DOCUMENT RESUME

ED 261 865 SE 045 992

TITLE	Physical Science Curriculum Guide. Bulletin 1644.
INSTITUTION	Louisiana State Dept. of Education, Baton Rouge. Div. of Academic Programs.
PUB DATE	84
NOTE	70p.; For other guides in this series, see SE 045 987.
PUB TYPE	Guides - Classroom Use - Guides (For Teachers) (052)
EDRS PRICE	MF01/PC03 Plus Postage.
DESCRIPTORS	*Behavioral Objectives; Competency Based Education; *Course Descriptions; Curriculum Development; High Schools; Matter; *Physical Sciences; Process Education; *Science Activities; Science Careers; Science Curriculum; Science Education; Science Experiments; *Science Instruction; *Secondary School Science; State Curriculum Guides
IDENTIFIERS	*Louisiana

ABSTRACT

This curriculum guide, developed to establish statewide curriculum standards for the Louisiana Competency-based Education Program, contains the minimum competencies and process skills that should be included in a physical science course. It consists of: (1) a rationale for an effective science program; (2) a list and description of four major goals of science; (3) a list and description of eight basic process skills (such as predicting and classifying) and five integrated processes (such as controlling variables and defining operationally); and (4) an eight-part curriculum outline. These parts provide performance objectives correlated with a concept, process skill(s), and suggested activities for each of the following major topic areas: nature of science; measurement; forces; work; characteristics of matter; chemistry of matter; energy; magnetism; electricity; light; heat; and careers. A list of 27 science-oriented careers and 27 organizations supplying additional information for each career, a list of reference materials, a list of suggested films available from the Louisiana Department of Education's Educational Film Catalog), a list of audiovisual suppliers, and brief comments on evaluation techniques are also provided. (JN)

ED261865

STATE OF LOUISIANA
DEPARTMENT OF EDUCATION

PHYSICAL SCIENCE CURRICULUM GUIDE

BULLETIN 1644
1984

Thomas G. Clausen, Ph.D.
Superintendent

SE 045 992

This public document was published at a cost of $ 883.86; 2500 copies of this public document were published in this first printing at a cost of $ 675.00. The total cost of all printings of this document, including reprints, is $ 883.86. This document was published by the Louisiana Department of Education, P. O. Box 44064, Baton Rouge, Louisiana 70804, to provide technical assistance to local school boards and the public under authority of R.S. 17:24.1. This material was printed in accordance with the standards for printing by state agencies established pursuant to R.S. 43:31.

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DEPARTMENT OF EDUCATION

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Issued by

Office of Academic Programs

THOMAS G. CLAUSEN, Ph.D.

Superintendent

FOREWORD

Act 750 of the 1979 Louisiana Legislature (R.S. 17:24.4) established the Louisiana Competency-Based Education Program. One of the most important provisions of Act 750 is the mandated development and establishment of statewide curriculum standards for required subjects. These curriculum standards include curriculum guides which contain minimum skills, suggested activities, and suggested materials of instruction.

During the 1979-80 school year, curriculum guides were developed by advisory and writing committees representing all levels of professional education and all geographic areas across the State of Louisiana for the following Science courses: Elementary K-6, Life Science, Earth Science, Physical Science, General Science, Biology, Chemistry, and Physics.

During the 1982-83 school year, the curriculum guides were piloted by teachers in school systems representing the different geographic areas of the State as well as urban, suburban, inner-city, and rural schools. The standard populations involved in the piloting reflect also the ethnic composition of Louisiana's student population. Based upon participants' recommendations at the close of the 1982-83 pilot study, the curriculum guides were revised to ensure that they are usable, appropriate, accurate, comprehensive, relevant, and clear.

Following the mandate of Act 750, the revised curriculum guides will be implemented statewide in the 1984-85 school year. The statewide implementation is not, however, the end of the curricular development process. A continuing procedure for revising and improving curricular materials has been instituted to ensure that Louisiana students have an exemplary curriculum available to them--a curriculum that is current, relevant, and comprehensive. Such a curriculum is essential if we are to provide the best possible educational opportunities for each student in the public schools of Louisiana.

Thomas G. Clausen

Thomas G. Clausen, Ph.D.

7

6

TABLE OF CONTENTS

8

9

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10

ACKNOWLEDGMENTS

This publication represents the cooperative efforts of personnel in the Bureaus of Secondary Education and Curriculum, Inservice, and Staff Development within the Office of Academic Programs. Special recognition goes to Donald W. McGehee, Supervisor, Science Section, who served as chairman in the development of the guide. Special commendation goes also to members of the writing and review teams who worked diligently to make this publication a reality.

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William E. Stephens, Jr.
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Joe Rivet, Director
Bureau of Secondary Education

CURRICULUM WRITING TEAM

Dr. Richard Ardoin (CHAIRMAN)
Calcasieu Parish School System
1724 Kirkman Street
Lake Charles, Louisiana 70601

Dr. Patsy Boudreaux (CONSULTANT)
Ruston High School
Cooktown Road
Ruston, Louisiana 71270

Marjorie King (CONSULTANT)
Jefferson Parish School System
519 Huey P. Long Avenue
Gretna, Louisiana 70053

James Kennedy
North Caddo High School
Vivian, Louisiana 71082

Thomas LaCombe, Jr.
Jones Street Junior High School
Post Office Box 2030
Alexandria, Louisiana 71301

Barbara Thompkins
Hornbeck High School
Hornbeck, Louisiana 71439

Karen Vincent
Chalmette Middle School
E. Chalmette Circle
Chalmette, Louisiana 70043

CURRICULUM REVIEW TEAM

Dr. Greg Hussey (CONSULTANT)
Department of Physics
Louisiana State University
University Station
Baton Rouge, Louisiana 70803

Joy Tingle (CONSULTANT)
Terrebonne Parish School Board
Post Office Box 5097
Houma, Louisiana 70361

Joan Barnard
Evergreen Junior High School
4134 West Main Street
Houma, Louisiana 70360

Barbara Leonard
A. J. Bell Junior High School
1010 North Galvez Street
New Orleans, Louisiana 70119

Catherine Ward
Airline High School
Airline Drive
Bossier City, Louisiana 71111

PREFACE

The Physical Science Curriculum Guide contains the minimum competencies and process skills that should be included in a Physical Science course. Each teacher should build on the foundation of these minimum competencies to establish the maximum program possible for his/her students, but the teacher must take special care to incorporate all skills contained in this guide within the framework of his/her instructional program. The guide is flexible enough to be adapted to most of the commercial basal programs; and teachers may adjust the sequence of content based on the needs of their students, the available equipment, and the textbooks.

