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ABSTRACT

GRADES OR AGES: Grade 7. SUBJECT MATTER: Earth science. ORGANIZATION AND PHYSICAL APPEARANCE: The introductory material suggests a time schedule for the major units and gives details of the reference materials referred to in the text. The main text is presented in four columns: topical outline, basic understandings, suggested activities and procedures, and references and supplementary information. The sections are introduction to science, astronomy, geology, and meteorology. The guide is lithographed and spiral bound with a soft cover. OBJECTIVES AND ACTIVITIES: The objectives for each section are listed under basic understandings. Activities are suggested but are not given in any detail. INSTRUCTIONAL MATERIALS: Films, filmstrips, and books are listed under suggested activities and procedures. STUDENT ASSESSMENT: No provision is made for evaluation. (MBM)

EARTH SCIENCE

Grade 7

Buffalo Public Schools
Buffalo, New York

Division of Curriculum Evaluation and Development

BUFFALO PUBLIC SCHOOLS
BUFFALO, NEW YORK

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FOREWORD

The rapid accumulation of scientific information about the universe has made it impossible for any individual to remain informed about any more than a very narrow segment of science, and unwise for designers of science courses to attempt to limit these courses to the transmission of facts. If education today is to be education for change, then science educators must prepare their students to use the methods of science to solve yet unstated problems.

This course has been designed to make it possible for the student to acquire both information and the ability to solve problems by scientific methods. Facts can be used to lead to an understanding of the continuity of science. Experiments, used skillfully and carefully, can create for the student the thrill that a professional scientist feels when he solves a problem in his study or laboratory.

The committee that drafted this course outline has blended facts with activities with the hope that science will come alive for all students. Depth of treatment will vary with the individual. Methods may have to be changed, but the basic approach to science remains the same for all students. Added emphasis on student activities, teacher demonstrations and audio-visual aids will make it possible for students to achieve a successful undertsanding of both concepts and methods.

In all cases the material in the Guide is the minimum required and the final examinations will test this required material. Occasionally questions may be asked concerning current scientific advances of significance. Material that can be used as enrichment to challenge gifted students is indicated by asterisks.

INTRODUCTION

Changes in our society which present many educational challenges have led to an increased concern for and emphasis upon the school curriculum. Methods and procedures of the past are no longer adequate to our needs. The explosion of knowledge in many areas and new understandings of the learning behavior of children require constant revision of existing programs. For this reason, the Board of Education, upon my recommendation, created a Division of Curriculum Evaluation and Development. This Division is now engaged in the process of developing new courses of study and revising long-established curriculums.

Science is one of the areas in which significant changes are taking place. The demand for more and more knowledge about and understanding of the physical environment has greatly increased the emphasis upon science instruction. This Curriculum Guide, Seventh Grade Earth Science, deals with the nature of the physical environment and the effect of this environment upon man. A committee of classroom teachers, working under the direction of the Director of Science, prepared this excellent guide. I wish to thank and commend the committee members for their valuable contribution. All teachers and students of seventh grade will profit from the work of the committee.

Joseph Manch
Superintendent of Schools

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INTRODUCTION

As this is the first year of a three year science sequence for seventh, eighth, and ninth grade pupils, time can be well spent at the outset of the course of study to explain the goals of science. This can be done effectivly by detailing the step by step process of the scientist.

This attack on a problem can be made more meaningful if some classical scientific investigations are related. Mention can be made of the work of men like Kepler, Mendel, Galileo, Darwin, or Salk. The work of the biologist can be illustrated by using filmstrips from the series *Great Names in Biology*.

That part of the introductory unit treating various aspects of matter should be related to the study of minerals in order to make the discussion of mineral properties more meaningful.

The entire course is more effective if illustrations from the realm of the pupils' experience are frequently interjected. The basis for the order of topics is that maximum use can be made of concurrent observations. For example, astronomy should be presented in the fall when clear skies are most common; and meteorology in the spring during a time of rapid, pronounced weather changes with their accompanying classical phenomena.

Following is an approximate time schedule for each of the major units:

Introduction	3 weeks
Astronomy	8 weeks
Geology	16 weeks
Meteorology	10 weeks

In each of the units, there is ample time to allow for frequent demonstrations and pupil activity. Without this activity, the course will fail to be a meaningful experience.

There are frequent references in columns 3 and 4 of the course of study. The titles of reference materials are abbreviated in the interest of space; therefore the complete titles and abbreviations are listed below.

