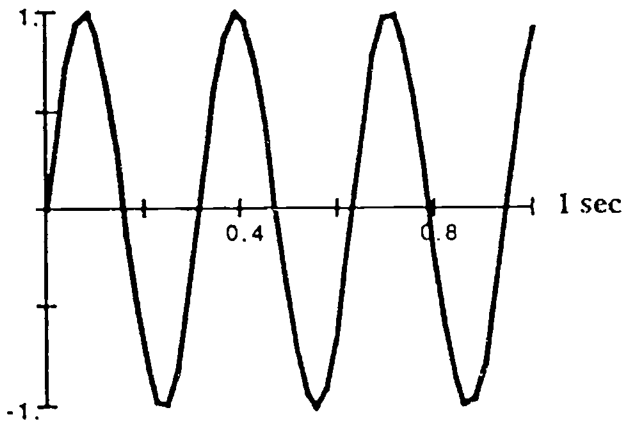
About 3¼ waves per second; amplitude of 1



6 waves per second; amplitude of 1



About 2⅓ waves per second; amplitude of about 10



About 3⅓ waves per second; amplitude of 1

ACTIVITY
Pitch It High

Objective

Students experiment with high and low pitches and say that the sound waves that each note makes are different in frequency.

High or Low?

Materials

a xylophone, autoharp (or piano, if available) or two tuning forks

Procedures

1. Students imitate animals that make high or low sounds, for example: cats, mice, birds, mosquitoes, or elephants, lions, bullfrogs.
2. Play two musical notes on the xylophone, autoharp or tuning forks. Students tell which note was higher and which was lower. Repeat this a few times.
3. Students examine the instruments and hypothesize what makes one sound higher than the other.
4. Students say that the bars on the xylophone or the strings on the autoharp that make higher sounds are shorter; the lower-sounding bars or strings are longer.

Tuning Up

Materials

Eight glasses or jars (all the same size); food coloring; metal spoon; grease pencil; water

Procedures

1. Students make a musical scale by experimenting with the amount of water each jar needs.
2. Students arrange the glasses by sound, from lowest to highest pitch. Number the glasses "1", "2" and "3" with the grease pencil.
3. Students can play several simple songs on the three jars such as "Mary Had a Little Lamb" by striking the glasses as follows.

- Students add jars to make an eight-note scale. Number the jars 4 through 7.
- Students experiment with the amount of water needed in each jar to get an eight-note scale.
- Ask students if they can detect a relation between jar 1 and jar 8.
- Students experiment with other tunes.

ACTIVITY
Who Likes It Loud?

Objective

Student say that volume (and/or amplitude) means that sounds are loud or soft, and that the sound waves are large or small in size.

Sing a Silly Song

Procedures

1. To practice loud and soft sounds, the class sings "John Jacob Jingleheimer Schmidt" (Juan Paco Pedro de la Mar) or another nonsense song. Students start off singing or chanting as loudly as they can.

John Jacob Jingleheimer Schmidt,
That's my name too.
Whenever we go out, the people always shout,
"There goes John Jacob Jingleheimer Schmidt!"
Da da da da da da da da!

Juan Paco Pedro de la Mar
Es mi nombre, sí.
Y cuando yo me voy,
Me dicen lo que soy Juan Paco Pedro de la Mar
Ta ra ra ra ra ....

2. Repeat the song several times, each time getting softer and softer, but yelling out the last two lines. The last time around, have children sing silently — only moving their lips — and then yell out the last two lines.

Rocking Rhythm Band

Materials

Shoe boxes; pencils; rubber bands of different widths; paper cups; balloons; rice or beans; scissors; strong tape; jars or plastic cups; wax paper; paper-towel tubes

Procedures

1. Tell children they are going to create a rhythm band with instruments they make themselves. Individual students choose the instruments they want to make: guitar, drum, maracas or "hum-a-zoo".
2. To make a guitar, have children stretch four or five rubber bands of different widths across a shoe box. When they pluck the strings, each band will have a different pitch.
3. To make a drum, cut the open end of a balloon off and stretch the rest of the balloon over the top of a jar or cup. Students can use the eraser ends of pencils as drumsticks.
4. Students make "maracas" by putting a handful of rice or beans into a paper cup, then inverting and taping another paper cup to the opening. Play the maracas by shaking them.
5. Students make a "hum-a-zoo" by stretching a piece of wax paper over one end of a paper-towel tube and fastening it with a rubber band. Children play the hum-a-zoo by humming into the open end.
6. The students play their instruments in rhythm to a tune they all know while one student acts as the conductor. Using a pencil or ruler as a baton, the conductor raises his/her hands to signal "louder" or lowers his/her hands to signal "softer". Students take turns choosing a new tune and being the conductor.

ACTIVITY
Musical Straws

Objective
Students associate length of radiators with pitch.

Materials
Paper drinking straws; garden hose one m. long; scissors; mouthpiece from a bugle, a trumpet or a trombone

Procedures
1. Cut one end of a paper drinking straw as shown in the illustration. Moisten the cut end and put it between your lips. Blow gently around the straw. Cut pieces from the end of the straw while playing it. What happened? What can you say about this?

2. Place a mouthpiece in a garden hose. Blow into the mouthpiece to see if you can make a sound. Change the shape of the hose. What happens to the pitch of the sound?

Getting the Idea

With practice, the students will be able to make the cut end of the straw vibrate to produce sound. This "instrument" is similar to a clarinet or oboe. Paper straws work better than plastic because the plastic does not compress as easily to form a reed.

When the group uses the garden hose, a child who plays the trumpet, trombone or bugle may be able to demonstrate and help others learn to play. Changing the shape of the hose will not vary the pitch; however, cutting a length off either the straw or the hose will shorten the vibrating column of air and raise the pitch.

LESSON 4

Radiators and Resonance

BIG IDEAS Radiators are vibrating objects that send out sound energy. Resonators vibrate at the same frequency as the radiators, but with different loudness.

Whole Group Work

Materials

Tuning forks of varying pitch; pieces of wood of varying size and thickness; book, sponge, metal pan, brick, tile and other objects to test as resonators

Word tags: radiator, resonance, amplify, amplitude, sounding board

Encountering the Idea

Strike a tuning fork and hold it in your hand to note its loudness. Touch the base of the tuning fork against a desktop. What happens to the sound? (It gets louder; it gets amplified.) What properties do the objects that made the sound louder have? Ask student if they know what amplifiers are. Have they seen their favorite groups on TV use amplifiers? Tell the students that in the **Science Center** they will experiment with amplifiers of different kinds. They need to think about questions such as: What are the best materials to amplify sound? Does amplifying a sound change its pitch? What does an amplifier do to the sound waves of the vibrating object? Can an amplifier make a sound softer (less loud)?

Exploring the Idea

At the **Science Center**, the students

1. complete **Activity** — Amplifiers
2. complete **Activity** — Musical Resonators
3. complete **Activity** — High/Low and Loud/Soft.

At the **Mathematics Center**, the students complete **Activity** — Music Multiplication.

Getting the Idea

Objects that vibrate and send out sound waves we call **radiators.** Can you think of something else that we call a radiator? Yes, a heater. What does it radiate? Heat, yes. But as you discovered in your experiments, these radiators affect other objects and make them vibrate at the same pitch as their own. The objects that are set to vibrating by the radiators we call **resonators.** You saw that all the musical instruments we investigated had one part that was a radiator (the strings, the drum heads and so on) and other parts that were the resonators. We also call these resonators "sounding boards." We say that these "sounding boards" **amplify** the sound — they make it louder. Have you heard the word "amplifier" before? How? With rock bands and other types of bands. Any time you want to get a louder sound you can use an amplifier — one that is made of wood or metal, or one that is electric. You can also use an amplifier to make a sound softer; an amplifier changes the volume by making it either higher or lower.

Organizing the Idea

Working in small groups of three to four, students summarize the results of their investigations with the musical resonators. They can do the summary on a chart that lists the instruments, the radiators (strings, drum heads, etc.) and the resonators (the sounding boards, the kettles on the kettle drums, etc., and the materials the resonators are made of — very thin wood, metal, etc.).

Applying the Idea

Students play some of their cassette or video tapes of different kinds of bands and orchestras and see and listen to the instruments to determine how musicians amplify or decrease the sound.

Closure and Assessment

Students write two paragraphs (one for resonators and one for radiators) using the "important thing" pattern for radiators and resonators, e.g. The important thing about radiators (resonators) is _______________. See **Closure** at the end of **Lesson 2.**

List of Activities for this Lesson

- ▲ Amplifiers
- ▲ Musical Resonators
- ▲ High/Low and Loud/Soft
- ▲ Music Multiplication

ACTIVITY
Amplifiers

Objective

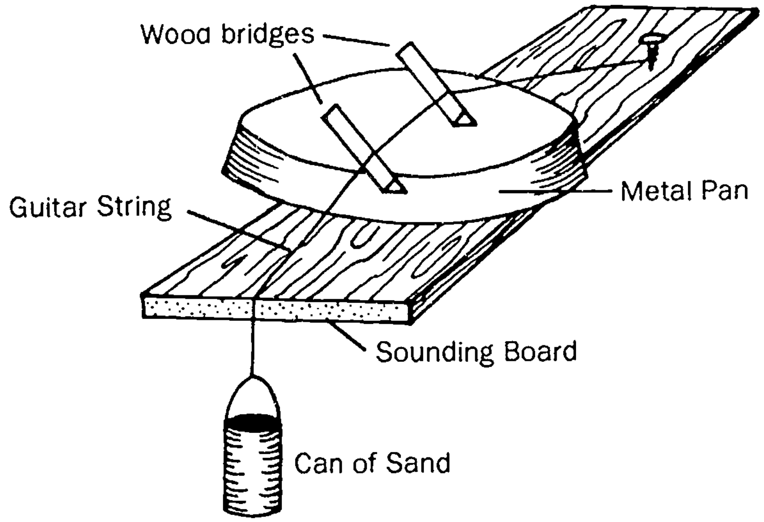
The student describes an amplifier as an object that vibrates at the same pitch as a radiator, or vibrating object, and that increases the volume (loudness) of the sound.

Materials

Large metal pan; pieces of wood to serve as bridges; guitar string; nail; wooden board; pail with handles; sand to put in the pail

Procedures

1. Set up a sounding board as shown below.
2. Pluck the string; the students describe the sound.
3. Compare the sound with and without the metal pan.
4. Use a sponge, thick piece of wood, brick and other materials as possible amplifiers.
5. The students describe the sound the string makes with the different materials.
6. Add sand to the pail or take some out to increase or decrease the tension on the string.
7. Students describe the changes.



Getting the Idea

1. Which materials amplified the sound? Which ones decreased the sound?
2. Make a rule about materials that amplify sound. Tell it to your group and the class so that we can discuss it.
3. How did adding more sand to the pail change the sound? Did it amplify it?
4. What changed the pitch of the string?

ACTIVITY
Musical Resonators

Objective
The student points to the radiators (strings) of a musical instrument, such as a violin or a piano, and to the resonators (sounding boards).

Materials
Musical instruments are usually available in a band room. Since this unit discusses only percussion (drums) and string instruments, the students may want to explore other instruments, such as the reeds and horns, on their own initiative.

Procedures
1. Take students to a band and/or orchestra room, if possible, to examine the various instruments available.
2. The music teacher reminds the students about the care of musical instruments: we can harm them if we drop them. Musical instruments are not easily damaged because they are to be used, but they can be broken or bent if used carelessly.
3. Students examine the drums and predict which ones will sound louder and deeper, or softer and higher. Students record their predictions and then check.

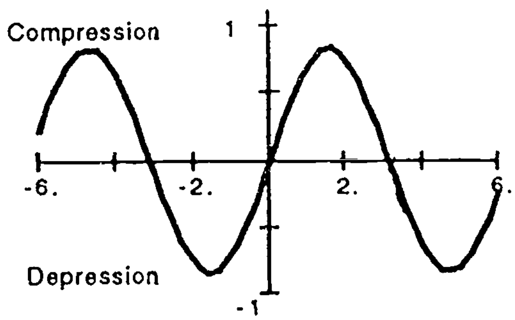
Getting the Idea
1. Which drum had the deepest tone? Why?
2. Find the string on each fiddle that has the highest pitch. Try to make it have a higher pitch. Ask the music teacher to show you how to change the pitch on a fiddle.
3. Which key on the piano has the highest pitch? The lowest? Which string is the longest?

ACTIVITY
High/Low and Loud/Soft: II

Objective
The student identifies the graph of the sound wave that shows a higher (or lower) pitch than another given wave, and a louder (or softer) sound wave than another given wave.

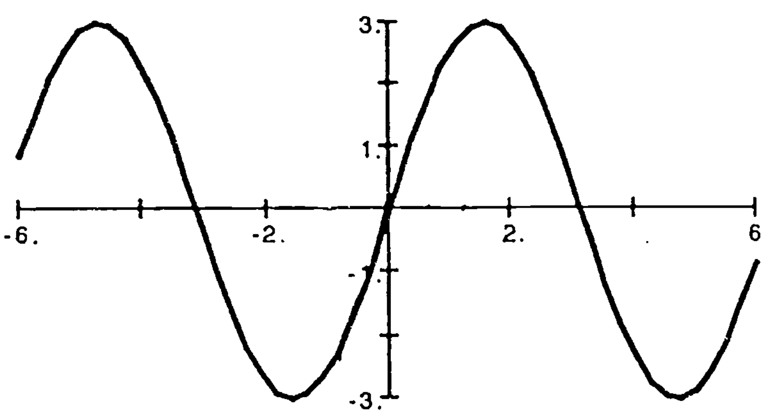
Materials
Laminated sheet of paper showing a coordinate graph; erasable markers of different colors

Procedures
Show students the graph of a sound wave as scientists use. The students copy all the graphs on the laminated sheet. After they can copy them with facility, the students draw their own graphs in their journals.

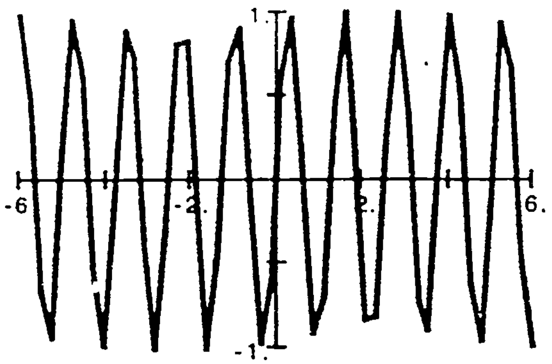


This picture shows the compression (the highest part of the graph) of the wave and the release (the lowest part of the graph).

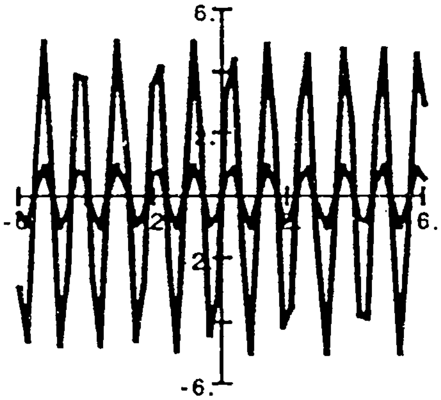
This picture below shows the same sound wave, but now it is louder because the size of the wave is bigger. The volume has changed. The wave goes to only one in the first graph, but it goes to three in the second graph. The volume is three times greater in the second graph.



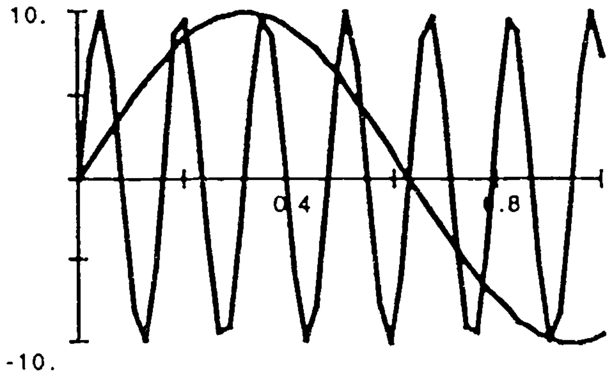
This picture below shows the same sound wave, but now it is higher in pitch because there are more vibrations than in the first one. The pitch has changed.



This picture (graph) below shows two sound waves, one over the other. One is from a rock concert and the other from a school choir singing the National Anthem. Color the wave from the rock band red and the wave from the school choir green. (Hint: Think of the sounds of each before you decide.)



This picture (graph) below shows two sound waves one over the other. One is from a police siren and the other from a bull. Color the wave from the police siren red and the wave from the bull green.