The guide contains suggested activities designed to assist the teacher in teaching each competency; however, the teacher and the students should not be limited to these activities nor bound to use all of them. There are many other activities available to the teacher which will help him/her to present each competency and process skill to the student. It is hoped that the teacher will be resourceful in using many types of experiences to teach the topics listed.

Methods of science instruction, to be most effective, must be based upon the development of process skills in critical thinking. An effort has been made to incorporate numerous process skills in the suggested activities, and the teacher should use as many of these skills as possible in daily instruction.

This curriculum guide should be of special benefit to the teacher in helping to organize the Physical Science course. It is suggested that additional textbooks, workbooks, and laboratory manuals be consulted for activities, demonstrations, and experiments to supplement those described in this curriculum guide.

14 15

RATIONALE

Developments in science technology have improved our way of living and have become a major influence on our culture. No one in our culture escapes the direct influence of science. Because of the impact of science on our social, economic, and political institutions, the education of every responsible citizen must include not only the basic principles of science but also the attitudes and processes of scientific thought.

The nature of science itself determines the way that it should be taught. The definition of science is a two-fold one: It is (1) an unending method or process of seeking new knowledge, and (2) the body of knowledge which results from this search. Science is an intellectual, active process which involves an investigator of any age and something to investigate. The discipline of science taught by the process approach teaches the student how to learn, and that intellectual gain is a permanent one for the student.

The process approach develops the intellectual abilities of students. Some students develop thinking skills in the normal course of growing up in a complex world, but the acquisition of useful skills and attitudes is by no means automatic. Many students succeed in school by repeating what they are told in a slightly different form or by memorizing; such strategies are of little extended value. At present, relatively few students develop persistence in and zest for dealing with new concepts because they are not aware of their intellectual capabilities. Thus, they need literally to experience application of scientific process skills in different situations.

To be most effective, methods of science instruction must be based upon the development of skills in critical thinking. Guided practice in experimenting, observing, gathering information, organizing facts, and drawing conclusions will help to develop critical thinking skills. Laboratory techniques should be employed whenever possible, and inquiry teaching/learning situations using both deductive and inductive reasoning should be the predominant method used in all classroom activities. The teacher's role in a process-oriented science classroom includes being a provider of problems, a discussion leader, a supplier of clues (when necessary), and a skillful questioner, i.e., a facilitator of learning activities. Thus, the aim of an effective science program should be to equip each child with competencies in the basic processes and concepts of science through individual participation in activities and investigations specifically designed to develop such capabilities.

GOALS

Achieving scientific literacy involves the development of attitudes, process skills, concepts, and social aspects of science and technology. Based upon this belief, the following major goals of science are stated:

1. To Foster Positive Attitudes Toward the Scientific Process

   Students will develop a deep appreciation of the role the scientific process plays in their everyday lives.

2. To Develop Process Skills

   Process skills development should be an integral part of science activities for students. Students should be given opportunities to develop those intellectual processes of inquiry and thought by which scientific phenomena are explained, measured, predicted, organized, and communicated.

   Basic Process Skills: Observing, inferring, classifying, using numbers, measuring, using space-time relationships, communicating, predicting.

   Integrated Process Skills: Controlling variables, defining operationally, formulating hypotheses, interpreting data, experimenting.

3. To Acquire Knowledge

   Included in the basic science curriculum should be those scientific facts, principles, concepts, and terms which will enable the students to understand and interpret natural phenomena.

   Areas of Knowledge: Life Science, Physical Science, Earth Science

4. To Recognize Social Aspects of Science and Technology

   The students should (a) understand the interrelationships of science, technology, and social and economic development; and (b) recognize both the limitations and the usefulness of science and technology in advancing human welfare.

PROCESS SKILLS

Eight basic science process skills are stressed: (1) observing, (2) inferring, (3) classifying, (4) using numbers, (5) measuring, (6) using space/time relationships, (7) communicating, and (8) predicting. There is a progressive intellectual development within each process category. A brief description of each basic process skill follows:

OBSERVING: To observe is to use one or more of the five senses to perceive properties of objects or events as they are. Statements about observations should be (1) quantitative where possible, (2) descriptive regarding change(s) and rates of change(s), and (3) free of interpretations, assumptions, or inferences.

INFERRING: To infer is to explain or to interpret an observation. Inferences are statements which go beyond the evidence and attempt to interpret or to explain one or more observations. Inferences are based on (1) observations, (2) reasoning, and (3) past experiences of the observer. Inferences require evaluations and judgments, and they may or may not be accurate interpretations or explanations of the observation.

CLASSIFYING: Classifying is the grouping or ordering of phenomena according to an established scheme. Objects and events may be classified on the basis of observations. Classification schemes are based on observable similarities and differences in arbitrarily selected properties. Classification keys are used to place items within a scheme as well as to retrieve information from a scheme.

USING NUMBERS: To use numbers is to describe the measurement, properties, and relationships of quantities through the use of symbols.

MEASURING: To measure is to find out the extent, size, quantity, capacity, and other properties of a given object, especially by comparison with a standard. Once the concept of measuring is introduced and mastered in first grade, the metric and/or SI system should be used exclusively.