Blanc — Blanc and Fischler, *Modern Science: Earth, Space and Matter.*

N & S — Namowitz and Stone, *Earth Science, The World We Live In*

ESS — Heller, *Geology and Earth Sciences Sourcebook*

ESH — The University of the State of New York, *Earth Science Handbook*

A number of suggested activities are listed by using a letter or letters following by a number. The letters refer to the following State Education Department publications. Activities are numbered within each booklet.

GSH — The University of the State of New York, the *General Science Handbook*, Parts One, Two and Three.

A — The University of the State of New York, *Science* 7, 8, 9, *Experimental Syllabus*, Part One.

E, F, G, H — The University of the State of New York, *Science* 7, 8, 9, *Experimental* Syllabus, Blocks E, F, G, H.

MS — Buffalo Museum of Science Audio Visual Department

Dept — Buffalo Public Schools Audio Visual Department

* — Materials for enrichment in honors classes

Material listed under "basic understandings" is the minimum material for the course and will be subject to testing on departmental examinations.

TOPICAL OUTLINE	BASIC UNDERSTANDINGS
I. What is Science?	Science is the study of the universe. Scientists are concerned with organizing and classifying a body of knowledge and explaining the behavior of living and non-living matter on the basis of natural laws.
II. Divisions of Science	Science is divided into a number of areas. Those branches of science included in this course are as follows: 1. Astronomy—the study of the heavenly bodies, their motions and nature. 2. Geology—the study of the composition and structure of the earth. 3. Paleontology—the study of the history of the earth. 4. Oceanography—the study of the oceans and ocean basins. 5. Meteorology—the study of weather and climate.
III. Methods of Science	Scientists conduct careful investigations that may lead eventually to laws of nature. Following are essential steps in this process: 1. Careful observations of a particular occurrence give rise to a problem. 2. After assembling observations and researching the problem, an hypothesis is formulated. 3. The hypothesis is then subjected to extensive testing. 4. A theory or law can result from the results of the tests.
IV. Matter	Matter is anything that has weight and takes up space.
A. Properties of Matter	Substances are identified because they exhibit specific properties. Some of these properties are as follows: 1. Weight—an object has weight because of gravity. 2. Space—all objects take up space. The amount of space they occupy is called their volume. 3. Density—the weight of one unit of volume of a substance is its density.

SUGGESTED ACTIVITIES AND PROCEDURES	REFERENCES AND SUPPLEMENTARY INFORMATION
	Material for the introductory unit is based on "The Ways of Science" pp. xix-xxx and pp. 3-69 in Blanc. It is intended as a prelude to the junior high school science program in general and this course in particular.
Review some topics studied in elementary science and place them in their proper scientific discipline.	
A-1, A-2, A-6	
Emphasize that many hypotheses may seem to fit a set of observations. All must be tested, and it may take many years before one is accepted as a theory. Much more time may elapse before a law is postulated and accepted.	

TOPICAL OUTLINE	BASIC UNDERSTANDINGS
B. States of Matter	Matter may exist in three different states or phases. 1. Solids have a definite shape and a definite volume. 2. Liquids have a definite volume but no definite shape. 3. Gases have neither a definite shape nor a definite volume.
C. Structure of Matter	All matter is made up of elements and compounds.
1. Elements	There are more than 100 known elements, each of which is composed of protons, neutrons and electrons. The smallest part of an element is an atom.
2. Compounds	Compounds are composed of 2 or more elements which are chemically combined. The smallest part of a compound is a molecule.
3. Mixtures	Mixtures are composed of 2 or more substances (elements or compounds) combined physically. The properties of the individual substances are not changed.
D. Changes in Matter	Matter may undergo changes which are physical or chemical in nature.
1. Physical changes	A physical change involves only a change in appearance. The chemical composition remains the same.
2. Chemical changes	A chemical change results in the formation of a new substance.

SUGGESTED ACTIVITIES AND PROCEDURES	REFERENCES AND SUPPLEMENTARY INFORMATION
Discuss the properties of various common solids, liquids and gases. Demonstrate the change of state of ice to water to steam.	Abler students may understand a limited discussion of the kinetic theory of matter.
Ask pupils to name some common elements. Refer to Blanc pp. 46-7. Name some common compounds and point out the elements of which each is composed. Mention may be made at this time that minerals are compounds, e. g. quartz is silicon dioxide. Most rocks are mixtures.	It is not necessary to present a detailed explanation of the structure of matter. The topic is introduced to enable pupils to have an understanding of the composition of rocks and minerals.
List and discuss a number of common physical and chemical changes.	Changes may be presented as an introduction to physical and chemical weathering.