ACTIVITY
Music Multiplication

Objective

The students develop a notion of multiplication as continued addition by 1) using a chart that shows the partial sums and the total sum, and by 2) using an array, which is a set of objects arranged in rows and columns.

Materials

For each student pair or student group:

paper and pencil to draw chart; counters to make arrays

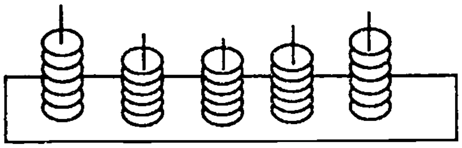
Encountering the Idea

A wave travels at the speed of six miles every hour.
How far will the wave travel if it travels at that same speed for five hours?

Procedures

The students work in groups to solve the first problem.

1. They summarize the results by using a trading chip board and a chart to show the partial sum each hour until they solve the problem.



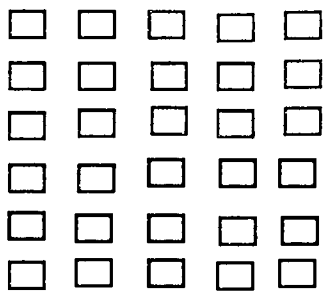
Distance Traveled Each Hour

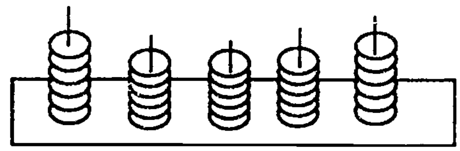
One Hour	2 Hours	3 Hours	4 Hours	5 Hours

2. Give the students the second problem to solve.

A music composer uses paper at the rate of five reams each year.
How many reams will he use in six years?

The students can use a chart or a trading chip board to solve the problem. They defend their solutions every time.





3. Students use the chips and arrays to solve a variety of problems, such as

**There are four violin strings in each package of strings.
How many strings will Jerry buy if he buys eight packages?**

Each package costs $4. How much will the strings cost?

Organizing the Idea

4. The students write an addition number sentence to represent each of the problems solved above, and read it and explain it to the class.
Ex. 6 + 6 + 6 + 6 + 6 = 30
Then they rewrite each additional sentence as a multiplication sentence and read it.
Ex. 5 X 6 = 30
5. Students write a rule in their journals about when to use multiplication.

Applying the Idea

6. The students continue to solve problems related to sound, using either a trading chip board, a chart or an array. For example:

One truck can move seven pianos. How many pianos can another truck that is two times as large as the first truck move?

One rock group's volume (The Orange Notes) is five times greater than another rock group's (The Purple Vengeance) sound.

The Purple Vengeance's volume wave looks like this.

On top of The Purple Vengeance's volume wave, draw the Orange Notes' volume wave.

LESSON 5 The Human Voice

BIG IDEAS The human voice comes from the larynx, the lungs, and the resonators in the mouth, nose and throat. The frequency of the sound waves of the human voice is between 80 and 400 cycles per second.

Whole Group Work

Materials

Story about the three little pigs for the **Language Center**
The shoe box guitars prepared for **Activity** — Rubber Band Band
Word tags: frequency, larynx, vocal chords

Encountering the Idea

Hold your hand around the front of your throat and hum and talk. Ask the students to do the same things you do. Make high sounds and low sounds. Make soft sounds and loud sounds. The students describe what their hands feel. Now, using the shoe box guitar to pluck the string that stretches across the box, the students will try to make a higher-pitched sound. Now, make a lower-pitched sound. Ask: How are these two activities related? Can you explain how you make sounds? The following activities in the learning centers will help you discover how we produce the human voice.

Exploring the Idea

At the **Science Center**, the students
1. complete **Activity** — See Your Voice
2. complete **Activity** — Humans, Sound and Words.

At the **Mathematics Center**, the students complete **Activity** — Frequency of the Human Voice.

Getting the Idea

Show students a diagram of the vocal apparatus of the body: the larynx, which we call the voice box and which contains the vocal chords; the lungs that force air in and out through the vocal chords; and the mouth, nose, tongue and teeth.

Ask the students to list and describe the parts of the body we need to produce our voices. Are there other mammals that can produce human sounds? Why are these sounds not really "speech"?

Discuss why children have higher voices than adults. (Their vocal chords are smaller, thinner and shorter, like piano strings.)

At the **Listening Center**, students
1. listen to vocal music from an opera or a popular musical. They list the different voices they hear and the types of sounds they make.

2. read in an encyclopedia about the different types of voices there are for singing, for drama and so on
3. invite the music teacher to talk about singing and the practice involved in learning to shape the sounds and the words.

Organizing the Idea

At the **Language Center**, the students read "The Three Little Pigs." After the students have had an opportunity to read the story, they gather in a group to discuss the following idea: Some words sound like the object they describe. Ask the students if they read any words that sound like what they are describing. (Huff and puff.) Can you think of other words that do the same thing? (Meow, bark, croak, etc.) The students make a list of the words.

At the **Science Center**, the students make a chart of body parts we use for our voices, classifying them as sound radiators or resonators.

The Human Voice

Radiators	Resonators
larynx	nose teeth throat chest

Applying the Idea

If possible, in this activity, students pair off with one student knowing the foreign language better than the other. This student serves as a "tutor" for the other.

Students listen to the tape of a story in a language other than English — Spanish, or some other language frequently spoken in the United States. The students try pronouncing the words and

1. make a list of the new sounds they heard and have trouble producing, such as the double "r" in Spanish
2. describe what they had to do to pronounce the new sounds more accurately than when they first tried them
3. report their efforts and successes to the class.

Closure and Assessment

Students create an "important thing" pattern report. See **Closure** at the end of **Lesson 2.**

List of Activities for this Lesson

- ▲ See Your Voice
- ▲ Humans, Sound and Words
- ▲ Frequency of the Human Voice

ACTIVITY
See Your Voice

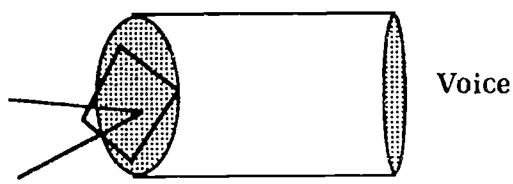
Materials

Mirror two-cm X two-cm (one-inch x one-inch); glue; film screen or white surface; flashlight

Oatmeal box drum, top covered with a large balloon stretched tightly and secured with a rubber band or string. (Cut the bottom end of the box parallel to the top.)

Procedures

1. Glue mirror to drum.
2. Make the room dark and shine the flashlight onto the mirror so the reflected light bounces off the mirror and hits the white surface.
3. Speak in a loud voice into the drum and observe the light on the wall.
4. Practice making different kinds of sounds to see if the pattern changes.



Discussion

1. What is making the mirror move?
2. What makes the light reflect in different patterns?
3. What carried the vibrations from the side of the drum where you talk to the side where the mirror is glued?
4. When you talk louder does that make the sound waves move faster? (No, sound waves move at the same speed. The volume or amplitude of the waves changes.)

ACTIVITY
Humans, Sound and Words

Objective
The student demonstrates that humans shape sounds into words.

Materials
Pictures of the vocal chords, mouth, throat, tongue and teeth
Copy of the rhyme "Mary Had a Little Lamb"

Procedure
1. Say a nursery rhyme like "Mary Had a Little Lamb" until you can say it without hesitating.
2. Try to say the nursery rhyme, except that you have to substitute every vowel for a single vowel, such as "i". The rhyme is now:
   Miry hid a little limb, its flice wis white as sniw.
   Ind iviri whir thit Miry wint, thi limb wis sire ti gi.
3. Try to say the rhyme with other vowels such as the o, and the u.
4. Hold your tongue and try to say the rhyme normally.
5. Repeat the rhyme with your teeth closed.
6. Sing or hum and note and change the shape of your mouth by opening it, puckering your lips and so on.
7. Think of your best friend and say something that your friend says, trying to imitate his or her voice.
8. Try to repeat the rhyme in Donald Duck's voice.
9. Pinch your nose and repeat the rhyme in your normal voice. How does it sound? How do you hear yourself? Do you sound the same? What can you say about the use of the nose in speaking?

Getting the Idea

1. When you were saying the nursery rhyme, when were you able to speak most easily?
2. Is talking easy, can you make the words sound the way you want them to when you can't move your tongue? When do people say "Has the cat got your tongue"?
3. When you are trying to imitate someone you know what parts of your body are you trying to control? (Vocal chords, tongue, teeth, shape of mouth, throat.)
4. Is learning to speak clearly an easy job?
5. Can parrots really talk? Explain your answer.

ACTIVITY

Frequency of the Human Voice

Objective

The student says that the frequency of the sound waves of the human voice is between 80 and 400 waves per second (cycles per second) and describes the graph of those frequencies.

Materials

Several tuning forks of different pitch — middle C, high C, etc. (may be obtained from music teacher)

Blank graphs to describe frequencies

Piano, or some other musical instruments (if possible, conduct this activity where these items are available for student experimentation)

Procedures

Students work in pairs or small groups.

1. The students examine the tuning forks, noting that they are marked with the frequency at which they vibrate. Are these tuning forks within the range of the human voice? Yes. How do you know? (264 cycles per second is between 80 and 400.)
2. The student strikes the tuning fork for middle C. The student hums or sings the note at that pitch. Can she/he sing (or hum) it?
3. At what frequency is the student singing the note? (Answer depends on the tuning fork that the student uses.)
4. The students repeat the procedure with the other tuning forks.
5. The students put the tuning forks in order according to the frequency at which they vibrate.
6. Is there a connection (relation) between the frequency of the tuning fork and the shape or the size of the fork? (Yes, the shorter the fork, the higher the frequency; the shape is the same; only the sizes are different.)
7. Look inside a piano. Describe the strings. (Some of the wires are long and thick while others are short and thin; the long ones have a low sound and the short ones have a high sound.)
8. Examine a bass fiddle and a violin. Compare the strings and predict and record the sounds the strings will make. Pluck the strings and check on your predictions.
9. Ask your teacher to help you find middle C and the C above middle C on the piano. Play one note and then the other. Try to describe the differences in the two sounds. Describe how they may be alike. Can you sing both notes? There are some singers who can sing the C above the high C you played. Can you?

LESSON 6 What Is Music? What Is Noise?

BIG IDEAS Music is sound that has rhythm, pitch and volume and that is pleasant to the ear; noise has none of these but is irregular sound.

Whole Group Work

Materials

Tape of children's popular songs: " Puff, the Magic Dragon," "M-i-c-k-e-y M-o-u-s-e,"or something of the students' choice.
Tape with noise recorded — street noise, static, other noises
Cymbals, castanets, other available rhythm band instruments, to place later in the **Rhythm Center**
Tape player/recorder
Reference books on sound and on the harmful effects of loud sounds on the ear
Tapes of Oriental music, music from other cultures, etc.
Word tags: rhythm, pitch, volume, pleasant, unpleasant

Encountering the Idea

Play the two tapes to the students. Ask them what they hear. (One is noise and the other is music.) What makes the difference? When do we call one sound noise, and another sound music? Play students music from other lands — Oriental, American Indian, African, etc. Students discuss the music in terms of pitch and volume. We will discover what qualities of sound humans call "music" and what they call "noise".

Exploring the Idea

At the **Science Center,** the students, in small groups, play segments of the songs and/or music tapes. The students tell the group what they especially like about the music. Then the students describe the music using as many new terms that refer to sound as possible, including the description of voices singing the songs.

Next, the students play segments of the noise tape. The students tell their group what they disliked about the tape. The students describe the sounds using the new terms that refer to sound. Then the groups report to the class.

Getting the Idea

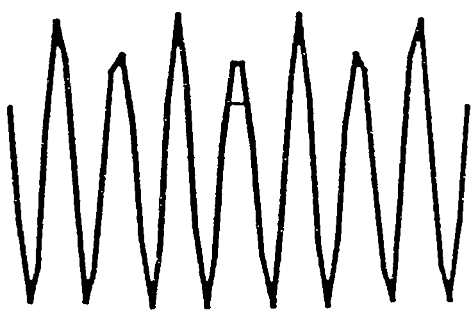
Tell students that music has certain characteristics — some of them students have already investigated, such as pitch and volume; music from all cultures has similar characteristics. Students have not, however, talked about **rhythm.** Other words for rhythm are "beat", "cadence" and "tempo". In pleasant sounds and in musical sounds usually we can detect patterns. One pattern is that of the rhythm, or beat. Can you listen to music and tell if it is rock music? How? How is rock different from the beat of "Mickey Mouse" or "Puff the Magic Dragon"?

At the **Rhythm Center**, the students listen to music of their choice and identify the beat of their favorite songs. They report to the class when they think they can repeat the beat by clapping their hands to the rhythm of the music. The other students check.

Organizing and Applying the Idea

At the **Reading Center**, the students read in reference books about the harmful effects of loud noises and loud music on the human ear.

After the students have had an opportunity to discuss their favorite songs and favorite sounds in the music, ask them to describe graphs of music sounds as compared to graphs of noise. Regular, even sound waves produce a pleasant sensation that we call a musical tone. On the other hand, irregular waves produce a sensation that is not musical and that may be unpleasant. These are pictures, graphs, of some sound waves. Which of these might have been produced by a musical tone and which one might be unpleasant? Which was caused by a breaking dish?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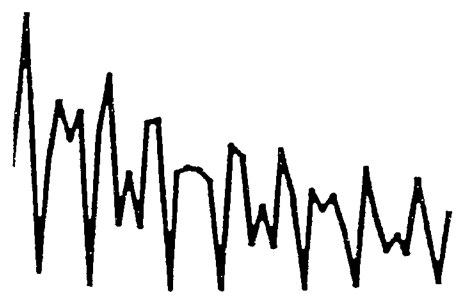
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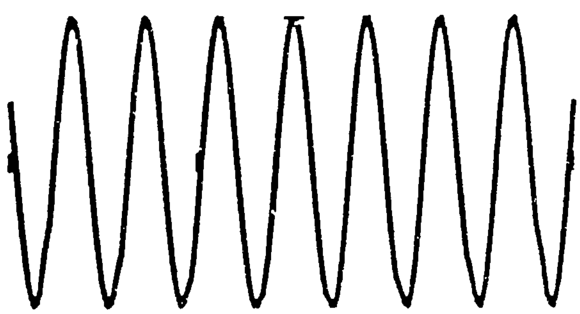
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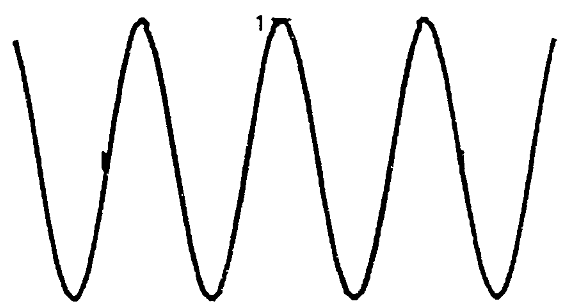
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Graphs C and D represent regular waves that would usually produce a pleasant sound, while waves A and B are irregular waves that would probably be unpleasant. Encourage the students to give arguments about which of the waves would represent pleasant and unpleasant sounds.

Closure and Assessment

Performance Assessment

1. Working in pairs, the students tap for each other a rhythm to a well-known song. One student taps and the other student tries to guess from the rhythm what the song is. When they find a song that is easy (or hard) to guess, or which has a unique rhythm to it, they demonstrate it to the class.
2. Students write the words to a song based on a popular tune or a nursery rhyme.
3. Students compose a tune to a popular poem or nursery rhyme.

List of Activities for this Lesson

▲ Music Mathematics

ACTIVITY
Music Mathematics

Objective
The students develop the notion of division as continued subtraction by solving various word problems.

Prior Knowledge
The students can subtract one- and two-digit subtrahends from two- or three-digit minuends with and without renaming and regrouping. The students need not have considered the notion of multiplication as continued addition.

Materials
For each student pair or student group:
paper and pencil to draw chart; counters to make arrays

Procedures
Part I
Students work on the following problems and then report solution procedures to the class. Tell students that they may use any of the manipulatives they need to help them solve the problems.

1. **An orchestra composed of 28 musicians is to sit at the front of a dinner party to play for the guests. How many different ways can you arrange the musicians in rows and columns? Which arrangement would you recommend for the occasion?**
   1. Write your solution as a number sentence.
   2. Explain what your group did to solve the problem and why you selected a particular arrangement.
   3. Would you suggest arranging the musicians in five rows? Why, or why not?
2. **A rock group audience of 168 people need to be able to sit in four rows. How many chairs would you set up for each row?**
   1. Write your solution as a number sentence.
   2. Explain what your group did to solve the problem.
   3. Would you suggest arranging the audience in rows of five chairs? Why, or why not?
3. **A rock group audience of 990 people need to sit in rows of 18 chairs each. How many rows will the helpers have to set up in the auditorium?**
   1. Write your solution as a number sentence.
   2. Explain what your group did to solve the problem.
   3. Would you suggest arranging the audience in five rows? Why, or why not?
   4. How are problems # 2 and # 3 alike? How are they different?
   5. Were the methods you used to solve the two problems the same?