USING SPACE/TIME RELATIONSHIPS: Space/Time relationships is the process that develops skills in the description of spatial relationships and how they change with time. This process skill includes the study of shapes, time, direction, spatial arrangement, symmetry, motion, and rate of change.

COMMUNICATING: To communicate is to pass information along from one person to another. Communications may be verbal, nonverbal (i.e., gestures), written, or pictorial (pictures, maps, charts, and graphs). Communications should be concise, accurate, clear, precise descriptions of what is perceived.

PREDICTING: Predicting is forecasting what future observations might be; it is closely related to observing, inferring, and classifying. The reliability of predictions depends upon the accuracy of past and present observations and upon the nature of the event being predicted.

As basic progressive, intellectual development proceeds in each basic process skill, the interrelated nature of the processes is manifested in the five integrated processes: (1) controlling variables, (2) defining operationally, (3) formulating hypotheses, (4) interpreting data, and (5) experimenting. A brief description of each integrated process skill follows:

CONTROLLING VARIABLES: A variable is any factor in a situation that may change or vary. Investigators in science and other disciplines try to determine what variables influence the behavior of a system by manipulating one variable, called the manipulated (independent) variable, and measuring its effect on another variable, called the responding (dependent) variable. As this is done, all other variables are held constant. If there is a change in only one variable and an effect is produced on another variable, then the investigator can conclude that the effect has been brought about by the changes in the manipulated variable. If more than one variable changes, there can be no certainty at all about which of the changing variables causes the effect on the responding variable.

DEFINING OPERATIONALLY: To define operationally is to choose a procedure for measuring a variable. In a scientific investigation, measurements of the variables are made; however, the investigator must decide how to measure each variable. An operational definition of a variable is a definition determined by the investigator for the purpose of measuring the variable during an investigation; thus, different operational definitions of the same variable may be used by different investigators.

FORMULATING HYPOTHESES: To formulate a hypothesis is to make a guess about the relationships between variables. A hypothesis is usually stated before any sensible investigation or experiment is performed because the hypothesis provides guidance to an investigator about the data to collect. A hypothesis is an expression of what the investigator thinks will be the effect of the manipulated variable on the responding variable. A workable hypothesis is stated in such a way that, upon testing, its credibility can be established.

INTERPRETING DATA: The process of interpreting data may include many behaviors such as (1) recording data in a table, (2) constructing bar and line graphs, (3) making and interpreting frequency distributions, (4) determining the median, mode, mean, and range of a set of data, (5) using slope or analytical equations to interpret graphs, and (6) constructing number sentences describing relationships between two variables. Interpreting data requires going beyond the use of skills of tabulating, charting, and graphing to ask questions about the data which lead to the construction of inferences and hypotheses and the collecting of new data to test these inferences and hypotheses. Interpretations are always subject to revision in the light of new or more refined data.

EXPERIMENTING: (Using the scientific method): Experimenting is the process of designing a procedure that incorporates both the basic and integrated process skills. An experiment may begin as a question for the purpose of testing a hypothesis. The basic components of experimenting are as follows:

1. Constructing a hypothesis based on a set of data collected by the person from observations and/or inferences.

2. Performing a test of the hypothesis. The variables must be identified and controlled as much as possible. Data must be collected and recorded.

3. Describing or interpreting how the data support or do not support the hypothesis, i.e., deciding whether the hypothesis is to be accepted, modified, or rejected.

4. Constructing a revised hypothesis if the data do not support the original hypothesis.

25

CONTENT OUTLINE

I. Nature of Science
   A. Prime movers
      1. Galileo
      2. Newton
      3. Edison
      4. Einstein
   B. Scientific method
   C. Physical science

II. Measurement
   A. Basic scientific arithmetic
   B. Tools of measurement
   C. Metric system

III. Forces
   A. Characteristics
   B. Weight and mass
   C. Friction
   D. Newton's three laws of motion

IV. Work
   A. Understanding work
   B. Simple machines

V. Matter--characteristics of
   A. Classification
   B. Change of state
   C. Properties--chemical and physical
   D. Changes--chemical and physical
   E. Elements, compounds, and mixtures

VI. Chemistry of Matter
   A. Atom
      1. Parts
      2. Bohr model
   B. Periodic table
   C. Compounds
      1. Formation
      2. Comparison with mixtures-elements
      3. Chemical formulas and chemical equations
   D. Solutions
   E. Acids and bases
      1. Indicators
      2. Neutralization

VII. Energy
   A. Definition
   B. Types
      1. Mechanical
      2. Heat
      3. Light
      4. Chemical
      5. Electrical
      6. Sound
      7. Nuclear (atomic)
      8. Magnetism
   C. Waves
      1. Transverse
      2. Compressional
   D. Sound
      1. Formation
      2. Characteristics
   E. Magnetism
      1. Properties
      2. Magnetic field
   F. Electricity
      1. Types and charges
      2. Conduction and insulation
      3. Generation
      4. Units
      5. Comparison of AC and DC
      6. Circuits
   G. Light
      1. Behavior
         a. Reflection
         b. Refraction
         c. Diffraction
      2. Color of light
         a. Combining
         b. Absorbing
         c. Transmitting
      3. Mirrors and lenses
      4. Electromagnetic spectrum
   H. Heat
      1. As a form of energy
      2. Transfer
      3. Kinetic-molecular theory
   I. Nuclear (Atomic)

VIII. Careers

COMPETENCY/PERFORMANCE OBJECTIVE	CONCEPT	PROCESS SKILLS	SUGGESTED ACTIVITY
The student will be able to:			
I. NATURE OF SCIENCE			
1. Identify prime movers in the field of physical science, including the work of Galileo, Newton, Edison, and Einstein, as their works are presented.	Important contributors to the field of physical science	Communicating	Ask students to do library research on scientists and their contributions.
2. Describe the characteristics of a scientist including curiosity, observing, recording, and drawing conclusions.	Characteristics of a scientist	Communicating, classifying	Bring an object into the classroom and ask the students to describe the object and activities of the teacher in intricate detail. For example, bring a beaker with a colorless solution into the room. When an unknown substance is added, it turns red (basic solution plus phenolphthalein).
3. Identify and describe the methods used by scientists in developing scientific knowledge.	Scientific method	Observing, inferring, interpreting data, predicting, experimenting, controlling variables, formulating hypotheses	"Mystery Box"--The teacher will place various objects in a sealed box. Using their senses and process skills, the students will formulate a mental model of the contents. The teacher should provide measuring tools for use by the students for drawing conclusions. Ask students to write up the activity for the mystery box or to compose some other simple experiment using the scientific method.