THE EARTH: ITS PLACE IN THE UNIVERSE

TOPICAL OUTLINE	BASIC UNDERSTANDINGS
I. The Universe	The universe consists of all known and unknown mass in any form and the void between. It is mostly empty space with the objects in it at great distances from each other.
A. Instruments Used in the Study of Space	In order to study the bodies that exist beyond our planet we must rely on the use of special instruments such as the optical telescope, spectroscope, camera, radar and radio telescope.
B. Distances in Space	The basic unit of distance in astronomy is the light year. It is the distance traveled by light in one year at a speed of 186,000 miles per second.
C. The Universal Force: Gravitation	Any two bodies will exert a force (pull) on each other. The amount of this force depends on the size of the bodies and the distance between them.
D. Stars	Stars are masses of hot (incandescent) matter. They are classified according to temperature and size. The hottest stars are blue-white; the coolest are red.
E. Galaxies	Galaxies are large clusters of stars, their related bodies and dust. Each galaxy is composed of millions of stars. Our galaxy is the Milky Way.
F. Constellations	A constellation is a cluster of stars and their related bodies that form a pattern or picture in the sky. Some constellations, such as the Big and Little Dipper and Draco, are visible the year around. Others, such as Orion are visible only part of the year.
G. Nebulae	A nebula is a cloud of dust or gases in space. They are thought to be an early stage in the development of stars or galaxies.
II. The Solar System	The solar system is made up of the sun and all the bodies that revolve around it. They are held in their orbits by gravity.
A. The Sun	The sun is an average sized star. It is the source of most of the earth's energy.
1. Structure	The sun consists of four ill-defined layers of material which increase in density towards the center of the sun. 1. Core – The dense central portion 2. Photosphere – The visible, light-producing layer 3. Chromosphere – The sun's atmosphere 4. Corona – The extremely thin outermost layer visible during solar eclipses.
2. Production of Energy	It is believed that the sun produces energy by means of nuclear fusion. Fusion is a reaction involving the collision and union of two particles during which a small amount of the original mass is converted into energy.
3. Distance	The mean distance from the earth to the sun is approximately 93,000,000 miles. The earth's orbit is an ellipse, so the actual distance varies from 91,500,000 to 94,500,000 miles. The mean distance is commonly called an astronomical unit, and is used to express distances within the solar system.

Movies: "Exploring the Universe" MS and Dept.
"Understanding Our Universe" MS
"Universe" MS
"Exploring the Edge of Space" Dept.

GSH 2713, 2714, 3754

GSH 2730
F - 16 (This may also be used with the study of the solar system)

One light year is about 6 trillion miles. The nearest star (Alpha Centauri) is 4.3 light years away.

Filmstrip: "Stars and Galaxies"

Movies: "Depth of Space" (Exterior Galaxies) – MS
"Beyond Our Solar System" Dept.
"Realm of the Galaxies" Dept.

Filmstrip: "Constellations"

Only those constellations located high in the northern sky are visible year round because of the revolution of the earth.

GSH 3753, 3757, 2726, 2727, 2731, 2734

Calculate the approximate diameter of the sun using a coin or pinhole in a shade.

In a dark room, place a sheet of metal or black paper in front of a light bulb so that only the "corona" will be seen.

Approximately 4 million tons of matter are converted into energy each second on the sun. This results in the production of energy at the rate of 5×10^{23} horsepower in accordance with Einstein's equation ($E = mc^2$)

To encourage a better sense of the distance involved, have the pupils compute the time required to travel to the sun at various speeds.

GSH 2719, 2720, 2721, 2722, 2723

Filmstrips: "The Sun and Its Planets"
"The Solar Family"

F-31

[illegible] p. 252 No. 15

B. The Planets

A planet is any non-luminous body of appreciable size which orbits a star.

There are nine known planets, each of which travels around the sun in an elliptical orbit. In order from the sun out they are:

1. Mercury
2. Venus
3. Earth
4. Mars
5. Jupiter
6. Saturn
7. Uranus
8. Neptune
9. Pluto

1. The Inner Planets

The four planets nearest the sun are relatively warm, dense and slow rotating.

2. The Outer Planets

The five planets farthest from the sun are generally large, cold, of low density, fast rotating, and have bands of clouds parallel to their equators.

C. Planetoids (Asteroids)

There are thousands of bodies too small to be considered planets which orbit the sun in a belt between the orbits of Mars and Jupiter.