4. **The manager of a recording company needs 200 musicians immediately to record some new CDs. She wants to audition the musicians in groups of 10 only and she wants an answer, now, on the telephone.**
   1. Can you send her the musicians in groups of 10 only?
   2. How do you know you can without having to subtract?
5. **Suppose you want to put 420 musical instruments into boxes. How many boxes would you need if you could only put 14 instruments into each box?** Show all your calculations here and then explain them to the class.

Part II

After solving these problems and looking for a process to do others like them, complete this sentence:

The important thing to remember about solving problems that ________________

is to ________________ and to ________________ and to ________________

(as many times as you need.)

LESSON 7 Sound Is Important in Communication

BIG IDEAS Sound allows communication among people and between people and animals through the use of vocal chords and ears. Humans can hear sounds that have a frequency between 15 cycles per second to about 20,000 cycles per second.

Whole Group Work

Materials

Book: **The Terrible Thing that Happened at our House** by M. Blaine
Picture of a newborn baby; picture of a pet (dog, cat, etc.)
Stack of cards with "ideas" to communicate such as: a big tree; a monster from outer space; a rabid dog; a singing canary; There is a fire in the house!; I just won a million dollars!; This is the most beautiful rainbow I have ever seen — it is pink, red, purple and extends over half the sky!
Reference books on sound, with pictures of the location of the hearing and speech functions of the brain
Words tags: communication, verbal, cells, neurons

Encountering the Idea

What is the first thing that most babies do when they are born? Yes, most babies begin life by crying. They take their first breath of air and let out a big yell. This is the beginning of communication between the baby and its mother, relatives and then the outside world.

What is the first thing the baby hears? Probably the mother's voice, the father's or the doctor's asking: Is it all right? Is it a boy? Is it a girl? The older brother may even tell the baby, "Hi, baby!" Can the baby hear these words? Is the baby communicating now? It will probably be a few weeks before the family can notice the baby paying attention to conversations and sounds, but eventually the baby begins to try to say words that **sound** like the words that are spoken to him/her. At last, what we usually think of as communication begins. During our exploration phase of the lesson, we will discover how important sound is in communicating with others.

During this lesson, we will explore why communication using sound — using our voices — is important. We will also talk about what makes it possible for humans to communicate — to talk, to hear, to listen and to understand verbal communication.

Exploring the Idea

Play a guessing game. Divide the class into groups of four each. Select one of the groups to be the **communicator group** to communicate a *secret idea* to the class. One student, the **Communicator,** selects a card from the stack, reads it and shows it to the communicator group but does not show it to the other groups. The communicator group plans how the Communicator will reveal the idea to the other groups by **only using body language.** The Communicator cannot speak or write the idea. The first group to guess the mystery idea wins and becomes the communicator group.

As an extension of the game, the **Communicators** suggest their own secret ideas to present to the other groups. They try to get the message to the other groups as quickly as possible, again without using verbal or written symbols.

Students complete **Activity** — Technology and Sound.

Getting the Idea

1. I will now read a story some of you probably can relate to, **The Terrible Thing that Happened at our House.** Teacher reads story. At the conclusion, students discuss why communication between/among human beings is important. Sound helps us to communicate.
2. In playing the guessing game were you successful in communicating all the secret ideas to the class? Why was it difficult? Are speaking and listening important parts of communication? If there had been a real fire in your house, how would you have communicated that news to your family?

How successful were you in communicating to the class that you had a million dollars? What would have been the most effective way to communicate this?

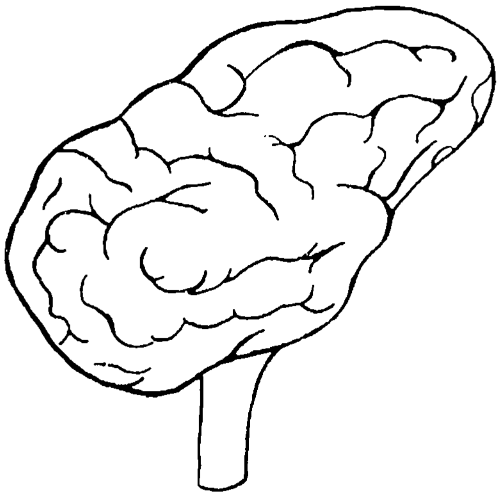
What did you do to communicate the idea of the beauty of the rainbow to the class? Are words always the best method of communication? Would it have been better to show the class a picture of a rainbow or the rainbow itself?

At the **Art Center,** students draw pictures of the brain as they have seen in their reference books and locate the speech and hearing functions.

Organizing the Idea

At the **Sound Center,** you discovered how important communication through sound is and, in the **Library Center,** you were able to see pictures of the brain and how we hear sound.

Tell the students that the brain has many parts, but we will locate and study only two parts of the brain — where speech and hearing form.



Remember that your brain consists of cells called "neurons". Neurons are special nerve cells. They are the main storage units for the information we receive, not only through hearing but through all the other senses.

At the top of the brain are large areas where ideas and relations form — this is where we "think". At the back of the brain is the area where we store what we see. This is the area that helps us "remember" things. Language and hearing — language processing goes on at the lower front area of the brain. Vision is located in the lower back side. The brain is able to coordinate what we see with what we hear.

When we "hear" a sound that means that

1. sound waves have hit the ear drum in the inner ear
2. the drum resonates with the sound from outside and sends the sensations through the nerves and neurons to the part of the brain where sound is "heard"
3. the brain interprets the sound and identifies it. So, really we hear with our brains and not with our ears. The ears only pick up the sound waves and transfer the sensation to the brain.

Applying the Idea

1. Can plants hear? Are plants sensitive to sound waves? Do plants generate (or make) sound waves? Take a position that: Yes, plants can hear, or take the position: No, plants cannot hear, and give reasons why you believe that to be true. Talk with a parent and report your opinions to the class.
2. Do the same with the question: Do plants communicate?
3. What do you think this idea means: A picture is worth a thousand words?

Closure and Assessment

Students write an "important thing" pattern report about the brain or about communication.

List of Activities for this Lesson

▲ Technology and Sound

ACTIVITY
Technology and Sound

Objective
The student names at least five technological inventions that have added to human ability to "hear" sound and thus have added to our ability to communicate.

Materials
Pictures and/or examples of a telephone, a telegraph, a radio, a television, radar, sonar, fax (facsimile), cellular telephone, telephone modem for electronic mail, CDs, video cassettes, tape cassettes, laser disks and any other technology that students know about and that may be available

Reference materials or commercially prepared advertisements from companies dealing with these devices

Procedures
Students work in small groups. Give students sufficient time before they begin the activity to examine each of the devices available to the class. Invite the students to bring to class (with parent permission) any of the items they wish to demonstrate to the class.

1. One group researches and reports to class what the device called "the wireless" was, how it worked and how it was important in the development of the West in the United States.
2. One group researches and reports on what radar is, how its name was selected, who invented it and why it was important during World War II.
3. One group researches and reports on what sonar is, how it got its name, who invented it and why it was important during World War II.
4. One group researches and reports on what the letters FM and AM mean on radios.
5. Student groups may suggest other topics to research and report on, provided the books relate to devices that aid humans in their ability to "hear sound."
6. After the groups have completed their assignments and reports, they make a web of the devices that have been developed to help humans in our ability to hear; then they expand on and describe how the new ability helps us communicate more effectively.

UNIT ASSESSMENT

Oral Assessment

The student will listen to instrumental music and identify sounds that have a high or low pitch and sounds that are loud or soft.

The student will briefly describe how sound develops when matter vibrates and how sound travels in waves.

The student will explain the difference between pitch and volume by describing the different sound waves of the two.

The student will explain the difference between music and noise.

Performance Assessment

The student will make an instrument using a shoe box and rubber bands of different widths (or same width stretched to different tensions (lengths)). The student will compare/contrast the vibrations that each of the rubber bands produce. The student will make loud and soft sounds and will change the pitch at will.

Paper and Pencil Assessment

The student will

1. define sound, sound waves, pitch and volume.
2. draw a sound wave and briefly explain and/or illustrate how the wave travels by compressing and releasing air (or liquid or solid, whatever medium through which it travels).

Annotated Children's Books

Ardley, N. (1984). *Action science: Sound and music.* New York: Franklin Watts.

This text contains simple experiments to explain the concept of sound and music.

Barrett, N. S. (1985). *Picture library: TV & video.* New York: Franklin Watts.

This book shows workings at a TV station and a traveling control room.

Bennett, D. (1989). *Bear facts: Sounds.* New York: Bantam Books.

An easy reader, this acknowledges that sound is heard because of both our outer and inner parts of our ear. It also contains simple illustrations of all kinds of sounds.

Blaine, M. (1975). *The terrible thing that happened at our house.* New York: Four Winds Press.

Mother goes back to work and everything changes. Communication get everything working better.

Branley, F. M. (1967). *High sounds, low sounds.* New York: Thomas Y. Crowell.

This text explains how sounds are produced and received by the ear.

Broekel, R. (1983). *A new true book: Sound experiments.* Chicago: Children's Press.

This introduces the principle of sound using simple experiments.

Catherall, E. (1989). *Exploring sound.* Austin, TX: Steck-Vaughn Library.

Explores aspects of sound and how it travels, how it is received by the human ear, and how it can be recorded. Topics are sequenced from easy to complex.

Conklin, G. (1965). *If I were a bird.* New York: Holiday House.

Bird songs and calls are the main theme of the book. Twenty-seven birds, along with their calls represented by musical notes, are shown in their natural surroundings.

Gibbons, G. (1985). *Lights! Camera! Action! How a movie is made.* New York: Harper.

This book is an overview of the complicated process of making movies.

Jacobsen, K. (1982). *A new true book: Television.* Chicago: Children's Press.

This text provides historical information and other simple materials to show how a TV set works.

Kettelkamp, L. (1982). *The magic of sound* (rev. ed.). New York: William Morrow and Company.

This is a good reference book that gives a clear description of the uses of sound.

Oppenheim, J. (1987). *Have you seen birds?* New York: Scholastic.

Containing pictures by Barbara Reid, this book uses a pattern to describe different birds — how they sound and what they do.

Scheer, J. (1968). *An upside down day.* New York: Holiday House.

Bells won't ring, cows won't moo, balloons won't pop, and drums won't beat are some of the things that happen on an upside down day. Simple text.

Sheldon, D. (1991). *The whale's song.* New York: Dial Books for Young Readers.

This magical story fills the imagination. Do whales really sing?

Webb, A. (1988). *Talkabout: Sound.* New York: Franklin Watts.

This book shows how sound vibrates.

Other resources

The five senses: Wonderful world of sounds [Cassette]. (1989). Carson, CA: Lakeshore Learning Materials.

unit

3 Simple Machines

Prior Knowledge

The student has

1. found products of two single-digit factors using arrays
2. found a linear measure using inches and feet
3. added and subtracted three-digit numbers with renaming
4. found items in an encyclopedia
5. put words in alphabetical order
6. sequenced numbers through 1000
7. constructed graphs
8. identified geometric shapes
9. identified written text as a poem.

Mathematics, Science and Language Objectives

Mathematics

The student will

1. calculate weight of an object in space
2. compute averages
3. record data
4. explore measurements of sides of a right triangle
5. use even and odd numbers to estimate
6. multiply and divide using two-digit numbers and three- or four-digit products
7. calculate the perimeter and, without using pi, the circumference of a circle.

Science

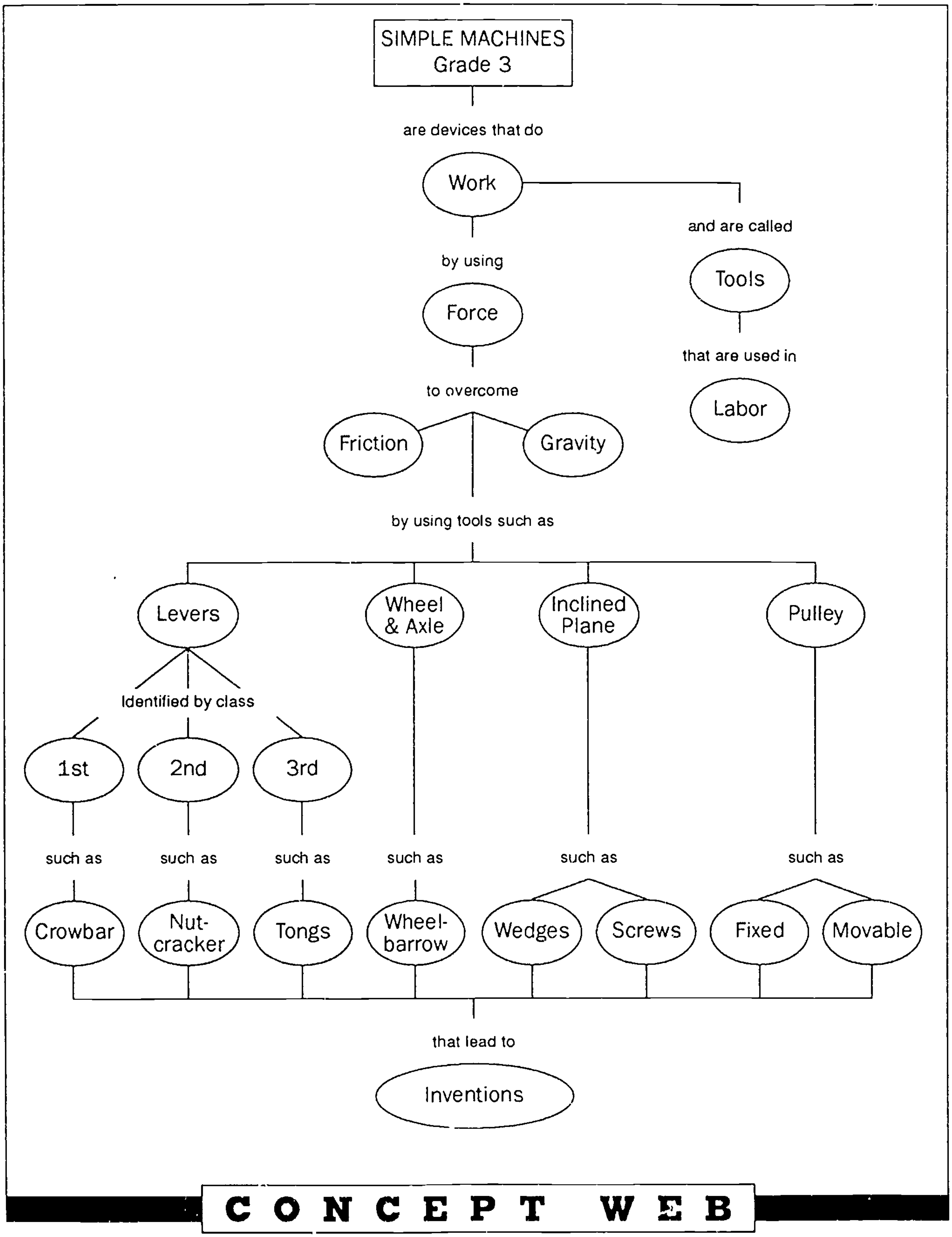
The student will

1. list and give examples of simple machines
2. give an example of a force, such as inertia, friction or gravity, overcome in work
3. construct at least one simple machine
4. predict the amount of force needed to move a resistance
5. name at least five inventors
6. associate at least three events of historical importance with the invention of three important machines.

Language

The student will

1. use related vocabulary to explain and describe the function of simple machines
2. use related books to illustrate, write, label and graph new concepts
3. write a book on simple machines
4. use related books in cooperative groups to help write a report on a simple machine
5. analyze related words for meaning.