COMPETENCY/PERFORMANCE OBJECTIVE	CONCEPT	PROCESS SKILLS	SUGGESTED ACTIVITY
4. Define physical science in relationship to other sciences.	Physical science	Defining, classifying	Students will define the sciences through the study of prefixes and suffixes. For example, biology is the study of life. If "bio" means life, then what does "logy" mean?
II. MEASUREMENT			
5. Demonstrate minimum proficiencies in basic computational skills related to problems in physical science.	Basic scientific arithmetic	Using numbers	Assess the proficiency of the student in basic computational skills and review areas of student deficiencies.
6. Identify and use the metric base units for length, volume, weight, and mass.	Metric system	Measuring, using numbers, classifying, interpreting data	Provide a point of reference for the metric system by comparing it with the system we now use. For example, provide the student with a quart measure and a liter measure; and, by manipulation with water, the student will form a mental image of comparative volumes. Similar activities can be done with length, mass, etc.
7. Measure specified bodies with recommended measuring instruments, such as meter stick, graduated cylinder, spring scale, balance, gram mass measure, thermometer, barometer.	Tools of scientific measurement	Measuring, using numbers	The students will practice making accurate measurements using the recommended instruments and writing up the results using a scientific method.
8. Construct a simple bar and broken line graph and be able to interpret them.	Interpretation of graphical data	Interpreting data, predicting, inferring, controlling variables	The students will experiment and calculate the densities of H_2O, ditto fluid (methyl alcohol) and karo syrup. The volume and mass for each substance will be plotted on the graph.

COMPETENCY/PERFORMANCE OBJECTIVE	CONCEPT	PROCESS SKILLS	SUGGESTED ACTIVITY
			Sample: Chart to determine Mass and Volume Mass of graduated cylinder in grams. / Mass of graduated cylinder and ___ in grams. / Mass of ___. / Volume of ___ in ml. 1. Construct 3 charts, one for karo, ditto, and water. 2. Calculate densities for each. 3. Graph the results of these charts on the same graph with volume on the X axis and mass on the Y axis.
III. FORCES			
9. Distinguish between weight (force) and mass.	Identify weight and mass	Measuring, defining observing, inter-	Use a spring scale to measure the weight of 5 metric masses. Students may construct a line graph of the data with weight along the vertical axis and mass along the horizontal axis.
10. Describe a force as a push or a pull (something that changes shape or motion).	Forces	Define	Student is asked to lift himself from a sitting position, and reseat himself, crumple a sheet of paper, and slide a book across the desk. Describe the force in each instance.
11. Describe how friction affects one's physical environment.	Friction	Measuring, observing, predicting, interpreting data, controlling vari-, ables, formulating hypothesis	Rub any two materials together (example hands, a pencil between the palms or wooden blocks). Observe and record the results.
12. State Newton's three laws of motion and give examples of each.	Newton's laws	Observing, interpreting data, formulating hypotheses, communicating and defining	Have students set a book on top of a sheet of paper on their desk. They should pull the paper out and observe what occurs.

COMPETENCY/PERFORMANCE OBJECTIVE	CONCEPT	PROCESS SKILLS	SUGGESTED ACTIVITY
IV. WORK			
13. Define work as the result of a force moving an object a certain distance.	Understanding the nature of work	Observing, operationally defining, controlling variables, using numbers, interpreting and measuring	1. The students are given a group of tasks by the teacher. After performing the tasks (for example, lifting a pencil), the student will classify the task as either one in which work is done or not done. 2. The student will solve simple work problems. 3. Using books, build a book staircase on the floor. Each step should be 10 cm. high. The staircase should have five steps and total 50 cm. After recording the weight in newtons of a half-kilogram mass or other standard mass, the student will calculate the work done as it is lifted to each step of the staircase.
14. Define simple machines, list the six machines, and explain how each makes work easier.	Simple machines and how they work	Defining, classifying	1. As an introduction to the lesson, show by example how machines make work easier. For example, ask a student to crush a pecan between two fingers, then give him a pare of pliers. Ask the student to lift a book at arm's length, then lift it using a meter stick with an eraser under it. 2. Given empty thread spools and coat hangers, students

COMPETENCY/PERFORMANCE OBJECTIVE	CONCEPT	PROCESS SKILLS	SUGGESTED ACTIVITY
			will construct pulleys. By using a set of weights and a spring scale, the students should be able to find the advantage of using a pulley over lifting weights directly. (Use pulley sets if available.) 3. Having been provided a definition for a lever, the student will construct a simple lever and investigate its characteristics. For example, the student should observe the relationship between the change of position of the fulcrum in relationship to the resistance force. 4. Using a board, weight, spring scale, books and string, the student will pull the weight up the inclined plane at different angles and record the results.
V. MATTER--CHARACTERISTICS OF			
15. Define matter and state the law of conservation of matter.	Matter	Classifying, formulating hypotheses	Having been given the characteristics of matter, through discussion the student will classify substances as matter. For example, weigh a deflated balloon and one that is inflated to prove that air is matter.