D. Meteoroids

A meteoroid is a mass of solid material in space. A "shooting star" is a meteoroid which has entered the earth's atmosphere, and has become incandescent because of frictional heating.

E. Comets

A comet is a mass of gas and fine particles orbiting the sun. They have very elongated orbits.

F. The Moon

The moon is the earth's only natural satellite. It has a diameter about ¼ as large as that of the earth. It is about 240,000 miles from the earth.

1. Surface Features

The moon's surface consists of plains (called seas), craters and mountain ranges.

2. Motions

The moon revolves about the earth every 28 days. It rotates on its axis once each 28 days. Because the periods of rotation and revolution are the same, the same side of the moon always faces the earth.

3. Phases

The moon is visible on earth because it reflects sunlight. As it revolves, different portions of the lighted surface can be seen from earth.

The principal phases are new moon, first quarter, full moon and last quarter. These phases are repeated each 29 days.

4. Tides

Because the moon has mass, it exerts a gravitational pull on the earth. The most noticeable effect of this pull on earth is tides. The sun exerts a smaller effect on tides.

The highest high and lowest low tides (spring tides) occur at the new and full moon.

Tides of least range (neap tides) occur at first and last quarter.

5. Eclipses

A solar eclipse occurs when the earth is in the moon's shadow.

A lunar eclipse occurs when the moon is in the earth's shadow.

Because Pluto is the outermost planet, insufficient information has been acquired about its specific physical properties.

Filmstrip: "Comets and Meteors"

Meteor showers occur when the earth intercepts a band of meteoroids.

A comet is visible because its gases are ionized, and because it reflects sunlight. The tail of the comet always points away from the sun.

Movies: "The Moon" MS and Dept.
"A Trip to the Moon" MS and Dept.
"How We Explore Space" MS

Filmstrips: "The Earth's Satellite – The Moon"
"Work of Astronomers and Space Travel"

GSH 2703, 2709, 2725
GSH 2701, 2702, 2710, 3744
GSH 2704, 2705, 2706, 2711, 2712, 2714

Two high tides and two low tides are formed simultaneously. The moon exerts the greatest attraction on the waters nearest it and least attraction on the waters on the far side of the earth.

GSH 2707

Eclipses do not occur during each new or full moon because the moon does not orbit the earth in the same plane as the earth revolves about the sun.

TOPICAL OUTLINE	BASIC UNDERSTANDINGS
III. The Earth	The earth is an oblate spheroid. It is slightly compressed at the poles. Its diameter is approximately 8000 miles.
A. Location on the Earth's Surface	In order to provide a uniform system for expressing position and direction on the earth's surface, it has been divided into a grid.
1. Latitude	Latitude is the angular distance north or south of the equator.
2. Longitude	Longitude is the angular distance east or west of the prime meridian.
	The prime meridian is an imaginary line from the North Pole through Greenwich, England to the South Pole.
B. The Earth's Motions	The earth revolves in an elliptical orbit about the sun once each 365¼ days.
	The earth rotates on its axis once each 24 hours.
1. Time	The regular motions of the earth are the basis of our time units.
	The earth rotates through 360 degrees of longitude each day, so the width of each of our 24 time zones is about 15 degrees of longitude.
2. Seasons	Seasons are caused by the following: 1. Inclination of the earth's axis to the plane of its orbit 2. Parallelism of the earth's axis 3. Revolution of the earth about the sun.
	The beginning of each season occurs when the sun's vertical ray falls on a particular parallel of latitude. Spring – March 21 – vernal equinox – vertical ray on equator Summer – June 21 – summer solstice – vertical ray on Tropic of Cancer Autumn – September 22 – autumnal equinox – vertical ray on equator Winter – December 21 – winter solstice – vertical ray on Tropic of Capricorn

Discuss the direct and indirect evidence of the earth's shape.

Movies "The Earth in Motion" MS and Dept.
"Earth Rotation and Revolution" MS and Dept.

Label the time zones on a map of the United States. Indicate the time in principal cities.

Time zone boundaries are not regular because of economic and political considerations.

Sketch the earth and sun at the times of the equinoxes and solstices. Indicate on each the areas of daylight and darkness, the position of the vertical ray, and the five named parallels of latitude.