SIMPLE MACHINES
Grade 3
are devices that do
Work
and are called
Tools
that are used in
Labor
by using
Force
to overcome
Friction
Gravity
by using tools such as
Levers
Wheel & Axle
Inclined Plane
Pulley
Identified by class
1st
2nd
3rd
such as
Crowbar
Nut-cracker
Tongs
Wheel-barrow
Wedges
Screws
Fixed
Movable
that lead to
Inventions
CONCEPT WEB

VOCABULARY

machine máquina	force fuerza	friction fricción	pliers pinzas, alicates, o tenazas
gravity gravedad	effort esfuerzo	resistance resistencia	fulcrum fulcro
pulley polea	inclined plane plano inclinado	fixed fijo, fija	hoist izar
wheel and axle rueda y eje	tool herramienta	device aparato	lever palanca
bicycle bicicleta	slide resbaladero	invention invención	broom escoba
scissors tijeras	wheelbarrow carrucha	tweezers pinzas	food press prensa para cocinar
crowbar barra	nutcracker cascanuez	hammer martillo	
seesaw sube-y-baja	pound martillar	nail clavo	

Teacher Background Information

The world we live in is constantly exerting different **forces** on itself and on the beings that inhabit it. Forces make objects move; forces make objects change their direction; and forces make objects stop. These forces appear to be more important when they are acting on us as individuals, or when we want to use these forces to change our environment to suit our likes. Over long periods of time humans have learned how these forces work, and to some degree we have these forces under our control. Granted, we may be novices in the use of these forces, but we have been able to use them to accomplish many things.

For example, humans have changed their environment in many ways, by building structures for shelter, by clearing land and obtaining and conserving water to grow food on a relatively dependable cycle. This has been accomplished by sawing and lifting large trees, driving nails through hard wood, removing large rocks and pulling out large stumps. All of the changes have come about as humans have learned to control these **forces as "push"s or "pull"s.** When we accomplish a change, such as raising a heavy rock or chopping down a tree, we accomplish work. **Work produces change** — and change is the result of work.

Humans could not have accomplished many of these changes by using only the energy our relatively weak bodies can exert. Humans, however, have used their brains to design devices that have helped in bringing about these changes. A machine is but one example of how human intelligence has helped in making our lives on earth easier.

A machine is, in a very general sense, a combination of parts we use to overcome a **resistance** (which is also a force, like a large rock that needs to be removed) **by transferring or transforming energy,** usually that exerted by a human being. There are fundamentally three basic machines — the lever, the inclined plane and the wheel and axle. We sometimes refer to other combinations as simple machines, and these appear somewhat more complicated but in reality are combinations of the three basics.

In this unit, we will look at two major forces that machines help us overcome — **friction and gravity. Inertia,** on the other hand, is a characteristic of matter — it is the resistance of mass to being in motion or removed from motion. Consequently, if we want to move matter, or a mass, which is expressed as weight, we need to exert force on that matter to overcome inertia as well as **friction** and/or **gravity.** Usually, the forces we want to overcome we call the "resistance". The forces we use to overcome the **resistance** we call the **"effort".**

When we do work, we use **energy.** Energy changes in form, but it does not disappear. In using simple machines for human work, energy transfers from one object to another, or it changes in form as sound, heat or light energy.

Understanding how simple machines function is a big step in understanding how much of the world around us functions even in modern times, because the nature of matter and energy has not changed — only our understanding of it has.

Current emphasis on the importance of elementary students' learning and applying basic concepts of probability and statistics suggests that a fundamental concept such as the **average** be introduced at an early opportunity using intuitive approaches. The following set of activities has been designed and implemented at a third grade level with bilingual children whose education emphasizes language development as a major strategy to develop mathematics and science concepts.

The intuitive notion in this strategy is that finding the **average** is similar to taking individual sets, whose cardinal numbers we know, and then making the sets **even** (i.e., make the stacks level). The teacher may want to begin the lesson by discussing the idea of **making stacks, or sets, level.** Showing two or three stacks having different numbers of chips, the teacher points out that the stacks have different heights. These stacks are **uneven** (i.e., not level). The stacks are to have the same heights. The students, in a problem-solving approach, discover how to make any number of **uneven** stacks into **even** or level stacks. Introduce the following activities with these notions in mind.

Studying a machine created to help humans work is an important approach for introducing students to relatively sophisticated ideas of inertia, which is a property of matter, and ideas of forces that act upon matter. Concepts of friction and gravity lead to the more complex ideas that students will be able to understand when they have this background supported by experiences that relate "science" to the "real world."

LESSON FOCUS

■ LESSON ONE — *Simple Machines*

BIG IDEAS — Simple machines are devices that help us do work. When we do work, we use energy; energy transfers or transforms, but it does not disappear.

■ LESSON TWO — *Force and Work*

BIG IDEAS — When we do work we use a force to overcome inertia, friction or gravity. We can measure work.

■ LESSON THREE — *A Crowbar*

BIG IDEAS — The three different kinds of levers have different fulcrum locations. We calculate work using multiplication.

■ LESSON FOUR — *A Bicycle*

BIG IDEAS — A wheel and axle is a machine that rolls its load by decreasing friction. We can estimate the perimeter (circumference) of a wheel.

■ LESSON FIVE — *A Slide*

BIG IDEAS — An inclined plane is a machine that changes the direction that force is applied and that helps decrease the effect of gravity, though it may increase friction. Different types of inclined planes form right triangles.

■ LESSON SIX — *A Pulley*

BIG IDEAS — A pulleys helps us change the direction of a force. A pulley transfers energy through distance (or **nothing in nature is free**).

■ LESSON SEVEN — *Inventions*

BIG IDEAS — An invention is a combination of simple machines, for example, a foot-pedal sewing machine or a car.

OBJECTIVE GRID

Lessons	1	2	3	4	5	6	7
Mathematics Objectives							
1. calculate weight of an object in space		•					
2. compute averages		•		•			
3. record data	•	•	•	•	•	•	
4. explore measurements of sides of a right triangle					•		•
5. use even and odd numbers to estimate				•			
6. multiply and divide using 2-digit numbers and 3- or 4-digit products				•	•		•
7. calculate the perimeter and, without using pi, the circumference of a circle.				•			
Science Objectives							
1. list and give examples of simple machines	•		•				•
2. give an example of a force, such as inertia, friction or gravity, overcome in work		•	•	•	•		
3. construct at least one simple machine			•				•
4. predict amount of force needed to move a resistance					•		
5. name at least 5 inventors							•
6. associate at least 3 events of historical importance with the invention of 3 important machines.							•
Language Objectives							
1. use related vocabulary to explain and describe the function of simple machines	•	•	•	•	•	•	•
2. use related books to illustrate, write, label and graph new concepts	•	•	•	•	•	•	•
3. write a book on simple machines	•						•
4. use related books in cooperative groups	•						
5. analyze related words for meaning.	•						

LESSON 1 Simple Machines

BIG IDEAS Simple machines are devices that help us do work. When we do work we use energy; energy transfers or transforms, but it does not disappear.

Whole Group Work

Materials

Books: **Simple Machines** by A. Horvatic and **Family Pictures** by C. L. Garza
Filmstrip: "Discovering Simple Machines"
Pictures of people involved in different activities such as playing, riding bikes, sharpening pencils, etc.
Long stick or cut-off broom handle
For mobile: yarn, paper clips, rulers, straws, magazines, paper
Word tags: force, gravity, friction, machine, simple, inertia, energy, work, transfer, transform

Encountering the Idea

People have to work to have the things they need, such as food, shelter and houses. People, however, have always tried to find ways to get help to do this work. Early people trained and used animals to help them work. One reason is that animals — for example, oxen — are stronger and have more energy than humans, therefore exerting more force. At a later date, however, people invented simple devices called machines to exert, transfer or transform energy to do work for us. All of us today still use our own energy to get work done; but we have also used our **brains** to help us do some things that we might not be able to do by ourselves. For example: Let's ask Sandra (a small girl who has trouble doing the task) to lift this heavy box to the top of this table. Sandra, can you do it? No, it's too heavy?

Exploring the Idea

Okay, then let's try this experiment. Students do **Activity** — Let's Share the Work.

After the demonstration, tell students that one of the important discoveries in the history of human beings was the development of our ability to use objects found in our environment to help us work. We will also explore some important ideas related to **energy** in order to understand how to make work easier.

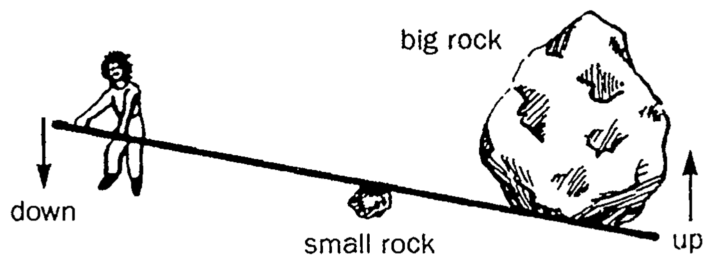
Getting the Idea

Show students the picture of the person moving a large rock. Tell them to observe that a small person can move a big rock if she uses a strong, long stick. Ask Sandra if she thinks she could raise the rock if she had a long stick. Again, ask for suggestions.

When the girl in the picture pushes down on the stick to move the rock, she is using energy. She is also doing work. Why? She is changing the place where the big rock was resting to a place higher up in the air with the aid of the stick. What does the big rock do to the stick? (It is pushing down with its mass.)

Yes, the rock is a force pushing down on the stick.

When the girl pushes down on the stick under the big rock, the stick pivots on a small rock or some other object, transferring the energy from the girl through the stick into the big rock and making the big rock move up.



What happens if the girl lets go of the stick? The rock will fall and transform its energy by crashing down with a noise. The rock transfers its energy by making a hole in the ground, making a loud noise as it hits and heating the ground around it. The energy transfers from the girl to the rock, and then if the rock falls, the energy goes back from the rock as sound, heat or motion energy.

Now, let's look at these magazine pictures. These people are all doing something. Let's name the activities. Each picture shows a force applied to something. Let's name the forces applied and how they are applied.

Devices that people use to help them work we call "machines".The strong stick together with the small rock shown in this picture form an example of a simple machine we call a **"lever"**. People do work by exerting a force on something. The machine transforms or transfers the energy to do work. The girl pushed down and the big rock lifted up. Let's all do the same thing using a pencil to lift a book. What did you use as a pivot, or substitute for the rock?

At the **Mathematics Center,** students complete **Activity** — A Paper Fan is a Simple Machine.

Organizing the Idea

1. Filmstrip: "Discovering Simple Machines."
2. Students use the book **Family Pictures** to find examples of simple machines in the illustrations.
3. At the **Art Center** the students complete **Activity** —Simple Machines Mobile.

At the **Language Center,** students

1. practice dictionary skills by spelling, syllabication, naming parts of speech, multiple meanings and use of the pronunciation key with new words from this unit (force, gravity, friction)
2. analyze words related to the ideas they will learn in this unit. Tell the students that to "analyze" means to take words apart and then to study the parts to see how they fit to make a new word.

"Uni - corn". (Show picture and write on chalkboard.)
What does "uni" mean? What does it remind you of in Spanish? (One.)
What is "corn"? In Spanish, "cuerno" is "horn". Then, a unicorn is a one-horn animal.
Let's look at "bicycle." (Show picture, write it on chalkboard.)
What do you think cycle means? (Circle, wheel.) What about bi? (Two.) A bicycle has two wheels. A unicycle? (Shows picture.) What is a tricycle? Tripod? Triplets? Triangle?

Look in your dictionaries to find other words that start with the prefixes "uni", "bi", or "tri" and then make a list. Report to the class after we have completed work at the learning centers.

Applying the Idea

Describe how a nutcracker works. Where does the energy come from that cracks the nut? What is the work that is done?

Closure and Assessment

Define and/or illustrate a machine. Try to use words such as "energy", "work" and "friction" or "gravity" in your definition.

List of Activities for this Lesson

- ▲ Let's Share the Work
- ▲ A Paper Fan Is a Simple Machine
- ▲ Simple Machines Mobile

ACTIVITY
Let's Share the Work

Objective
The student understands the concept of work as using a force to move a mass over a distance and gives an example of work.

Materials
Large open box with several heavy books or other objects in it

Procedures
Students working in small groups help Sandra decide how to lift the box, but before we help her, let's try to see if we can:

1. have the groups look for one way to compare the task
2. give, write down and implement different suggestions; for example, two large students lift the box (or three or four students)
3. consider all the suggestions and give opinions as to which would be easier, more efficient, etc.

One suggestion could be that Sandra take one book out of the box at a time until she can lift the box by herself, then put all the books back in the box.

Getting the Idea

1. Ask the students: Regardless of which way we solved the problem, was the amount of work done the same? (Yes. Regardless of how we did it, we lifted the heavy box with its contents to the table.)
2. Did the box weigh the same when two, three or four people lifted it? (Yes, it weighed the same, but the people shared the work.)
3. When two people lifted the box, how much work did each one do? (1/2 each.)
4. When three people lifted the box, how much work did each one do? (1/3 each.)
5. When Sandra did the work by herself, how much work did she do? (All of it.)
6. When you were lifting the box to the table what force were you working against? (Gravity.)

One other thing that we have to remember: When we do work we use energy.

7. Who used energy in doing the work of lifting the box? (Yes, everyone who helped had to use energy to get the work done.)

Work, then, is defined as moving a mass over a distance.

8. What work was done here? (This box, this mass, we raised (moved) 38 inches.)

ACTIVITY

A Paper Fan Is a Simple Machine

Objective

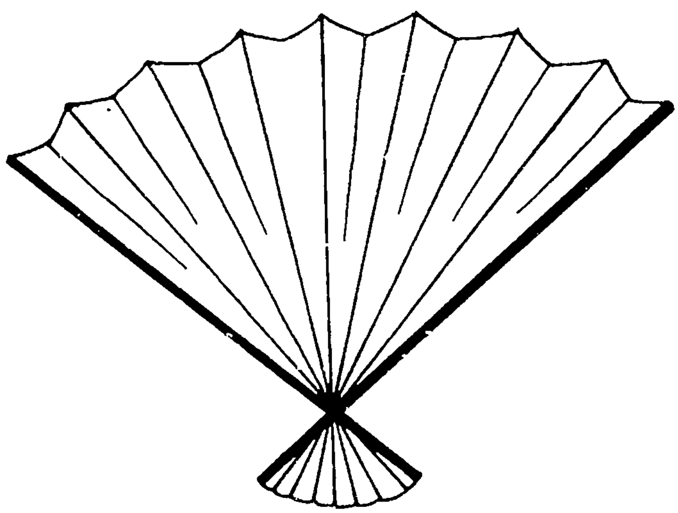
The student constructs a paper fan and describes it as a simple machine, indicating where the resistance is exerted, where the force is applied and where the fulcrum is located.

Materials

Sheet of construction paper; transparent tape; crayons

Procedures

1. Decorate an 8 1/2 X 11 sheet of paper in the style of a fan.
2. Fold the sheet of 8 1/2" X 11 paper in half along the width (the 8 1/2" side), then 1/2 again, 1/2 again and 1/2 again, making sharp creases.
3. There will be 16 strips of paper (or 15 creases).
4. Unfold the paper and refold it in an accordion pleat.
5. Secure with transparent tape one end of the newly folded paper.
6. Open up the unsecured part as a fan.
7. As you fan yourself, locate the resistance, the force applied to overcome the resistance and the fulcrum.
8. Discuss this with your group. When you think you have the correct answers, report to the class or to your teacher, giving them the reasons for your answers.



Getting the Idea

This paper fan is an example of a machine. What work does it do? (Air has mass and it moved, therefore the fan does work.)

ACTIVITY
Simple Machines Mobile

Objective

Students draw or identify simple machines from pictures in magazines.

Materials

Five to six pieces of yarn 20-22 centimeters long; paper clips; cutouts of simple machines on different-color tagboard[1]; drinking straws in different lengths depending on the shape you want to give to the mobile; magazines

Procedures

1. Cut several pieces of yarn 20 to 22 centimeters long.
2. Tie one end of each piece of string to a paper clip.
3. Select machines to depict and cut out of tagboard to hang.
4. Select a place to hang the mobile.
5. Hang the objects from a drinking straw with yarn. Loop the yarn once around the straw. Make half a knot. Pull the yarn tight. Clip the paper clip to each object.
6. Balance the objects by sliding the yarn on the straw.
7. Change the clip on each cutout as needed to make the mobile attractive.
8. Suggest to the students that they design and construct other mobiles, as they have time.

[1]Students can cut pictures of simple machines out of magazines and glue pictures on tagboard to use in the mobile, or they can draw their own designs of simple machines on pieces of tagboard and use those for the mobile.

LESSON 2 Forces and Work

BIG IDEAS When we do work we use a force to overcome inertia, friction or gravity. We can measure work.

Whole Group Work

Materials

Piece of carpet about three feet x three feet
Blow dryer
Book or song: **Wheels on the Bus** by P. O. Zelinsky
Books: **Friction** by E. Victor, **Force: The Power Behind Movement** by E. Laithwaite, and **Up, Down, and Around: The Force of Gravity** by M. Selsam
Word tags: force, gravity, friction, machine. simple, inertia, energy, work, transfer, transform, resistance

Encountering the Idea

A force is a "push" or a "pull". We cannot do work without a force either pushing or pulling on something; machines help people exert energy in special ways to help them do work. We all know what work is — we move something or pick it up. Many of us do not like to do hard work if there is a machine that will help us do it more easily and quickly. Let's read **Wheels on the Bus**. Why are the people riding the bus? (To get somewhere, go shopping, not have to walk.) Why don't they walk? (It's too tiring.) Why is it tiring? (It's very far, takes too long; bus covers distance in shorter time.)