COMPETENCY/PERFORMANCE OBJECTIVE	CONCEPT	PROCESS SKILLS	SUGGESTED ACTIVITY
16. Distinguish between the states of matter as related to the relative motion of molecules.	States of matter	Classifying, observing, defining, formulating hypothesis	Take an ice cube and measure the volume. Let it melt and measure the volume of the water. Pour the water into a flask, place a balloon over the mouth and heat it. Observe and record results. Variable--air will expand.
17. Differentiate among specific physical and chemical properties of matter, such as density, conductivity, boiling points, taste, odor, color, malleability, and shape.	Physical and chemical properties of matter	Experimenting, classifying, defining, observing	1. Give the students two balls of equal volume but different mass and have them discuss their physical properties. 2. Calculate densities. 3. Set up a series circuit with a dry cell battery, bulb, and wire and test sugar water and salt water for conductivity.
18. Distinguish between physical and chemical changes in matter.	Physical and chemical changes	Experimenting, classifying, defining, observing	1. Break a match, strike a match, and let it burn. 2. Use iron and sulfur to make mixtures and compounds.
VI. CHEMISTRY OF MATTER			
19. Identify the three parts of an atom including proton, neutron, and electron.	Parts of an atom	Communicating, interpreting data	Use films and other audiovisual aids to teach this objective.
20. Construct Bohr model for the selected elements on the periodic table.	Use of a scientific model	Defining, communicating	Have the students draw or construct a Bohr model.

COMPETENCY/PERFORMANCE OBJECTIVE	CONCEPT	PROCESS SKILLS	SUGGESTED ACTIVITY
21. Use the periodic table to determine the atomic number and atomic weight, symbol, valence (combining ability), energy levels, number of electrons and some chemical and physical properties.	Use of the periodic table	Classifying, using numbers, interpreting data, communicating	Exercises in using the atomic table.
22. Illustrate atomic shell (Bohr models) of compounds consisting of two elements from the first two periods of the periodic table.	Compound formation	Communicating, controlling variables, using numbers	By using atomic shell (Bohr models), have students construct compounds consisting of two elements from the periodic table. (You may use something as simple as colored gumdrops and toothpicks to construct models.)
23. Distinguish between compounds, mixtures, and elements.	Differences between compounds	Classifying, defining, experimenting, controlling variables, formulating hypothesis	Let the students mix some iron filings with sulfur. Try separating them with a magnet. Now take four grams of iron filings and six grams of sulfur, mix thoroughly, and place in a test tube. Heat until the mixture turns red. Break the test tube and see if you can separate the iron from the sulfur. Try to separate this compound with a magnet. Use HCl to chemically separate the compound. A substance is formed--identity is lost, heat is absorbed.
24. Describe the function of a chemical formula and a chemical equation.	Chemical formulas and chemical equations	Communicating, using numbers, interpreting data, inferring	Introduce an exercise on constructing and balancing chemical equations and chemical formulas.

COMPETENCY/PERFORMANCE OBJECTIVE	CONCEPT	PROCESS SKILLS	SUGGESTED ACTIVITY
25. Identify the types of solution, parts of solutions, and the factors affecting rate of solubility.	Solutions	Communicating, experimenting, controlling variables, formulating hypotheses, inferring	1. When students are familiar with the parts of a solution, have them graph how much solid per volume to determine solubility rates of sugar to salt. Graph results. 2. Students will demonstrate the factors affecting the rate of solution by dissolving sugar cubes in H_2O. 3. Drop one whole sugar cube and one crushed cube into separate test tubes of H_2O. Record results. 4. Take two test tubes and drop one sugar cube in each; stopper, and shake one of the tubes. Record results. 5. Take two test tubes of H_2O, heat one, drop one sugar cube into each. Observe each step identifying the factors which affect the rate of solubility. Optional: Set up six artificial stomachs with stomach acid. Test common antacids using universal indicator. Find which is the best antacid. Graph results in relation to speed of reaction.
26. Use chemical indicators to distinguish between acidic and basic solutions.	Chemical indicators	Experimenting, observing, predicting, interpreting data, controlling variables, formulating hypotheses	Students would be provided with several solutions and indicators to test for acids and bases. Students would construct a table from this information. Graph results.

COMPETENCY/PERFORMANCE OBJECTIVE	CONCEPT	PROCESS SKILLS	SUGGESTED ACTIVITY
27. Define neutralization as the process by which a salt is formed by the combination of an acid and a base.	Neutralization	Experimenting, observing, classifying, controlling variables, formulating hypotheses	Have students make salts through the combination of weak acids and bases. (Example: combine HCl and $NaHCO_3$, use a chemical indicator to determine when neutralization occurs. Evaporate liquid and observe residue which is NaCl/table salt).
VII. ENERGY			
28. Define energy, state the law of conservation of energy, and classify energy as kinetic or potential.	Energy	Classifying, defining	1. Use a pendulum demonstration to illustrate types of energy. 2. Discuss roller coasters and explain how it illustrates the types of energy. 3. Drop a book from hands to floor. How does this illustrate kinetic vs. potential energy?
29. Distinguish among the types of energy, given the following examples: mechanical, heat, light, electrical, chemical, electromagnetic, sound and atomic (nuclear).	Types of energy	Classifying, interpreting data, defining, formulating hypotheses	Rub two objects together and feel the heat produced. Make a simple wet cell. Use a radiometer to show light energy and a palm glass to show heat energy.
30. Illustrate and define transverse and compressional waves explaining that energy travels in waves.	Waves	Classifying, observing	1. Put a tuning fork in H_2O to show sound energy. 2. Demonstrate reflection and wave motion using ropes, slinkies and/or a ripple tank.
31. Describe how sounds are created and how they travel.	Sound	Communicating, defining, formulating hypotheses	Mount an electric bell inside a bottle so that the bell can be connected to a dry cell outside. The bottle should be sealed with a one-hole stopper containing a piece of glass tubing. Attach