TOPICAL OUTLINE	BASIC UNDERSTANDINGS
I. Structure	The solid earth consists of three layers.
A. Core	The *CORE* is under extreme pressure, is very dense, may be partly liquid and is thought to be mostly iron.
B. Mantle	The *MANTLE* is thought to consist of solid, rock-forming iron and magnesium compounds. The mantle is about 1800 miles thick.
C. Crust	The *CRUST* varies in thickness from 3-30 miles. The crust consists of soil, rocks and minerals.
*D. Moho	The boundary between the crust and the mantle.
II. Composition of the Crust	
A. Minerals	A *MINERAL* is a naturally occurring substance (elements and compounds), e. g. halite (rock salt), sulfur, quartz (the sand around Lake Erie is mostly quartz).
1. Identification	
a. Physical Properties	
(1) Color	Azurite: blue, malachite: green, sulfur: yellow
(2) Streak	*STREAK* is defined as the color of the fine powder of a mineral. To obtain this powder, the mineral may be crushed or it may be rubbed across a streak plate (unglazed porcelain). The streak of a mineral is always the same regardless of the color of the mineral.
(3) Luster	The way in which a mineral reflects light. e. g. halite: glassy, mica: glassy
(4) Hardness	The ability of a mineral to resist scratching. If one mineral scratches another mineral or substance it is harder than that mineral or substance. The hardness of a mineral is determined by a scale on which talc is the softest (1), and diamond is the hardest (10). Quartz is the hardest common mineral (7). Convenient materials for determining hardness, with the hardness number for each are: Fingernail 2.5 Penny 3.3 Glass 5.5
(5) Cleavage	The tendency of a mineral to split naturally along smooth, flat surfaces, e.g. mica, halite.

TOPICAL OUTLINE	BASIC UNDERSTANDINGS
b. Chemical properties	
(1) acid test	Limestone is made up of the compound calcium carbonate and can be identified by dropping hydrochloric acid on the sample. Bubbles of carbon dioxide will be given off.
*(2) flame tests	Some minerals can be identified by the color given a flame when the mineral is heated.
2. Important minerals	Minerals are the source of elements, e.g. aluminum (bauxite), iron (hematite), lead (galena), chlorine (halite). Minerals are a source of building materials: asbestos, plaster (gypsum); mica (electric insulation: toaster, etc.)
B. Rocks	The crust of the earth consists of rocks made up of one or more minerals.
1. Igneous	Igneous rock is formed as the result of the cooling and hardening of hot, molten material (magma) on or below the earth's surface. Slow cooling below the earth's surface, produced large crystals: granite. Rapid cooling on the earth's surface produced fine crystals, e.g. obsidian, pumice
2. Sedimentary	Streams carry dirt and particles of rock to the oceans where it is deposited. Some materials form in the oceans and settle (skeletons of tiny animals, minerals such as calcium carbonate). Pressure causes these materials to form solid rock.
a. Sandstone	Produced from bits of rock cemented together.
b. Shale	Produced from clay and mud.
c. Limestone	Produced from skeletons (shells) of marine animals.
3. Metamorphic	Sedimentary rock that has been changed by pressure and temperature. Ex: marble from limestone, slate from shale.
C. The Rock Record	Rock layers found near the surface of the earth are younger than layers found beneath them.
1. Age of Rocks	The age of rocks can be determined by measuring the amount of radioactive elements present.
2. Fossils	Fossils are the remains of plants or animals preserved in rocks.
a. Types	Some common types of fossils are: 1. Actual remains 2. Casts and molds 3. Tracks and imprints 4. Replaced fossils
b. Age of fossils	The age of fossils can be determined by knowing the age of the rock in which they are found, by radioactive dating (using Carbon-14) or by comparing with index fossils.

Review the material on change of state. Blanc pp. 12-16.

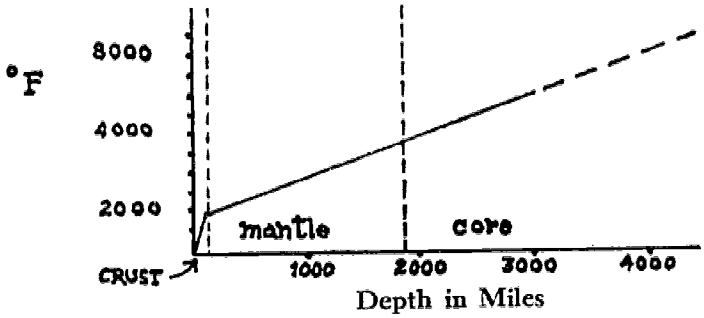
Draw a circle on the board having a diameter of about 2 feet. The crust would not be as thick as the chalk line.

Movie: Project Moho.

*A discussion of Project Moho and its aims may be held at this point.

Demonstrate the relationship between cleavage and crystal structure with ESH 1.06.