Bertha, please walk across the room. Are you doing work? Yes, how do you know you are doing work? For one, you are using energy; for another, you are moving your weight across the room. Now, suppose that I ask you to walk and carry this 10-pound load for one mile. That would really be a lot of work because you would not only have to move your body that has mass and that weighs around 90 pounds because **gravity is pulling** on it, but you would have to carry the load that also has mass and that weighs 10 pounds. You would have to carry 100 pounds for one mile.

Now, let's think about this. Raul, please pull your desk across the floor. Can you do it? Now, place the desk on top of this piece of carpet and pull the desk across the carpet. Can you do it? Why was it easier to pull the desk across the floor? What did you feel when you were pulling the desk across the carpet? Yes, the carpet was making it stick. (If a student says that the carpet makes friction, acknowledge the comment and say that it is correct and will be discussed later in the lesson.) In this lesson we are going to discover how work, energy, force, friction and gravity relate. Before you go to your learning centers, we are going to do some interesting kinds of things that might surprise you.

Exploring the Idea

The students complete **Activity** — Kickball.

Back in class after playing kickball, students identify when they used their body force (which is also the inertia of the human body put into motion by the body's muscles) and gravity during the game. They complete the **Getting the Idea** phase of the activity.

Now, let's try a new situation. Let's use this eraser to erase this word. (Write a word in pencil on a piece of paper.) When I rub the word with the eraser, the eraser rubs out the word. Feel the eraser; how does it feel? (It got hot and so did the paper.) Friction is a force and can transfer energy of movement (moving the eraser back and forth) to heat energy. Let's put our hands together, squeeze them and rub. What happens? Why? (Friction transforms motion energy into heat.)

Tell students that we do work when we move an object that has mass. Mass has the characteristic of **inertia**. Roll a heavy object (a bowling ball); a student stops it but uses force to stop it. Roll the object again; this time a student changes the direction of the ball; again a student has to use force to do it. The students describe the force needed to move, stop and change the direction of the rolling object.

At the **Mathematics Center**, the students

1. complete the **Activity** — Fractions
2. complete **Activity** — Friction of Surfaces
3. complete **Activity** — Measuring Work.

Getting the Idea

We have studied two forces today. What are they? Gravity and friction. When we overcome a force, such as gravity or friction, we are doing work. When we work, we are usually moving against a force through a distance. Let's give some examples of the work we did in the experiments.

1. What work did Bertha do in walking across the room? Yes, she moved her weight by working against friction, but she also worked against her own inertia. Inertia is the property of matter that resists change from being at rest or from being in motion. For example, if we place a piece of wood on a table, it will stay there until some force, like a person pulling on the rubber band or a strong gust of wind, moves it. (Demonstrate with a blow dryer, if possible.) So, when we move our bodies, we are working against the inertia of our bodies. When we carry a load, we have to move the load against its own inertia.
2. What work did you do when you pulled the chair across the floor? Yes, you moved against the inertia of the chair and also against the friction of the floor.
3. What work did you do when you pulled the chair across the carpet? Yes, you used energy to move against the inertia of the chair but also against the greater friction of the carpet.
4. What work did you do when you were pulling on the wood block?

Tell students that sometimes the force that we overcome in doing work is the **resistance.** Remember — **a resistance is always a force** that is opposing the **effort** we exert when we do work. For example, when I shovel some dirt from the bottom of a hole to the top of the hole, what is the resistance? Yes, the dirt is the resistance but also the shovel, because I have to move both of them against their own inertia, and in bringing up the dirt I have to overcome gravity too.

Organizing the Idea

At the **Writing Center**, assign each student group to read in reference books on energy, force, friction, gravity, resistance, inertia and work. They report to the class and define and illustrate each term in their own words.

Applying the Idea

Using new words from the unit — force, gravity, friction, machine, simple, inertia, energy and work — write a paragraph using each of the words **or**

make an illustrated dictionary by putting all the words in alphabetical order, defining each (you may look in a dictionary to make sure you get the correct definition) and illustrating the word **or**

make an illustrated dictionary by putting all the words in alphabetical order, defining each (you may look in a dictionary to make sure you get the correct definition) and constructing a model of the word.

Design a rocket ship to go into space. Decide what forces you will have to overcome, then design the craft to overcome these forces.

Closure and Assessment

Oral Interview

Use your pencil as a tool to write. Write your name and as you write decide whether the pencil is a simple machine. Explain, verbally, why you think it is, or why you think it is not. If you prefer, you may explain your reasons to your group, and then after the group thinks you have the correct answer, explain it to your teacher.

List of Activities for this Lesson

- ▲ Kickball
- ▲ Fractions
- ▲ Friction of Surfaces
- ▲ Measuring Work

ACTIVITY
Kickball

Objective

Students experience three forces in playing kickball; students say that inertia, friction and gravity are forces operating in playing kickball.

Materials

Kickball

Pictures of people involved in different activities such as playing, riding bikes, sharpening pencils, etc.

Procedures

Students play a game of kickball. As students play, the teacher directs their attention to the energy they are using in playing ball. They have to have energy to kick the ball with force that they need to move the ball; they need the force to change the direction of the ball, and need force to stop the ball. Tell them that after the game you will ask them about the three different kinds of forces they are using in playing.

Getting the Idea

After the game:

1. Tell students that a **force is a push or a pull.** What is the push in playing when you kick the ball? Your foot is a push against the ball. What is the force your foot feels when you kick it? You are kicking against the mass, the matter of the ball. The resistance you feel in kicking the ball is the **inertia of the ball.**
2. Ask the students what happened when they kicked the ball into the air. Was there another force acting on the ball? Yes, gravity pulled it down. **Gravity is a pull,** so gravity is also a force. When you stop a falling ball with your foot or your head, how can you tell that gravity is a force? (It hits you hard, and you know it is a force because it pushes against you.) When a ball falls, we say that gravity pulled it and caused it to fall.
3. What happens when you roll a ball on tall grass? Does it go fast or slow? What causes it to slow down? (Friction.) **Is friction a force?** How do you know? (It pushed against the ball and made it stop.)

Energy is what we need to exert a force.

Display pictures of people involved in different activities such as playing, riding bikes, sharpening pencils, etc. Define energy, force, gravity and friction while pointing to pictures illustrating each. Have students identify other examples of the forces found in the pictures.

ACTIVITY
Fractions

Objective

The student use fractions to measure the length of an object to the nearest one-eighth of an inch.

Materials

Rulers or measuring tapes marked in inches
Laminated strips of thick paper (one inch by 13 inches), marked in inches to simulate a ruler
Various objects to measure length
One screwdriver (or some other tool) of the same size for each group

Encountering the Idea

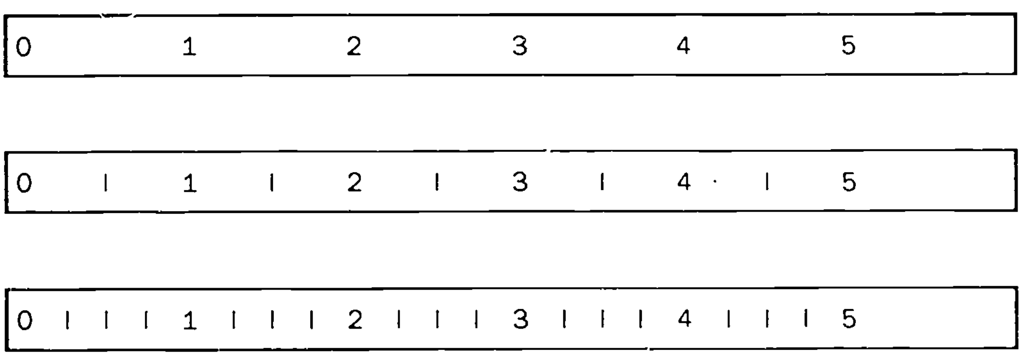
Each of you will work in groups to find the lengths of these objects. First, however, each group finds the length of the screwdriver. Using the laminated rulers, each group measures the same-size tool.

What is the length of the screwdriver? Some of you are saying it is eight inches, others say it is 8½ inches and some of you say it is closer to nine inches.

It is true that the screwdriver is longer than eight inches, but is it shorter than nine inches? Yes, but what do you suppose we can do to get closer to its true measurement? Yes, one way is to cut the inches into smaller parts such as ½ or ¼.

Exploring the Idea

Let's use the strips to measure the length of the screwdriver again. Take your marker and draw how you would cut the inch to get closer to the length of the screwdriver.



Getting the Idea

Sometimes when we have to measure the length of objects, we want to get as close as possible to their true length. To do that we cut the unit of length into smaller equal parts to help us. Some of you cut the unit into halves, others into fourths and some into eighths.

Some of you said the screwdriver measured 8½ inches, and some of you said it measured, 8 2/4 inches. How can you show with your strips if ½ and 2/4 are the same?

We say that ½ and 6/12 are two ways of showing the same fraction. We say that they are **equivalent fractions.** Other names for ½ are 5/10, 12/24, and what others? Can you find a pattern between the **numerator** and the **denominator** for all the fractions that are other names for $\frac{1}{4}$?

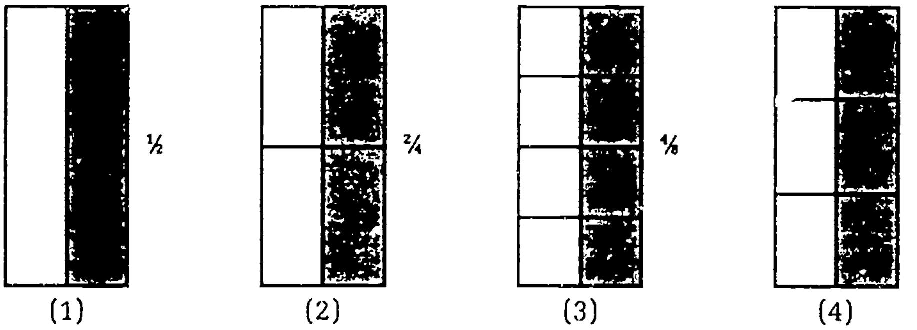
Organizing the Idea

Students mark their number strips with $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$ and mark their equivalents on the strips. For example, the students mark $\frac{2}{4}$, $\frac{3}{6}$ etc. to show the different names of the basic fraction $\frac{1}{2}$.

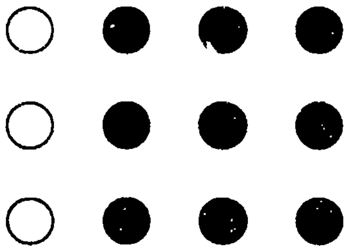
Applying the Idea

Fractions are numbers we can use when we want to talk about parts of things. In the activities below, you can see that there are many ways to use fractions.

1. Suppose you have a candy bar that you want to share with your friend. You can cut the candy bar in half like this (1). You can take the white part and your friend the brown part. Are the two parts the same? You can also divide the candy like this (2). You take two parts white and your friend takes two parts brown.



2. Maria's mother told her to go to the store to buy one pound of pecans for a cake she was making. At the store, the clerk told Maria that all she had were bags of $\frac{1}{4}$ pound each. What should Maria do?
3. Are $\frac{2}{4}$, $\frac{3}{6}$ and $\frac{4}{8}$ all other names for $\frac{1}{2}$? Draw other different pictures for $\frac{1}{2}$ and write fractions for those pictures.
4. Suppose there are 12 people on a team. Three players are injured. What fraction, or what part, of the team is injured? ($\frac{3}{12}$, and also $\frac{1}{4}$).



Assessing the Idea

1. In your own words, tell what equivalent fractions are.
2. Use the laminated strips to show some equivalent fractions for $\frac{2}{3}$ and $\frac{1}{8}$. Using these paper clips (some are bent to the point that we can no longer use them), tell the fraction of the paper clips that we can't use.
3. Write three equivalent fractions for $\frac{3}{6}$, $\frac{1}{4}$, $\frac{5}{10}$.

ACTIVITY
Friction of Surfaces

Objective

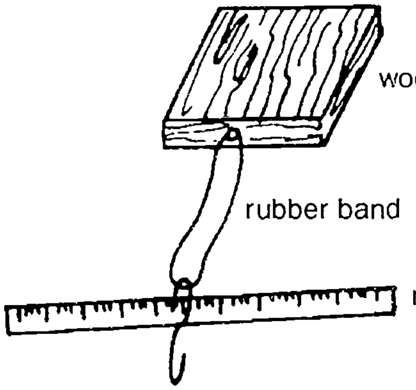
The student demonstrates that overcoming a force such as friction is work.

Materials

Two wood blocks of the same size; thumbtacks; thin rubber band; paper clips; sheets of sandpaper; waxed paper; aluminum foil; construction paper; centimeter ruler

Procedures

1. Place a wooden block on a wood surface.
2. Fasten a rubber band to it with a thumb tack.
3. Hook the rubber band with an opened paper clip.
4. Hold the rubber band end over the end of a ruler.
5. Pull the rubber band very slowly. Observe and record where the rubber band end is over the ruler.
6. Measure how far the band stretches before the block moves. Make the reading before the block begins to move. Read the ruler to the nearest centimeter.
7. Perform the same experiment on other surfaces.



Discussion

1. What mass did we move?
2. What distance did the mass move?
3. What work did we do in this experiment?
4. What force did you overcome when you did this work?

ACTIVITY
Measuring Work

Objective

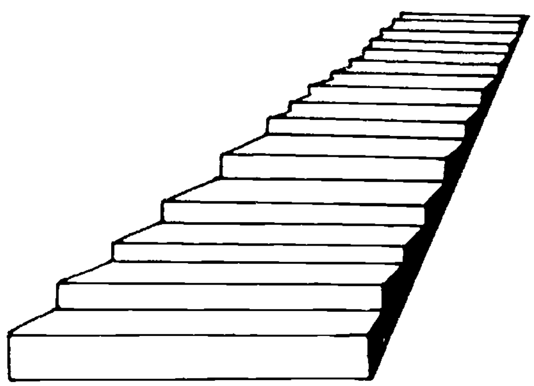
Students calculate work done by moving various weights over a distance.

Materials

Plastic bag filled with dirt to weigh a pound
Foot ruler or tape ruler to use to measure distances across the room
Scale to weigh various objects in the classroom

Procedures

1. Stand the ruler on the table or the floor.
2. Raise the one-pound weight to the top of the ruler.
3. Raise the one-pound weight six inches. How much work did you do? (1/2 foot-pound.)
4. Raise the weight two feet. How much work did you do this time? (two foot-pounds.)
5. Select various objects in the room. Weigh them. Determine the amount of work you do in carrying that object a measured distance.
6. Each person weighs herself/himself. Climb a set of stairs. How much work did you do to get to the top?



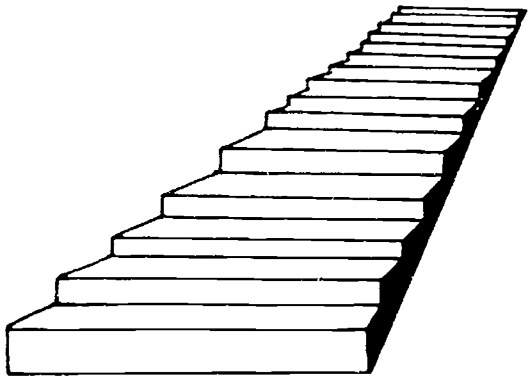
Getting the Idea

Finding the amount of work you do in climbing stairs is a little tricky. To find the work you did, did you multiply your weight times the distance along the line along the steps? NOT!

There is a small problem in calculating the work in this situation because if you climbed a set of stairs you can't measure the distance along the stairs but can measure from the floor to the top of the stairs (the dark line), as in the picture shown above. If you can't climb up the side of the stairs to measure the height, then you need to find the vertical distance another way. The students work in their groups to find a solution.

If you haven't figured it out, try this. Measure the height of each step and add to get the total vertical distance. Or if all the steps are the same height, measure one of them and multiply by the number of steps!

Remember: The amount of work you do to raise one pound a distance of one foot straight up is called one foot-pound. You did _____ foot-pounds of work in walking up the set of stairs.



Applying the Idea

Suppose you need to carry 100 pounds of computer paper up the set of stairs in the problem above. Find one way to make your work easier.

Assessing the Idea

1. What is work? Give examples.
2. What two things do you need in order to do work?
3. What provides the force when you are riding a bicycle? In a car?
4. Write your own definition of work.