COMPETENCY/PERFORMANCE OBJECTIVE	CONCEPT	PROCESS SKILLS	SUGGESTED ACTIVITY
			a rubber tube to the glass tubing and connect it to a vacuum pump. Connect the bell so it rings. Then pump the air out of the bottle. Does the loudness of sound increase, decrease, or remain the same?
32. Identify the characteristics of sound, including pitch, frequency, wave length, and amplitude.	Sound	Classifying, inferring, experimenting, controlling variables	1. Using tuning forks to illustrate frequency and pitch. Choose a tuning fork with labeled frequency, strike it, and have students describe the pitch they hear. 2. Take eight test tubes and pour varying amounts of H_2O into each tube. Blow across tube and compare the pitch produced to the water level. (Optional: "tune" the test tubes to match the eight notes of a musical scale and have students play simple melodies.) 3. Draw and label the various parts of a sound wave.
33. Define a magnet in terms of the arrangement of the domains.	Magnetism	Communicating, experimenting, formulating hypotheses, controlling variables, classifying, observing, predicting and interpreting data	1. Place a layer of iron filings in a test tube lying horizontally. Stroke the test tube several times in the same direction with a magnet. Bring a compass near the tube to show that a magnetic field has been created.

46

47

COMPETENCY/PERFORMANCE OBJECTIVE	CONCEPT	PROCESS SKILLS	SUGGESTED ACTIVITY
			2. Given a group of objects, a student will use a magnet to discriminate between magnetic and nonmagnetic objects.
34. Determine magnetic fields.	Magnetic field	Observing, experimenting, inferring, measuring	1. Students can prepare a pattern of a magnetic field using iron filings on waxed paper. Place a magnet under a piece of glass, place the waxed paper on top, and sprinkle on the filings. When the magnetic field is established, pass a hot electric iron over the filings keeping the iron about 1.5 to 2 cm. above the surface. Students will then describe in writing what they observe. 2. Use an overhead projector to show a magnetic field by placing a magnet on it covered by a transparency. Sprinkle on the iron filings and have the students describe the magnetic field as it is projected on the screen.
35. Distinguish between static and current electricity.	Static electricity, current electricity	Classifying, experimenting, interpreting data, observing, inferring and communicating	1. Electrify a rubber rod or comb with wool, and pick up bits of paper; electrify balloons suspended on strings. Use a Van Graaf generator if available. Cut two slits in a lemon; insert a piece of copper in one and a piece of zinc in the other. Attach

48

49

COMPETENCY PERFORMANCE OBJECTIVE	CONCEPT	PROCESS SKILLS	SUGGESTED ACTIVITY
			wires to the strip. Use a galvanometer to test the electricity produced. 2. Contact local utility company for demonstration and/or films. 3. Construct an electroscope. 4. Students may go to the library to report on Ben Franklin so that they discover the relationship between lightning and static electricity.
36. Categorize materials as conductors and insulators.	Conduction, insulation	Classifying, interpreting data, predicting, experimenting, controlling variables, formulating hypotheses	1. Collect a group of objects and have the students experiment to discriminate between conductors and nonconductors. Use a voltmeter if available to separate conductors and nonconductors. Graph results. 2. Wire simple circuits with bells; use different materials in the wiring of the circuit to distinguish nonconductors from conductors. 3. Use in the circuits described in Activity 2; illustrate complete and incomplete circuits.
37. State that the two ways that current electricity can be produced are through magnetism and electrochemistry.	Generation of electrical energy	Communicating, classifying, interpreting data, experimenting, controlling variables	1. Produce electric current using magnetism. Use a coil of wire, a magnet, and a galvanometer or a compass to determine whether or not electric current is being produced. 2. Make a simple wet cell using HCl as the electrolyte and zinc and copper strips as the electrodes.

COMPETENCY/PERFORMANCE OBJECTIVE	CONCEPT	PROCESS SKILLS	SUGGESTED ACTIVITY
38. List the components of electrical current including volt, ohm, and ampere.	Units of electrical current	Classifying, experimenting, communicating, interpreting data	1. Use transparencies or other audiovisual aids to explain this concept. 2. Solve problems using Ohm's Law.
39. Distinguish between alternating current and direct current.	Comparison of AC and DC	Communicating, predicting, inferring, experimenting, formulating hypotheses, controlling variables	Use dry cells and simple generators to distinguish between AC and DC current.
40. Describe and illustrate series and parallel circuits.	Series and parallel circuits	Communicating, defining, interpreting data, controlling variables, formulatting hypotheses	1. Using bulbs, test leads, and a power source, have the students set up a circuit in which if one bulb is removed, the others will remain lit. Then have them set up a circuit in which if one bulb is removed, the others will go out. (An inexpensive string of Christmas tree lights cut into sections is a great way to allow the students to make circuits.)
41. Distinguish among reflection, refraction, and diffraction of light.	Behavior of light	Observing, classifying, communicating, predicting	1. Place a pencil or a spoon in a glass of H_2O. Have students observe what happens to the appearance of the object. Record results. (Illustrates refraction) 2. Use plane mirror to demonstrate reflection for students. 3. Use diffraction grating to illustrate diffraction.