The temperature of the earth increases with depth. This is shown in the following graph.



See N & S p. 4, 208-9.

Summaries of mineral identification characteristics may be found in Block E p. 101 and ESS p. 14-15.

Some of the common minerals and their streaks are:

1. Hematite—reddish brown
2. Malachite—green
3. Azurite—blue
4. Pyrite—greenish black
5. Sulfur—pale yellow
6. Graphite—black

The Mohs Scale of Hardness consists of ten minerals arranged according to hardness:

1. Talc	5. Apatite	8. Topaz
2. Gypsum	6. Orthoclase	9. Corundum
3. Calcite	7. Quartz	10. Diamond
4. Fluorite		

A diagram relating the hardness of minerals and common substances is found in ESH p. 15.

A discussion of common crystal shapes may be found in N & S p. 12 and ESS p. 23.
See N & S p. 13

SUGGESTED ACTIVITIES AND PROCEDURES	REFERENCES AND SUPPLEMENTARY INFORMATION
E-10	In conducting flame test demonstrations, elements or compounds used may be powdered and introduced into a bunsen flame. A platinum needle does not have to be used. Do not use pure lithium, potassium or sodium. Salts of these elements such as NaCl, $NaHCO_3$, LiCl, KCl, KI and $KMnO_3$ may be used safely.
*ESS p. 19	
E-12, ESH 1.15	The rate at which the molten material cooled can be determined by examining the crystal size of the rock. Coarse grains are formed slowly. Rapid cooling does not allow for crystal formation. Therefore, glassy or fine textured rocks indicate rapid cooling.
E-15, ESH 1.19, 1.20, 1.21	See N & S pp. 41-45 and ESS pp. 44-46.
E-16, ESH 1.22	
Filmstrip—"How We Know About Life Long Ago" "Up Through the Coal Age" "When Reptiles Ruled the Earth" "Mammals Inherit the World" "Stories that Fossils Tell" "Hunting Fossils"	The Law of Superposition states that in a sequence of undisturbed sedimentary rocks, younger rock layers lie on top of older rock layers. Diagrams of fossils frequently found in New York State are found in ESH p. 91. A discussion of fossil formation is found in N & S pp. 50-52.
Movies—"Fossils are Interesting" MS "The Story of Coal" MS	Methods of determining the age of rock formations are discussed in N & S chapter 21.
Plaster of Paris casts and molds of common objects may be made to simulate Fossil Formation. E–40	Fossils in the Buffalo area are from the Devonian Age.

TOPICAL OUTLINE	BASIC UNDERSTANDINGS
III. Changes in the Earth's Surface	The earth's surface is being constantly changed by forces that build it up and wear it down.
A. Weathering	Destructive forces causing the breakdown of rock materials into its components without being moved to another location.
1. Chemical Weathering	Breakdown of rock materials by chemical means, e.g. rusting of iron to produce red clay and rock, acid (rain water and carbon dioxide) on limestone.
2. Physical Weathering	Breakdown of rock materials by physical means, e.g. frost action, plant roots, temperature changes, solution (cave formation, stalactites and stalagmites).
B. Erosion	The wearing away of soil and rock and the transportation of the materials formed.
1. Gravity	The force of attraction that pulls everything toward the center of the earth. Landslides, rockfalls
2. Running water	Running water carries soil and rock particles from higher elevations and deposits them at lower elevations. Running water causes most of the erosion of the earth's surface. Running water erodes by wearing away by friction between the rock material in the water and the stream bed. The rate of erosion depends on the velocity and volume of a river and the amount of rock material carried in the water. The lowest level to which a stream can erode is the level of the body of water into which the stream flows.
3. Glaciers	A glacier is a large sheet of ice formed from compressed ice and snow. Glaciers form in areas where the summer melting is less than the amount of snowfall.

SUGGESTED ACTIVITIES AND PROCEDURES	REFERENCES AND SUPPLEMENTARY INFORMATION
Movie–"The Wearing Away of Land" MS	
E-25 (Demonstration only), E-28 In order to effectively review the weathering unit, discuss the formation of caves, stalactites, stalagmites and columns. This involves solution, carbonation, evaporation and precipitation. ESH 2.04 p. 60	ESS p. 420-28
Movie–"Erosion" Dept. "Force of Gravity" Dept. Movie–"The Work of Rivers" MS E-32	Emphasize that transportation is the difference between weathering and erosion. The fragments formed by agents of weathering remain in place while erosion results in the carrying away of the rock particles. For a complete discussion of erosion by running water and the resulting land forms, see N & S, Chapter 9.
E-35, E-36 Movie–"Geologic Work of Ice" MS	A discussion of glacier formation is found in ESS p. 181.