LESSON 3 A Crowbar

BIG IDEAS The three different kinds of levers have different fulcrum or pivot locations. We calculate work using multiplication.

Whole Group Work

Materials

As many as possible of the tools listed in **Activity** — Is This a Machine?
Chart showing the types of levers with diagrams of each type
Word tags: resistance, fulcrum, effort

Encountering the Idea

Here is a broom. Is a broom a machine? Is this shovel a machine? This crowbar and these tongs, are they machines? What about a fishing pole? How do we know when something is a machine? We said that a machine helps us in doing our work by helping us transfer or transform energy to do work. In this lesson, we are going to discover how each of these tools helps us in our work and why we say they are machines.

Exploring the Idea

At the **Science Center**, the students begin Part 1 of **Activity** — Is This a Machine?

At the **Mathematics Center**, the students complete **Activity** — Seesaw Math.

Organizing the Idea

Students complete Part 2 of **Activity** — Is This a Machine?

At the **Writing Center**, students write the names of the tools in alphabetical order in their word bank.

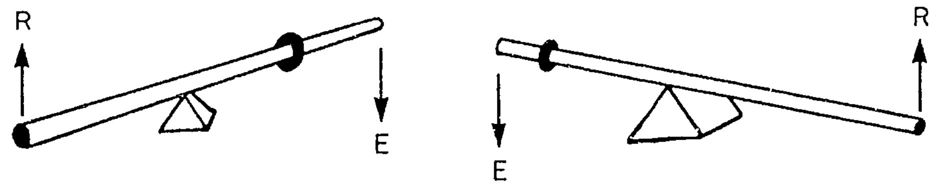
At the **Library Center:**

1. Students look for more examples of levers in magazines and books. They also include on their list tools found around the school or house. The students may refer to the chart showing the three types of levers with examples of each.

   The idea is that the students think through the examples in order to classify them, rather than memorize the specific definition of each type of lever.
2. Students read and discuss **A Book About the Lever** by H. Wade.

Applying the Idea

1. Name at least three jobs done around the house or school with levers. Describe the way the levers work.
2. Draw a seesaw; locate the fulcrum. Where are the resistance and the effort located? (The fulcrum is between the resistance and the effort; in this case either end of the seesaw is the effort or the resistance depending on the direction.)



For example: One washer is at the end of a rod, but the fulcrum is placed so that the other end of the rod rests on the table. We can move the fulcrum so that the seesaw will balance (as best as possible since the wedge marks on the rod may not make for a perfect balance). Ask the students: Would this be a winning combination since there was one fewer washer used?

The students discuss: What weight on the side opposite the washer made the seesaw balance? (The rod has weight that will balance against the washer.)

Closure and Assessment

1. Draw a lever showing where you would place two objects in relation to the fulcrum to make them balance, one object of two pounds and one of four pounds. Label the type of balance your lever is and locate the fulcrum, the resistance and the effort.
2. The student selects an example of the lever she/he uses the most and writes about it, describing it, what type it is and how she/he uses it.
3. Look around the playground and at home and list and/or draw all the levers you can find. If you can, label their class.

List of Activities for this Lesson

- ▲ Is This a Machine?
- ▲ Seesaw Math

ACTIVITY
Is This a Machine?

Objective
The student identifies the force exerted to overcome the resistance in a given lever.

Materials
Ball and bat; broom; shovel; crowbar; fishing pole; pliers; hedge clippers; tongs; paper cutter; tennis racket; garlic press; car jack; seesaw; hammer; wheelbarrow; hockey stick; tweezers; scissors; golf club; canoe and paddle; cart; nutcracker; bottle cap opener

Procedures
Part 1
Students examine each of the tools and then take turns demonstrating to the members of their groups how to use each tool. The students complete the parts of the chart labeled: Tool, Resistance, Force Used (Effort) and Work Done.
1. Determine the force overcome — the resistance — on each tool (for example, with the broom, the inertia of the dirt on the floor).
2. Determine the force used to overcome the resistance (the hand pushing on the broom handle).
3. Determine the work done (moving the dirt from one place to another).

Tool	Resistance	Force Used (Effort)	Work Done	Fulcrum
pliers	nail	hand squeezing on the handles	pulled out the nail	bolt on the pliers

Part 2
Students complete the chart by locating the "fulcrum" for each lever.

Tell students that a **lever** is one of the simplest machines man has invented. We have already examined some levers. The students name each of the tools examined in the activity.

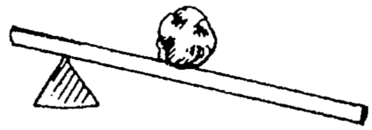
Ask students to see if the tools are alike and different in some ways. These are all levers, but they are somewhat different. After the students have had an opportunity to look for differences, help them organize the levers in some way.

Suggest this: In a **first-class** lever, the fulcrum is between the load (resistance) and the effort (force). One example is the crowbar. The girl lifting the big rock exerts **effort** on one end of the bar, the rock is the **resistance,** and the small rock that provides a pivot is the **fulcrum.**

In a **second-class** lever, the load or the resistance is between the fulcrum and the effort. One example is a nutcracker. The resistance is the nut, the effort is the hand pressing on the handles, but the fulcrum is the screw on the edge of the nutcracker.

In a **third-class** lever, the effort is between the load and the fulcrum, as with a pair of tongs.

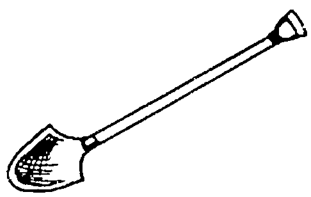
First Class



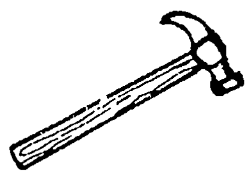
Second Class

Third Class

At the **Art Center,** the students make diagrams of tools showing where the resistance is located, and where the forced we use in work is located.



Shovel



Hammer

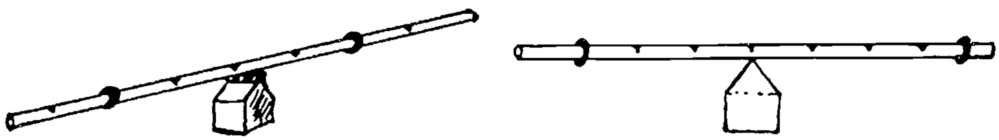
ACTIVITY
Seesaw Math (The Game)

Materials

Students construct the game and compete in groups of four. For each group:
One yard-long dowel rod 1/2-inch diameter
One empty 1/2-pint milk carton
Several same-size and same-weight metal washers or counters with a hole that fits the dowel rod without slipping

Preparation

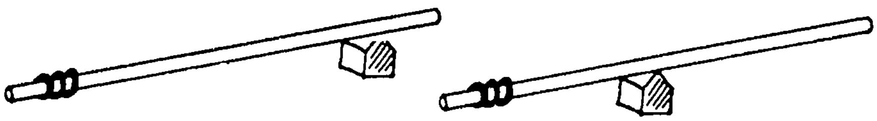
1. Cut a wedge shape on a dowel rod (one yard in length) at its center.
2. Cut a wedge shape on the dowel every inch to the right and every inch to the left of the center wedge. Do not label the marks. After working with the seesaw, the students may want to label the marks. They may do so if that is one of their strategies to win the game.
3. Use the milk carton as the fulcrum by placing one of the wedges on the rod on top of the carton to form a seesaw.



Before playing the game, the children:
1. explore and explain to each other what they did to make the seesaw balance
2. record their observations
3. discuss the rules with the other groups.

The Game

1. The teacher demonstrates: Put the center cut on the fulcrum. Put washers on the seesaw on both sides to make it balance. Put three on one side and make the seesaw balance in different ways.
2. Place the washers at different distances from the fulcrum and again make the seesaw balance.



3. Tell the students that the rules of the game are these:
   - each team has a complete set of washers, rod and carton
   - the object of the game is for one team to place a set of three washers, say, on one side of the seesaw and another team (after team consultation) to place one more or one less washer on the opposite side to make the see-saw balance in only one attempt
   - the first team to beat the challengers (the ones who place the washers) gets to set up the next set of washers and also to decide how many washers they will set up
   - if the first team doesn't make the seesaw balance, the next team gets a turn, until a team wins.
4. Make some rules about how you can lift a heavy load. When you report to the entire class be sure you have reasons for your rules.

LESSON 4 A Bicycle

BIG IDEAS A wheel and axle is a machine that rolls its load by decreasing friction. We can estimate a wheel's perimeter (circumference).

Whole Group Work

Materials

Books: **Exploring Uses of Energy** by E. Catherall, **Let's Find Out About Wheels** by M.C. Shapp, **Wheels: A Tale of Trotter Street** by S. Hughes and **Unconventional Invention Book** by B. Stanish

Large, empty spool of thread; unsharpened pencil or a rod; scissors; lightweight cardboard box; balloon; box of drinking straws; 20 pencils; 20 marbles, same size

Encountering the Idea

Show students a wheel and axle consisting of the spool with the rod inserted in the center. Ask the students if they think it is a machine. Ask them if they think it is a lever. No, levers don't use a wheel. After a discussion, ask them to list the characteristics of a device that would help us decide if it is a machine. Although a machine requires that we exert effort, it is a device that still makes work easier.

Can this wheel with the rod help us in our work? How? Is it easier to roll something than it is to pick it up and carry it?

Exploring the Idea

Before working at the learning centers, the students in a whole group activity make a **Rolling Cart,** as described below.

Materials

Many of these materials can be brought from home. For each student:

four empty spools of thread; two unsharpened pencils; an empty box (e.g. large matchbox); small objects to put in the box; masking tape or four to eight clamps; Super Glue

Procedures

1. Put one pencil through the holes in two spools.
2. Put a clamp on the outside and inside of each spool to keep the pencil from moving from side to side.
3. Make a second axle with the other two spools and pencil.
4. Glue each end of the box to the length of one of the pencils.

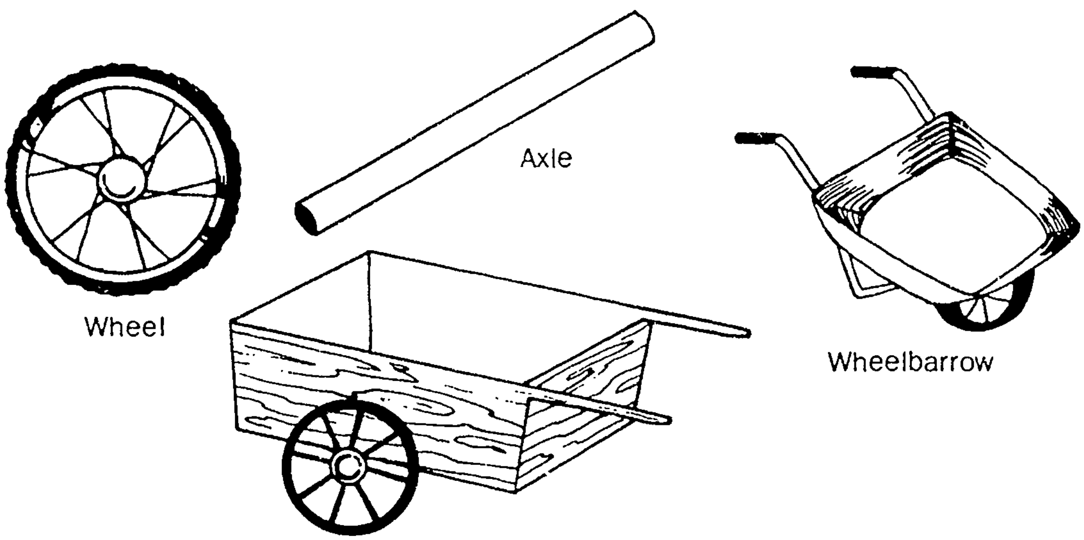
At the **Mathematics Center:**

1. Complete **Activity** — Circumference of a Wheel.
2. Complete **Activity** — Let's Get Even. Students need to be do this activity before the other activities in the **Science Center** to get the required background.
3. Complete **Activity** — Average Speed.

At the **Science Center,** the students have a choice to complete either or both racers. Complete **Activity** — Tin Can Racers, and/or complete **Activity** — Spool Racers.

Getting the Idea

Read to the class **Wheels: A Tale of Trotter Street.** After reading and discussing the book, tell the students how a wheel and axle, another type of simple machine; has two parts, as the name says. One part of the machine is the wheel, and it has a shape like a circle. The other part is the axle, which has a shape like a cylinder. The wheels of a wheelbarrow are an example of a wheel and axle. Many times two wheels combine with one common axle to roll things from one place to another. An example is a donkey cart.



Show a picture of a bicycle. A bicycle is an example of a machine that has two wheels and two axles; it is not a simple machine, however. Ask the students to describe the bicycle. (Has two wheels; wheels turn on an axle; the chain looks like a belt on a pulley, etc.) What geometric shapes do you see in a bicycle? In a unicycle?

Organizing the Idea

At the **Writing Center** students make a list of the characteristics of a lever and of a wheel and axle. Add to this list as the students learn about other simple machines. They can choose a simple machine and write a poem or a riddle describing it. For added interest, the student can write the poem or riddle on the inside of a large outline of the selected machine.

At the **Library Center,** students research the history of the wheel and report to their groups and to the class. The students also look for pictures of simple machines and name the various geometric shapes they see in the machines.

Applying the Idea

At the end of the lesson, the students race the cars they construct by completing **Activity** — Car Races. They have acquired all the understanding necessary to determine a racing winner.

Closure and Assessment

Problem Solving

The student makes a list of things that roll or are circle-shaped. Then he/she selects one from the list and explores ways to use it as part of a wheel and axle.

Student constructs a toy that uses a wheel and axle to move.

List of Activities for this Lesson

- ▲ Tin Can Racers
- ▲ Spool Racers
- ▲ Circumference of a Wheel
- ▲ Let's Get Even
- ▲ Average Speed
- ▲ Car Races

ACTIVITY

Tin Can Racer

Objective

The student builds a racer from various objects found in the house and uses the racer to obtain data from which to make decisions.

Materials

For each student or student group:
Coffee can with the bottom intact and one or two plastic reclosing lids
Large, strong rubber band or section cut from a bicycle inner tube
Wooden dowel or sturdy chopstick; a smaller piece should be smaller than the diameter of the can bottom, and a larger piece should be approximately 10 cm long with one end rounded
Metal washers
Twine, wire or a twist tie

Procedures

To make the tin can racer:

1. Drill holes in the precise center of the coffee can bottom and plastic lids. The holes must be large enough so the rubber band will thread through them easily; the edge of the hole in the can bottom must be smooth so it won't cut the rubber band.
2. With the lids on the can, thread the rubber band through the holes so that its loops protrude from both ends of the can.
3. Push the shorter wooden dowel or stick through the loop of rubber band protruding from the can bottom.
4. Punch two small holes in the can bottom on either side of the stick and tie the stick securely to the can bottom with twine, wire or a twist tie.
5. Thread the other loop of the rubber band through the holes in several washers. There must be a sufficient number of washers to keep the longer stick, which is added in Step 6, from rubbing against the edge of the can. Later, you can increase or decrease the number of washers.
6. Place the longer wooden dowel or stick through the loop with the washers.

To give the racer the needed energy to roll:
Hold the can firmly in one hand and rotate the rod with the other hand. When the rubber band has wound tightly, the racer is ready to go.

Students customize their racers with names, colors, slogans, etc.

ACTIVITY
Spool Racers

Objective

The student builds a racer from various objects found in the house and alters the design of the racer to observe and discover the function of the different parts of the racer.

Materials

For each student or student group:
spool — the size that holds 200 yards of sewing thread
rubber band
two wooden kitchen matches
small chunk of soap with a hole cut through the middle and carved into a rough disk about four mm smaller than the flat end of the spool

Procedures

To make the spool racer:

1. Pass the rubber band through the center of the spool.
2. Through one end of the rubber band, firmly anchor a short piece of match-stick. Its length should be less than the diameter of the flat end of the spool.
3. Thread the other end of the rubber band through the hole in the disk-shaped piece of soap.
4. Place a longer piece of match stick (the stick minus the head) in the loop of the rubber band that you threaded through the disk of soap.

To give the racer the needed energy to roll:

Twist or "wind up" the rubber band by holding the spool firmly in one hand and rotating the stick with the other.

Observations

1. Are the racers reliable?
2. What is the function of the soap?
3. Why is the longer match stick important?
4. What happens if we cut notches on the edges of the spools?

ACTIVITY

Circumference of a Wheel

Objective

The student estimates the circumference of a wheel by multiplying the diameter by three and "adding a little bit more."