52

53

COMPETENCY/PERFORMANCE OBJECTIVE	CONCEPT	PROCESS SKILLS	SUGGESTED ACTIVITY
42. Explain how colored light is combined, absorbed, and transmitted.	Light	Observing, classifying, communicating, predicting, formulating hypotheses, and controlling variables	1. Show the effect of light as it strikes wax paper, a brown paper bag, saran wrap, and aluminum foil. 2. Identify what type of substance each is and how it affects light.
43. Show how images are formed by mirrors and lenses.	Mirrors and lenses	Observing, classifying, communicating, predicting, formulating hypotheses	Use convex, concave lenses and parabolic mirrors to show real and virtual images.
44. State the uses of electromagnetic waves of different frequencies.	Electromagnetic spectrum	Observing, classifying using numbers, communicating, predicting and interpreting data	1. Use audiovisual aids (charts and pictures) to illustrate the electromagnetic spectrum. 2. Use of prism or spectroscope to show the electromagnetic spectrum.
45. Explain why heat is a form of energy and describe its effect on matter.	Heat	Observing, inferring, measuring, communicating, formulating hypotheses, interpreting data, experimenting	1. Illustrate the difference between heat and temperature. 2. Use a thermometer and calorimeter to distinguish between temperature and heat. 3. Solve simple heat problems. For example, find the calories of heat gained by 100 grams of water heated by a burner for one minute.
46. Explain and use example to show how heat is tranferred.	Transfer of heat	Observing, inferring, measuring, communicating, formulating hypotheses, interpreting data, experimenting, predicting	1. Compare radiated heat by checking temperature inside two cans (one black, the other white). Use desk light as a source of heat. 2. To demonstrate connection, heat a large beaker of water over a burner (do not boil). Drop ink or tiny wood shavings into the heated water. Observe the path of the current created.

COMPETENCY/PERFORMANCE OBJECTIVE	CONCEPT	PROCESS SKILLS	SUGGESTED ACTIVITY
47. Use the kinetic-molecular theory to explain the behavior of gases and how particles move in solids, liquids, and gases.	Kinetic-molecular theory	Experimenting, observing, measuring, predicting, using space/time relationships	Blow up a round balloon. Carefully measure its circumference. Place it in a pan of hot water for 10 minutes. Measure the circumference again. Place the balloon in a tray of ice for 10 minutes. Measure again.
48. Develop an understanding of the nature, properties, types, and uses of nuclear radiations.	Radiation	Observing, inferring, classifying, using numbers, using space/time relationships, communicating, predicting, formulating hypotheses, interpreting data, experimenting	1. Illustrate the half-life of radioactive elements. 2. Construct a cloud chamber by suspending a jar on dry ice. 3. Demonstrate a geiger counter if one is available. 4. Use local resources such as civil defense, hospitals. 5. Use audiovisual aids to demonstrate the different types of radioactivity.
VIII. CAREERS			
*49. Students should be familiarized with the various careers available in the fields of physical science.	Careers	Observing, inferring, classifying, communicating, predicting	1. Use attached career list as reference. 2. Have students do library research on several careers they are interested in.

*Optional

56 .

57

CAREERS IN SCIENCE

1. Airplane Mechanic	Aviation Maintenance Foundation Post Office Box 739 Basin, Wyoming 82410
2. Airplane Pilot	Air Line Pilots Association, International 1625 Massachusetts Avenue, N.W. Washington, D.C. 20036
3. Appliance Repair	Association of Home Appliance Manufacturers 20 North Wacker Drive Chicago, Illinois 60606
4. Assaying	American Chemical Society 1155 16th Street, N.W. Washington, D.C. 20036
5. Astrophysics	American Astronomical Society 211 Fitz Randolph Road Princeton, New Jersey 08540
6. Automobile Mechanical	Automotive Service Industry Association 230 North Michigan Avenue Chicago, Illinois 60601
7. Broadcast Technician	National Association of Broadcasters 1771 North Street N.W. Washington, D.C. 20036
8. Biochemist	American Society of Biological Chemists 9650 Rockville Pike Bethesda, Maryland 20014
9. Chemical Technician	Engineers Council for Professional Development 345 East 47th Street New York, N.Y. 10017

10. Computer Programmer — American Federation of Information Processing Societies
210 Summit Avenue
Montuale, New Jersey 07645

11. Criminalistics — American Academy of Forensic Sciences
Suite 501, 11400 Rockville Pike
Rockville, Maryland 10852

12. Electrician — A local electrical company or a licensed electrician

13. Environmental Analysis — Association of Environmental Engineering Professors, Department of Civil Engineering
Tufts University, Medford, Massachusetts 02155

14. Etching — American Institute of Graphic Arts
1059 Third Avenue
New York, N.Y. 10021

15. Flight Engineers — Airline Pilots Association International
1625 Massachusetts Avenue, N.W.
Washington, D.C. 20250

16. Food Chemistry — Consumer Inquiries, Food Safety and Quality
U. S. Department of Agriculture
Washington, D.C. 20250

17. Machine Tool Operator — International Association of Machinists and Aerospace Workers
1300 Connecticut Avenue, N.W.
Washington, D.C. 20036

18. Mineralogist — American Geological Institute
5205 Leesburg Pike
Falls Church, Virginia 22041

19. Musician — American Federation of Musicians
1500 Broadway
New York, New York 10036

20. Optician — Opticians Association of America
1250 Connecticut Avenue, N.W.
Washington, D.C. 20036

21. Pharmaceutical Science — American Pharmaceutical Association
2215 Constitution Avenue, N.W.
Washington, D.C. 20037

22. Photographer — Professional Photographers of America, Inc.
1090 Executive Way
Des Plaines, Illinois 60018

23. Physicist — American Institute of Physics
335 East 45th Street
New York, New York 10017

24. Piano Technicians — Piano Technicians Guild
Post Office Box 1813
Seattle, Washington 98111

25. Science Writers — National Association of Science Writers
Post Office Box 294
Greenlawn, New York 11740

26. Switchboard Operator (Electric Powerplant) — National Institute of Uniform Licensing of Power Engineers
176 West Adam Street
Suite 1914
Chicago, Illinois 60603

27. Truckdriver — American Trucking Associations, Inc.
1616 P Street, N.W.
Washington, D.C. 20036

REFERENCE MATERIAL

Textbook Reference List:

1. Appenbrink, D.; Hounshell, P.; and Slate, S. Introductory Physical Science. 3rd Edition. Englewood Cliffs, New Jersey: Prentice-Hall, 1977.