a. Valley or Mountain Glaciers

Valley glaciers are found at high elevations and descend through mountain valleys. Surface features resulting from mountain glaciers are:

1. Scratches and grooves
2. Moraines
2. U-shaped valleys

b. Continental Glaciers

Continental glaciers are thousands of feet thick and cover extremely large areas. They erode the land by scouring or "bulldozing."
Surface features resulting from continental glaciers are:

1. Scratches and grooves
2. Outwash plain—a level deposit of sand and gravel left by a melting ice sheet.
3. Great Lakes basin
4. Finger Lakes—which were rivers dammed by glacial action

4. Wind

Wind erosion is most effective in arid regions. Erosion results when wind picks up loose particles and wears away rock by an effect similar to sandblasting. Land forms associated with wind erosion are almost vertical cliffs of silt and sand dunes.

C. Crustal Movements

Evidence from the past indicates that the earth's crust has undergone extensive movement

1. Folding

Extreme pressure within the earth may cause the bedrock to warp. This warping is responsible for the formation of many mountains, e. g., the Appalachians.

2. Faulting

Pressure exerted upward or sideward may cause rock to break along a line of weakness. A fault is a break in the bedrock along which there has been movement. Faulting has caused the formation of part of the Rockies.

Filmstrip—"Work of Ice and Snow"

ESH 2.18

Moraines are the rock material carried by and deposited by a glacier. They are named according to where in the glacier they were carried, e. g.

Lateral moraine—caried along the sides of a glacier.

Medial moraine—carried in the center of a glacier; this usually results from the joining of two valley glaciers.

Terminal moraine—rock material pushed ahead of a glacier. This deposit marks the limit of the forward movement of a glacier.

Ground moraine—rock material carried beneath a glacier.

Diagrams of moraine locations are found in N & S p. 140 and p. 145.

Movie—"Great Lakes" Dept.

ESH 2.15

Discuss the changes indicated in the maps on p. 324 in Blanc.
ESH 3.06, GSH 2851

Extensive areas of the Appalachian chain have been formed from folding. The Alps are also folded mountains.

ESH 3.01

Block mountains (formed from faulting) are the Sierra Nevadas and the mountains ringing the Great Basin area. A discussion of mountain formation is found in N & S pp. 188-191.

TOPICAL OUTLINE	BASIC UNDERSTANDINGS
3. Vulcanism	Movements of liquid rock are called vulcanism. These movements occur both on the surface and within the earth.
a. Volcanoes	The eruption of molten rock on the earth's surface results in a cone shaped mountain or volcano.
b. Hot springs	When ground water passes through a region of vulcanism, a hot spring results. If the proper opening is present and the water is heated to its boiling point, an erupting hot spring or geyser may result.
IV. The Oceans	Oceanography is the study of the earth's oceans. Approximately three-fourths of the earth's surface is covered with water.
A. Importance	The ocean is important for many reasons, not the least of which is that it represents the largest unexplored area on earth.
1. Mineral resources	The ocean represents a vast, virtually untapped source of minerals. Magnesium, petroleum and coal are among the few resources commercially obtained at the present.
2. Food resources	Present food resources are limited to some fish. Fish farms are planned to increase the harvest. Some forms of ocean plant life are possibilities for the future. The oceans also represent our largest potential source of drinking water.
3. Exploration	Clues to the nature of the earth's interior may be found by drilling on the ocean floor. The earth's crust is thinnest beneath the oceans.
B. Difficulties in Exploration	Tremendous pressures in the ocean depths restrict exploration. Satisfactory equipment to explore the depths is presently under development.
C. Geography of the Oceans	The topography of the ocean floor is similar to that found on the continents, e.g. 1. Plateaus correspond to the continental shelf. 2. Plains are found off the continental shelf. 3. Mountains exist in mid-ocean. Those tall enough to break the surface are islands.

Movies—"Birth of a Volcano" M. S.
"Earthquakes and Volcanoes" M. E.
"Volcanoes in Action" M. S.
"Eruption of Mt. Vesuvius" M. S.
ESS p. 76 Nos. 1, 2
ESH 1.35, 1.36

Volcanoes of Hawaii rise 30,000 feet from the ocean floor.

Most active volcanoes are found in a ring around the Pacific Ocean.

Hot springs and geysers are found in Yellowstone National Park.