Materials

At least 10 bottle or jar caps of various sizes for each student group
A tape measure

Procedures

Tell the student groups that the class will estimate the perimeter, or distance, around a circle, but that the accepted word for perimeter of a circle is "circumference." Students are to note the word "circumference" has in it the root "circum," which means "around". Remind the students that the diameter of the circle is the measure of the line that starts at a point on the circle, passes through the center of the circle and ends at the opposite edge.

1. Students locate the diameters of each of the caps.
2. The students measure and record the circumferences of the caps using the tape measure.
3. The students measure and record the diameter of the circular object.

Note: The following are suggestions to make to the problem-solving teams to help them continue pursuing the problem.

ESTIMATING CIRCUMFERENCE

Diameter inches	What Happened to It to Get to This?	Circumference
17		53½
22		69
5		15½

4. Students speculate what other names for 53 involve 17 (e.g., 17 x 3 = 51).
5. Suggest that students will have to add a large number to a number like 17 to get to 53.
6. Suggest that starting with the smaller lids might help students estimate, since the numbers are smaller.
7. Suggest that students might need an operation such as multiplication to get to larger numbers faster than by addition.
8. After the students start to try multiplication, they may want to try multiplying in sequence, first with two, then three, then four, to get some ideas.
9. Frequently remind students that the task is to **estimate** the circumference only.

ACTIVITY
Let's Get Even

Objective

The student finds the average of three given numbers.

Materials

For each student or student pair:

one trading chip board with 20 - 30 chips; one game chart; Cuisenaire rods —

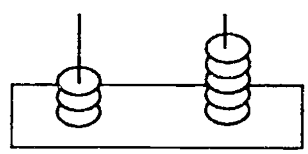
10 orange, 20 white, five yellow (or some other manipulative to use in fraction form)

Procedures

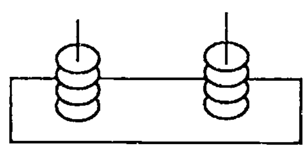
The teacher shows students the trading chip board and the chips. Place two stacks of chips on the board. The teacher tells the students that these two stacks are not even or level. Then the teacher shows the students two level stacks and says that the stacks are even.

The students complete the activities.

1. Make two stacks, one having three chips and the other five chips.



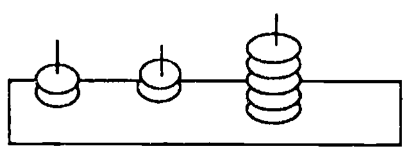
Make the stacks even, or level.

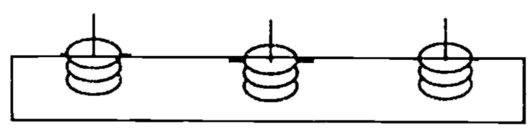


The stacks are now level. How many chips are there in each equal stack?

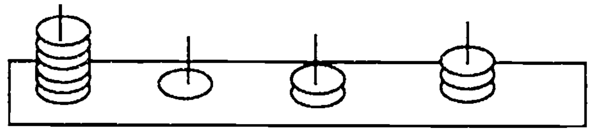
There are four chips in each stack.

2. Suppose this time there are three stacks having three, seven and two chips. Make the stacks even and say how many are in each even stack.
3. Three stacks with two, two, five. Show picture before and after.



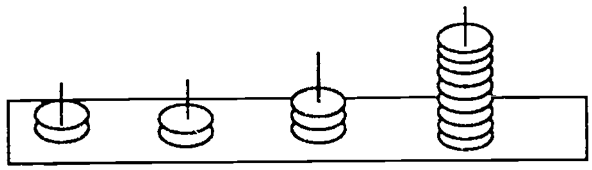


4. Four stacks with six, one, two, three.



[1]A board with pegs to allow the students to place chips in various stacks

5. Four stacks with two, two, three, nine.

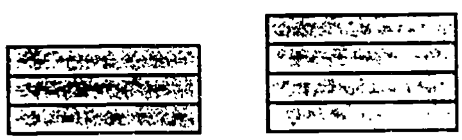


Let's organize what we did in this game by putting the information on a chart. As you use the chart look for a pattern that may help you make correct decisions quickly.

How Can We Get Even?

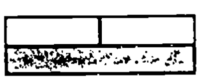
Activity	Number in each Stack	Number of Stacks	Total Number of Chips	Number of Chips to Make the Stacks Even

6. After you have completed **Step 5** do the following:
   If you have found a **fast** way to make the stacks even, write it down here and show it to another group after they have completed **Step 5**, or show it to your teacher.
7. Use the orange and yellow Cuisenaire rods to form stacks. Make one stack of three and one of four orange rods. Now make two even stacks. You may use the orange and white rods to make the equal stacks.



You may use other rods if you need to, to make the stacks equal.

At this point, encourage the students to solve the problems **on their own initiative.** If they need some suggestions, the students may continue as follows:



Try lining up 2 of the yellow rods with the orange rod. Can you see a way to make the 2 stacks even by using the yellow rods?

Trade 2 of the yellow rods for one of the orange rods and make the 2 stacks level. If you do that, how tall is each stack?

Each stack is now 3½ rods tall.

8. If you have five stacks of two, three, five, five and six orange rods, how high will the stacks have to be to have even stacks? Explain and draw a picture of how you solved this problem.
9. Elise found a fast way to make the stacks even first by adding all the stacks and then dividing by the number of stacks. Do you think Elise's system works?

Look for patterns in your chart to check if Elise is correct.

How Can We Get Even?

Activity	Number in each Stack	Number of Stacks	Total Number of Chips	Number of Chips to Make the Stacks Even

ACTIVITY
Average Speed

Objective
Students apply the concept of "average" by looking for a way to assign an "average" speed.

Materials
For each student: the racer the student constructed; copy of the chart to record times

Procedures
Seven cars race in three heats.

Phase 1
How can we find the fastest car?
1. Is it the one with the single fastest trial?
2. What about the car that has trials of four, four, five seconds?

Car	Heat 1	Heat 2	Heat 3	Average
1	3	7	4	
2	6	5	6	
3	4	3	4	
4	6	4	5	
5	4	4	5	
6	5	5	6	
7	7	6	4	

Phase 2

Procedures
1. Students race cars as before, but in two heats instead of three.
2. Look for a method to assign an "average" speed to each car.
3. Students justify this method to their group and report to the class.
4. Identify the winning car.

Phase 3
Students continue races with four heats, five heats, as time permits.

ACTIVITY
Car Races

Objective

Students calculate several averages and apply the concept to predictions about future events.

Materials

Race car for each student or student group
Digital clock or stopwatch that shows seconds
Chart showing race times and averages
A distance marked on floor tiles for the race (about four meters)

Procedures

1. Each student or student group races the car three times.
2. Calculate the average time to travel the marked distances.
3. Answer the following questions after collecting the data.

Car Owner	Time 1st race	Time 2nd race	Time 3rd race	Average for 3 races

1. Whose car was the fastest?
2. Whose car was the slowest?
3. What was the average time for all the cars?
4. Whose car had the single fastest time?
5. Whose car had the single slowest time?
6. Whose car had an average time equal to the whole group (class) average time?

[1] Instructions for construction of a race car given in Activities — Tin Can Racer and Spool Racers

LESSON 5 A Slide

BIG IDEAS An inclined plane is a machine that changes the direction that force is applied and that helps decrease the effect of gravity, though it may increase friction. Different types of inclined planes form triangles.

Whole Group Work

Materials

Book: **Hump, the Escalator** by D. Faubron
Per student group:
Large solid boxes, one about six inches high and the other about one foot high; a large screw and other screws; pictures of the pyramids; picture of a spiral staircase; shovel; plywood board, one yard X two yards; small piece of board; books to make an inclined plane; paper brads; doorstop; picture of a tooth; spring scales; toy cars; rubber bands; rulers; screwdriver; tack; nail; knife; chisel

Encountering the Idea

Read the story of Paul Bunyan to the class. Students note that Paul Bunyan used a tool. Ask the students if the tool he used was a lever. A wheel and axle? What tool did Paul Bunyan use? Yes, an axe. Is an axe a machine?

Rosa, please walk up this ramp. Now, walk up this higher one. Which is easier to climb, the steep one or the one that is not so steep? Is this ramp a machine?

Robert, here is a piece of wood I need attached to this larger piece of wood. What could I use to attach them? Yes, I can use a hammer and a nail, or I can use a screw and a screwdriver. Is a hammer a machine? Is a screwdriver a machine? One of the students demonstrates using a nail to attach the two pieces of wood.

What questions do we need to ask to decide if a device is a machine? Yes: Does the device help us overcome a force? Does the device help us transfer energy? In our investigations today, we will discover if these two devices are machines, how they work and what forces they overcome.

Exploring the Idea

At the **Science Center**, the students complete
1. **Activity** — Moving Heavy Objects
2. **Activity** — Using an Inclined Plane
3. **Activity** — Wedge: the Double Plane, as below.

Procedures

1. Provide each student group the following tools: shovel, tack, nail, doorstop, picture of a tooth, knife, chisel.
2. The students examine each of the tools and decide how they work. They describe how the tool does the work.

3. The students draw a picture of what they think the device does.
4. They decide how the devices are alike.

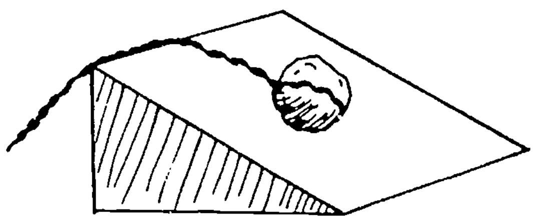
4. **Activity** — What is a Screw?, as below.

Procedures
1. Provide a large screw to each student group.
2. Ask each group to examine the screw closely and describe it. What does it look like? If you were a tiny ant on the tip of the screw, what would it look like to you? Yes, a screw is an example of an inclined plane. It looks different because the plane circles around itself. Is a screw a machine?
3. What forces does the screw overcome? (It has to break the material by overcoming the forces that bind the wood fibers together. It also overcomes the friction of the screw against the wood, which causes the wood and the screw to get hot.)
4. How do we transfer energy in using the screw?

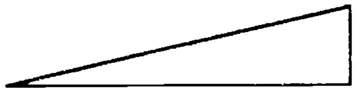
Getting the Idea

Part 1
The inclined plane is one of the simplest machines that we know. It helps people raise heavy things or lower them more easily. Any board or flat surface that leans against something can become an inclined plane. An inclined plane, as it slants on a base, forms a triangle.

In the picture shown below, a stone is raised from ground level to the top of the plane as it might have been done when the pyramids were being built. Many people, pulling on stout ropes, were able to raise stones that would have been too heavy for them to lift without the inclined plane. Also the workers used logs as rollers (wheels)!



Discussion
1. When you are sliding down the slide and you go very fast, or you have on very thin clothing, what do you feel? (Gets hot.) What causes the heat? (Friction, because the surface of the slide resists the body going down the slide.) What can you put on the slide if you want to go faster? (Some kids spill dirt down the slide; what happens?)
2. What work did the slide do? (It is moving your body weight down to the ground — moving a mass a distance.)

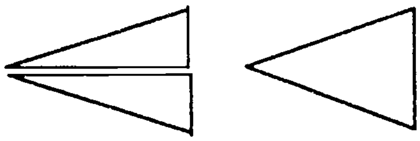


We know the ancient Egyptian pyramids were built by men using inclined planes to raise the heavy stones that they needed to build these huge monuments. The Egyptians built the pyramids many thousands of years ago — in 300 B.C.

Part 2

Another simple machine we call a "wedge". A wedge is two inclined planes placed back to back to look like a triangle.

Wedges do many things that require lifting an object, cutting or splitting something or holding something in place. Examples of common wedges are: a shovel to dig into the dirt, a tack to hold up paper on a bulletin board, a nail to hold a board in place, a doorstop to hold a door open, an axe to split wood or a tooth to chew a piece of meat.



Part 3

Students give and draw examples of the screw such as: spiral staircases, roads that wind around a steep hill, vises for workbenches, clamps to hold things together, adjustable piano stools, adjustable parts of wrenches, propellers for airplanes and boats, etc. On the pictures, students color the part that shows the screw.

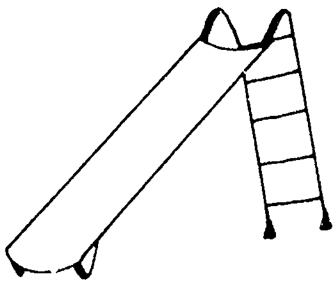
Organizing the Idea

At the **Drama Center,** the class divides into three groups — the Inclined Planes, the Wedges and the Screws. Each group reports, using pantomime, how to use each tool and the work each tool does.

At the **Art Center,** students draw several different objects and color the part that shows a wedge. Describe how we use each of these objects as a wedge. Where can you see a triangle shape? Where is the point of the wedge?

At the **Writing Center,** the students complete the following:

Have you seen this in your schoolyard? What is it?



Unscramble these words:
dlsie ___________ elpna ___________ glenatri ___________
elsipm ___________ ihcmaen ___________

Applying the Idea

Problem Solving with Calculators

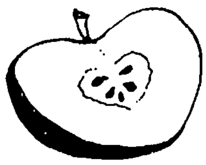
Working in pairs, students solve the following:

1. Two loggers use axes to split logs. One logger can split 20 logs in 15 minutes. Another logger can split 30 logs in 15 minutes. How many more logs does the second logger split in one hour than the first logger? Students discuss different ways to solve the problem.
2. How long will it take the two loggers working together to split 200 logs? Students discuss different ways to solve the problem. Can a chart showing how many logs each logger splits each hour help us solve the problem?
3. When students have finished, they help write a "directions" paragraph about what they did to solve the second problem. Write their contributions on the board. Encourage them to use signal words like "first", "next", "then" and "last". After the class is satisfied with the paragraph's sequential order, volunteers read the paragraph.

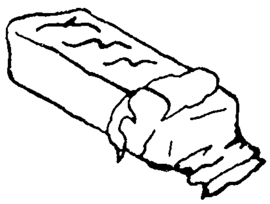
Closure and Assessment

Robert, suppose you needed to carry a refrigerator up to the second floor of a house, what would you do?

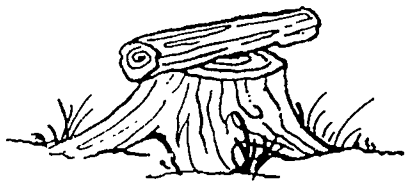
Which inclined plane do you use to do the following?



core an apple



cut a candy bar



split a log

Reconvene students for closure and assessment. Read to the children the poem in **Childcraft Encyclopedia**, Vol. 7, pp. 94-95. Students identify the words used as nouns in the poem. Students write a sentence for each animal shown on the escalator. The students write in journals about the escalator as a machine and underline each noun.

Math Activity — **Discover Science**, Scott Foresman, pp. 132-133.

List of Activities for this Lesson

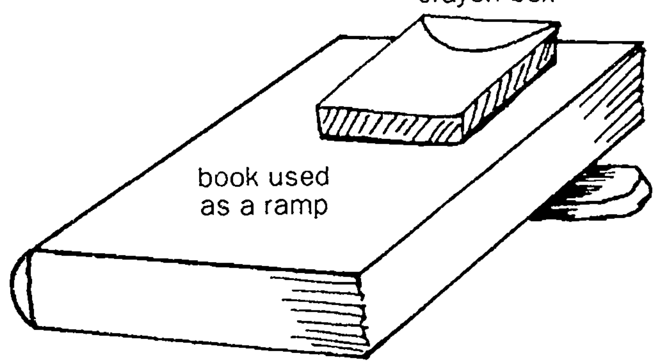
- ▲ Moving Heavy Objects
- ▲ Using an Inclined Plane

▲ ACTIVITY
Moving Heavy Objects

Objective
The student describes how an inclined plane functions to produce work.

Materials
For each group of three:
a book, a crayon box, an eraser

Procedures
Use a book to make a ramp. Place an eraser under one end of the book. Place the crayon box at the top of the ramp (the book). Now without touching the box, try to move the box down the ramp. You can use objects to help you. After the students have moved the crayon box up and down the ramp, have them suggest how they could make the box easier to move (greasing bottom, inclining the ramp more, attaching wheels at the bottom).



At the **Language Center,** the students write a report in their journals about how people move heavy objects.

ACTIVITY

Using an Inclined Plane

Objective

Students examine the graph data for heights of one, two, three, five and six books. Students predict the number of centimeters the rubber band will stretch for four books, and then test their predictions.