2. Barman, C.; Rusch, J.; Schneiderwent, M.; and Hindin, W. Physical Science. Morristown, New Jersey: Silver Burdett, 1982.

3. Bernstein, L.; Schachter, M.; Winkler, A.; and Wolfe, S. Concepts and Challenges in Physical Science. Fairfield, New Jersey: CEBCO Standard, 1978.

4. Blecha, M.; Fisk, F.; and Holley, J. Exploring Matter and Energy. 2nd Edition. River Forest, Illinois: Laidlaw, 1980.

5. Branduien, P.; Yassin, W.; and Brovey, D. Concepts in Science Series: Curie Edition Energy: A Physical Science. New York: Harcourt, 1980.

6. Brown, W., and Anderson, N. A Search for Understanding Series Physical Science: A Search for Understanding. Philadelphia: Lippincott, 1977.

7. Heimber, C., and Price, J. Focus on Physical Science. Columbus, Ohio: Chas. E. Merrill, 1981.

8. Hill, F., and May, J. Spaceship Earth/Physical Science. Revised. Boston: Houghton Mifflin, 1981.

9. Ramsey, W. Holt Physical Science. New York: Holt, 1982.

10. Thurber, W.; Kilburn, R.; and Orvell, P. Exploring Physical Science. Boston: Allyn and Bacon, 1977.

61

62

REFERENCES/RESOURCES

Suggested Film List (From Educational Film Catalog - Louisiana Department of Education, Bulletin #1406)

Acid - Base Indicator

Balancing Forces

Conservation of Mass - An Inquiry

Conservation of Energy

Color from Light

Chemical Bonding

Chemical Families

Controlling Atomic Energy

Demonstrating Gas Laws

Determination of Atomic Weight

Determining Molecular Formulas

Energy and Reaction

Electrons and Electronics - An Introduction

Energy and Matter

Electromotive Force Series, The

Elements, Compounds, and Mixtures

Energy - New Series

Energy - The Nuclear Alternatives

Exploring the Atomic Nucleus

Electrostatic Charges and Forces

Fundamentals of Electricity

Force of Gravity, The

Kinetic - Molecular Theory

Liquids in Solution

Magnetic Force

Magnetism and Electricity

Nature of Burning, The

Newton - The Mind That Found the Future

Properties of Solutions

Structure of Atoms, The

Temperature and Matter

You and Machines

63

64

AUDIOVISUAL SUPPLIERS

The audiovisual materials suggested in the curriculum guide can be obtained from the following suppliers:

Association Instructional Materials
347 Madison Avenue (Department DC)
New York, New York 10017

BFA-Ealing Corporation
2211 Michigan Avenue
Post Office Box 1795
Santa Monica, California 90406

BFA-Educational Media
2211 Michigan Avenue
Post Office Box 1795
Santa Monica, California 90406

Beckman Instruments Inc.
Attention: New Dimensions
2500 Harbor Boulevard
Fullerton, California 92634

Coronet Films
65 East South Water Street
Chicago, Illinois 60601

Education Audio-Visual Inc.
Pleasantville, New York 10570

Encyclopaedia Britannica
Educational Corp.
425 North Michigan Avenue
Chicago, Illinois 60611

Inquiry Audio Visuals
1754 West Farragut Avenue
Chicago, Illinois 60640

International Communication Films
1371 Reynolds Avenue
Santa Ana, California 92705

John Wiley and Sons, Inc.
605 Third Avenue
New York, New York 10016

Kalmia
Department C1
Concord, Massachusetts 01742

Lansford Publishing Co.
Post Office Box 8711
1088 Lincoln Avenue
San Jose, California 95155

McGraw-Hill Films
CRM/McGraw-Hill
110 15th Street
Del Mar, California 92014

Modern Learning Aids
1212 Avenue of the Americas
New York, New York 10036

65

66

Harper and Row Media
10 East 53rd Street
New York, New York 10022

Holt, Rinehart, and Winston, Inc.
383 Madison Avenue
New York, New York 10017

Indiana University
Audio-Visual Center
Office for Learning Resources
Bloomington, Indiana 47401[2]

Prentice Hall Media
Servode HC236
150 White Plains Road
Terrytown, New York 10591

Scholarly Audio-Visuals Inc.
5 Beekman Street
New York, New York 10038

Science Software Systems Inc.
11899 West Pico Boulevard
West Los Angeles, California 90064

Shell Oil Film Library
1433 Sadlier Circle W. Drive
Indianapolis, Indiana 46239

Modern Talking Picture Service
2323 New Hyde Park Road
New Hyde Park, New York 11040

Peter M. Robeck and Company
230 Park Avenue
New York, New York 10017

James J. Ruhl and Association
Post Office Box 4301
Fullerton, California 92631

Thorne Films
1229 University Avenue
Boulder, Colorado 80302

Universal Education and Visual Arts
100 Universal City Plaza
Universal City, California 91608

Westwood Educational Productions
701 Westport Road
Kansas City, Missouri 64111

Sutherland Educational Films
201 North Occidental Boulevard
Los Angeles, California 90026

Since these materials vary from quite simple to complex, teachers are urged to preview materials before presenting them to the class.

EVALUATION TECHNIQUES

Methods for evaluating pupils' achievement and progress are an integral part of the instructional program. Evaluation techniques must reflect (1) the objectives to be reached, and (2) the activities employed to reach those objectives. Since the objectives are stated clearly, the method of evaluation is indicated within the objective. The objectives are stated in behavioral terms, the process skills are identified, and suggested activities are listed. Thus, it is clear what the student is expected to be able to do after successful completion of a learning activity. The successful attainment of an objective can be demonstrated by having the student do specific things which can be observed.

Therefore, evaluation should consist of more than just paper and pencil tests on recall of factual knowledge. A variety of evaluation activities should be used.

69

70