Materials

Six books; board; rubber band; spring scale or ruler; paper clips; toy car or roller skate

Procedures

1. Make an inclined plane by placing the board on one book.
2. Place a roller skate on the board.
3. Hook a bent paper clip around the tied shoelace of the roller skate.
4. Attach a rubber band.
5. Measure and record with a ruler the length of the **unstretched** rubber band.
6. Pull the skate slowly up the board.
7. Measure and record with a ruler or spring scale how much the rubber band stretches.
8. Repeat steps with height of two books, then five and six books.
9. Record what you find on a graph.
10. Predict and then test your prediction using four books for the ramp.
11. With your student group, write a rule about using inclined planes. Show the rule to another group and defend your reasons for stating the rule your way. Show it to the teacher and to the other members of the class.

LESSON 6 A Pulley

BIG IDEAS A pulley helps us change the direction of a force. A pulley transfers energy through distance (or **nothing in nature is free**).

Whole Group Work

Materials

Books: "The Elevator", in **Childcraft Encyclopedia**, Vol 1., p. 214 and **The Simple Facts of Simple Machines** by E.J. & C. Barkin

Small pulley; meter stick; string; pail; sand; spring scale; wire; cotton spools; hook; toy bucket with heavy objects; a pulley hung from the ceiling

Word tags: pulley, direction

Encountering the Idea

Aak a student to lie flat on her/his stomach on a table and to pull up the toy bucket full of heavy objects. Secure a stout rope to the handle of the bucket so the student can raise it to table level. Ask students to give suggestions about how to raise the bucket in an easier way. If students suggest various ways to help, accept them and record them on the board for later reference. Tell the students you will ask them the same questions again at a later time.

Exploring the Idea

At the **Science Center**, students complete **Activity** — The Pulley, as below.

Procedures

1. Fill a pail about 1/4 full of sand.
2. Lift the pail with the spring scale; record the weight in the pail.
3. Attach one end of the string to the meter stick; run the string through the pulley.
4. Attach the free end of the string to the spring scale.
5. Hook the pail onto the pulley; lift the pail using the scale; record the weight.
6. Compare the two forces used to lift the pail.
7. Design your own experiment using several pulleys at the same time.
8. Write a rule about how to use a pulley, or several pulleys.
9. Share your findings with your teammates and with your teacher.

Students complete **Activity** — Make Your Own Pulley, as below.

Procedures

1. Bend about eight inches of wire into a triangle shape; push the ends into a spool.
2. Bend the two protruding ends of the wire together.
3. Hang your pulley from a suitable place.

4. Tie one end of the string to the handle of the load (resistance).
5. Wind the other end of the string over the cotton spool.
6. Raise the load one foot. Record how much string you used to lift the load one foot.
7. Raise the load to different heights. Can you find a pattern?
8. Make a rule about the use of pulleys and the force needed to raise a given weight to a given distance.

Students complete **Activity** — Pulleys and the Direction of Force.

Getting the Idea

A pulley is a machine we make from a belt, rope or chain that wraps around something like a tree branch, a rod or a wheel. A fixed pulley helps to change the direction of the load, as you saw in this demonstration. A movable pulley, however, helps the person do work by moving the load.

Let's see if you have been able to solve the problem with which the lesson began. How can Betty raise that tub of heavy objects to the table? You think we could use the pulley that we hung from the ceiling? How can we do that? Attach the bucket and have Betty sit on the table, instead of lying on it on her stomach, and have her pull down. In what direction is the bucket going? Yes, it is going up — **but Betty is pulling down!** Yes, a pulley is a very simple machine, but it can do very important things — change the direction in which we have to apply the force, for one.

What did you discover when you completed **Activity** — The Pulley? A pulley — the name says what you do to it — you pull it. It is a machine that, in its simplest form, makes you use equal force, but you can do a very important job: change the direction of the load. With a fixed pulley, you pull down and the load goes up. When you use several pulleys, you can use less force, but you lose distance.

At the **Writing Center,** students read about and then discuss how an elevator works. Students write a poem about elevators.

Science Activities: Read the definition in **Science Horizons,** Silver Burdett, pp. 198-199. Students will do the problem solving on p. 199. They will write out a solution. They will gather in groups of three or four to discuss solutions.

Organizing the Idea and Assessing the Idea

Written Assessment
Make a list of the way we use pulleys around the house or the school.

Performance and/or Written Assessment
Is an elevator a simple machine? Why, or why not? Draw and/or write a paragraph to defend your position.

List of Activities for this Lesson

▲ Pulleys and the Direction of Force

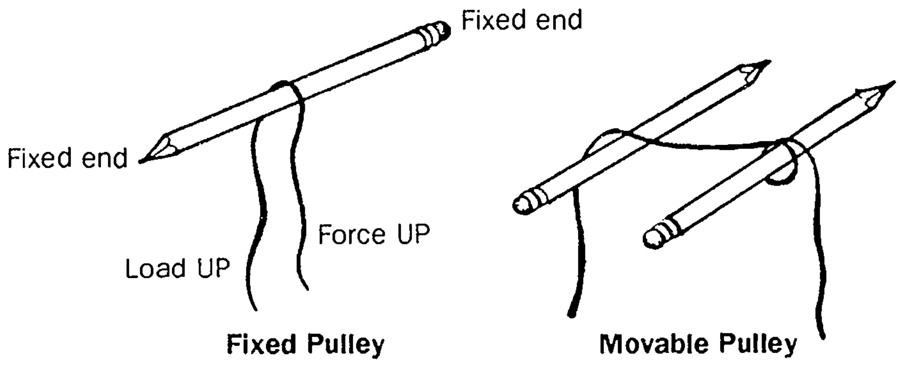
ACTIVITY
Pulleys and the Direction of Force

Objective
The student describes how a pulley works.

Materials
Empty margarine tub with two holes cut out on top and bottom
Piece of heavy-duty string or yarn (to make a handle for the margarine tub and to make the pulley belt)
Pencil or one-inch thick dowel rod to secure the pulley

Procedures
1. Drape yarn or string over a pencil or rod while keeping the pencil or rod still. Students pull on the string to raise the tub. Place items in the tub and lift them.
2. Tie one end of the string onto the pencil and loop the string through the tub handle, then over the pencil or rod. Students pull on the string to raise the tub. Use the same items to fill the tub again, and lift the tub. Students discuss the effort required in each case.
3. The students also discuss that if you use a pulley to raise the tub, then you pull down on the rope.

Discussion
1. Which is a fixed pulley? Movable?
2. Experiment with more pencils (or rods) to make the effort to raise the tub easier.



3. Now let's try to solve this problem: Can a person pull a 100 pound weight with only 50 pounds of effort to a height of three feet? Explain how.
4. Students use the idea of a pulley to raise and lower a flag. They complete Activity — Class Flag, as below.

Class Flag Activity

Materials

Long pole with stand; two pulleys (can be purchased at a hardware store)
Stout rope and tape or pins to secure the flag on the rope

Procedures

1. Teams of four students each design a class flag.
2. Class votes on one of the flags as the class flag (or use each flag sequentially for several weeks).
3. One team makes a flag pole.
4. Another team makes the flag.
5. Students take turns hoisting the flag and bringing it down daily.

LESSON 7 *Inventions*

BIG IDEAS An invention is a combination of simple machines, for example, a foot-pedal sewing machine or a car.

Whole Group Work

Materials

Book: **The Way Things Work** by D. MacAulay
Scissors; hand drill; toy crane; pencil sharpener; a jack-in-the-box toy
Different objects the students can bring from home, such as tin cans, rubber bands, plastic lids from margarine tubs, screws, string, rods and anything else thay can use to make their invented toys

Encountering the Idea

Tell the students that the lesson will begin with an activity. During the first part of the activity, the students examine the toy and make comments to each other about how the toy works. They are to describe it using new terms to discuss parts of the toy that work like simple machines. After they have had an opportunity to study the toy, they separate into groups for the writing part of the activity.

Activity — Jack In the Box

Display a jack in the box toy. Students examine the toy. The students hypothesize as to how the toy works. If possible, the jack-in-the-box has one side removed to show the inside. Students turn the crank to see how it works. Students dictate a hypothesis about how or why the toy works They dictate sentences about how it works. The teacher writes them on the strips of poster board for easy ordering. Then the students sequence the sentences that explain how the toy works. They write the sequence in paragraph form.

- Close the lid so that the spring with the doll will go down.
- Turn the handle so that the band can move.
- The bumps on the band make music when they turn and hit metal prongs.
- The song ends and one large bump hits the catch that opens the lid.

At the **Mathematics Center,** the students:

1. complete **Activity** — Buy a Toy
2. complete **Activity** — Right Triangles

At the **Writing Center:**

1. after constructing their inventions in the **Organizing the Idea and Assessing the Idea** part of this lesson, students write an advertisement telling about their wonderful new toy! What does it do? How does it work? Why would children want to play with it?
   Children exchange advertisements and peer-edit them.
2. students in teams of three or four research an inventor or invention. The teams give oral reports about the inventor, make posters or role-play a scene

they write. Each team contributes to a chart that lists Inventor and Invention, date of invention, inventor's country of origin.

At the **Social Studies Center:**

1. the students make a time line putting invention dates in chronological order from oldest to newest.
2. using a drawing of a world map, students locate the inventors' countries. Students write each inventor's name on the appropriate country.

Organizing the Idea and Assessing the Idea

Students think about what kind of toy or machine to make from some of the objects brought from home. Your toy or machine should have moving parts. Draw a design of your new toy. Show the moving parts. Build a model of your toy. After building your toy, measure its parts and write the measurements next to your drawing. Tell the rest of the class about your invention.

List of Activities for this Lesson

- ▲ Buy a Toy
- ▲ Right Triangles

ACTIVITY

Buy a Toy

Objective

The student finds a product by performing multi-step addition and/or multiplication problems requiring regrouping and renaming.

Materials

Commercial catalogs (J.C. Penney's, Sears, etc.)
Construction paper for cutouts
Toy $100, $10, $1 bills and various coins

Procedures

1. Using commercial catalogs, students cut out and paste on a piece of construction paper various toys they'd like to purchase.
2. On the back of the cutouts, they use coin and dollar bill stamps to show how much each toy costs.
3. They make a list of the toys they will buy and find the cost of all the toys.
4. The students calculate how much it would cost to buy the same list of toys for five children who will soon be having a birthday.
5. Next, the students calculate the cost for 10 children.
6. The students discuss different ways to work the problems.
7. Students compare their totals and how much it would take to buy the same set of toys for five and then for 10 children.
8. The students look for a way to combine the problems so that fewer calculations are necessary.

If the total is $57.29 for the list of toys a student wants, and the student needs to buy sets of toys for five children he/she may explore:

combining the number of $10 bills needed, then the number of $1 bills, dimes and pennies, and then regrouping: five $10s; seven $1s; two dimes and nine pennies; etc.

adding 57 dollars and 29 cents five times and then placing the decimal point appropriately to show dollars and cents, or other ways that students themselves may be able to explain to the class.

In finding the cost for 10 children, have the students note the relationship between the cost for one set of toys, then for 10 sets. They should see a pattern if they draw tables or charts and list the coins.

ACTIVITY
Right Triangles

Objective

The student says that inclined planes form right triangles and draws the triangle to show the inclined plane.

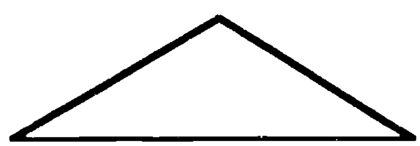
Materials

For each team of three students: paper or cardboard; three paper brads.

1. Mark the strips in inches and punch a hole in the center of the strip at every inch.
2. To make a triangle or inclined plane, connect the strips two at a time at the holes and align to make an inclined plane.
   Adjust each triangle so that one of the angles is a right angle (makes a corner).
3. The students make all the different triangles they can; use only the ones that make a right angle in this activity.
4. Measure each side from the first fastened hole to the second fastened hole. Some examples are the following:

Numbers	Relation to each other and to the right angle?
3, 4, 5	Five is longest side opposite. Three is shortest side opposite.
6, 8, 10	
9, 12, 15	

5. Students measure the lengths of each side and record the results.
6. Students make statements about their observations; i.e. the longest side is opposite the right angle.
7. If you make a triangle like this does it include an inclined plane? Color the inclined plane so it will show.



UNIT ASSESSMENT

Performance and Oral Assessment

The student creates an invention and is able to give an oral presentation as to its function.

Performance Assessment

1. Students working in small groups select machines, simple or otherwise (one per group) and report on how this machine helps people on earth overcome gravity and helps them do work. For example, they may select airplanes, trains, pulleys, carts, etc. to talk about.
2. Describe and/or draw pictures of people moving heavy objects up and down a ramp (truckers loading ramp, airplane ramp, furniture mover's ramp).

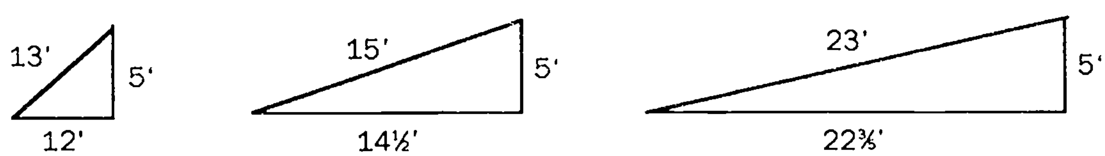
Written Assessment

1. Complete the following:

________ is done when we overcome a ________, like inertia, friction or gravity.

A ______ helps us do work by overcoming resistance, or force. For example, when we use a shovel to take dirt out of a hole, then we use it like a __________ , but when we use it to dig the hole, then we are using it like a _______ . When we walk from one place to another the forces we have to overcome are ___________ and __________. When we run very fast outside in the playground, we also have to overcome ________ resistance. That is why we get tired.

2. Given a list and pictures of simple machines, the student classifies them by type of machine.
3. Given drawings of different-size inclined planes and a load to carry up any one of the ramps, the student will select one of the ramps and explain why he/she selected that ramp.



(Students can select any one of the ramps, provided they give reasons: I only had a short 13-foot ramp; I was in a hurry; I only had a little space to work in and it had to fit it in; I didn't want to walk 23 feet, and I could get a 15-foot ramp; I'm wimpy and would rather walk a small hill than a steep one, etc.)

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Ancona, G. (1983). *Monster movers*. New York: Dutton.
A book on how 16 large haulers work.

Ardley, N. (1984). *Action science: Force and strength*. New York: Franklin Watts.
Shows how force and strength are an important part of your life. Great activities for the student to do.

Ardley, N. (1984). *Why things are: The Simon and Schuster color illustrated question and answer book*. New York: Julian Messner.
This is a question and answer book on a wide variety of science topics.

Barrett, N. (1990). *Picture Library: Trucks*. New York: Franklin Watts.
Focuses on the bigger trucks — tractor-trailer, dump trucks, liquid cargo carriers, and fire trucks.

Barton, B. (1979). *Wheels*. New York: Thomas Y. Crowell.
Describes the history of wheels and their importance through the ages.

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Depicts workers using a variety of machines at a construction site.

Bendick, J. (1984). *A first book of automobiles* (rev. ed.). New York: Franklin Watts.
Different types of cars are presented, with special materials on traffic problems and pollution.

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Hughes, S. (1991). *A tale of Trotter Street: Wheels*. New York: Lothrop, Lee & Shepard Books.
A young boy receives "wheels" for his birthday, but not the kind he expected.

James, E. & Barkin, C. (1975). *The simple facts of simple machines*. New York: Lothrop, Lee & Shepard Books.
Shows how simple machines use power effectively.

James, S. (1989). *The day Jake vacuumed*. New York: Bantam.
This is a very colorful, easy-to-read book about a little boy, Jake, who is asked to vacuum by his mother. Jake ends up vacuuming everything in sight, including his family.

Laithwaite, E. (1986). *Science at Work: Force. The power behind movement*. New York: Franklin Watts.
Uses photographs, illustrations, and diagrams to explain the concepts of force and related subjects. Concepts addressed are gravity, friction, wheels, inclined planes and lots more.

Liberty, G. (1960). *The first book of tools*. New York: Franklin Watts.
This book traces man's toolmaking history from the earliest know implements of the stone age to their modern descendents. Explains six simple machines.

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Written for readers of all ages, it is particularly useful for those who find technology intimidating and who wish it were less so.

Rockwell, A., & H. (1972). *Machines*. New York: Macmillan.
Describes simple machines such as levers and wheels.

Shapp, M & C. (1962). *Let's find out about wheels*. New York: Franklin Watts.
A simple approach to the concept of wheels and their friction.

Smith, E. B. (1983). *The railroad book*. Boston: Houghton Mifflin Company.
This story describes different parts of the train and the different cars.

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Shows Indian arrowheads of the Texas Indians. Gives a Texas meaning to prehistoric man and the tools he made.

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Easy to read, very informative book with carefully controlled vocabulary.

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A simple explanation of how a lever works.

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