Of the total earth's surface only 17% is suitable for cultivation.

Discuss the mineral content of sea water based on charts in ESS p. 160 and N & S p. 241.
ESH 1.26

We have only begun tapping vast oil resources on the continental shelf and here only in the shallow locations (not over 200 feet water depth).

Coal deposits are being worked off the British Isles.

Fish farming is presently being attempted off Scotland and Japan.

ESH 1.27

Discuss the features found in the diagram of the ocean floor in N & S p. 245, 246. Another diagram which may be used is found in ESS p. 164-5.

The continental shelves slope rather abruptly to deep plains. These depths are called abyssal plains. These deep abyssal plains cover more than one-half of the earth's surface.

D. Ocean effects

The oceans have the greatest effect on coastal areas.

1. Climate

Oceans tend to moderate the climate of coastal areas. The presence of warm or cool currents raises or lowers the average temperature. The following are significant:

1. Gulf Stream—a warm current which causes mild winters in the British Isles.
2. Japan Current—a warm current affecting the Pacific northwest.
3. Labrador Current—a cold current which cools the Maritime Provinces and New England.

2. Changes in Shorelines

The action of waves striking a shoreline results in both building and erosion.

a. Wave Erosion

The constant pounding of waves upon a shoreline tends to wear irregular coasts to make them straighter. Cliffs and caves also result from erosion by waves.

b. Wave Deposits

Incoming waves in shallow water carry rock particles and deposit them on or near the shoreline. This results in sandy beaches and sand bars.

V. Conservation

Conservation techniques are used to minimize the effects of weathering and erosion. Some methods used to offset the destruction by running water are:

1. Planting cover crops
2. Contour plowing
3. Strip farming
4. Terracing
5. Building dams

Some methods used to control wind erosion are:

1. Planting wind breaks
2. Planting cover crops
3. Irrigation

ESH 1.27

A discussion of shorelines and the changes caused by wave erosion and deposition is found in N & S pp. 264-69.

Review the activities demonstrating erosion effects. Point out methods used to counteract these effects.

Conservation methods can be profitably taught during the discussion of the effects of each agent of erosion.

ESH 2.11

TOPICAL OUTLINE	BASIC UNDERSTANDINGS
I. Characteristics of the Atmosphere A. Composition	Our atmosphere is a mixture of gases extending to an altitude of at least 2200 miles. In the lower levels, the average composition of the atmosphere is as follows: Nitrogen 78%; Oxygen 21%; Argon, Carbon Dioxide, Water Vapor, Rare gases 1%
B. Structure	For convenience, the atmosphere is divided into layers according to their principal characteristics.
1. Ionosphere	The ionosphere is found from 30 to 600 miles above the earth's surface. It is composed of charged particles (ions) which reflect some radio waves.
2. Stratosphere	The stratosphere is found from 8 to 30 miles above the earth's surface. It is characterized by an almost constant temperature and clear skies.
3. Troposphere	The troposphere extends from the surface up to 8 miles. It is the layer in which all turbulence and weather phenomena are found.
II. Changes in the Troposphere	Because it is nearest the earth, differences in characteristics and temperature of the earth's surface cause differences in the troposphere.
A. Temperature	The earth receives most of its energy by radiation from the sun.
1. Changes with Altitude	Because the lower levels of the atmosphere are denser, they intercept more radiation. Considerable heating is also obtained from energy re-radiated from the earth.
2. Changes with Latitude	The equator receives the most direct solar radiation and is warmest. The poles receive the least direct radiation and are therefore cold.
B. Pressure	Air pressure is the weight of the atmosphere pushing on each square inch of the earth's surface.
1. Changes with Altitude	Normal air pressure at sea level is about 15 pounds per square inch. This will support a column of mercury about 30 inches high. Air pressure decreases with an increase in altitude. At an altitude of 3½ miles the air pressure is half as great as at sea level.
2. Differential Heating	Adjacent areas on the surface may have different air pressures because of differences in the surface temperature, e. g. 1. During warm afternoons land is warmer than water and air pressure over land is lower than over water. 2. The equator is warm, so air pressure along the equator is low. 3. The polar regions are cold and air pressure is high.
3. Measuring Air Pressure	Air pressure is measured by an instrument called a barometer. The two basic types of barometer are mercury and aneroid.
C. Moisture in the Air	The amount of water vapor in the air varies. Warm air can hold more moisture than cold air.

SUGGESTED ACTIVITIES AND PROCEDURES	REFERENCES AND SUPPLEMENTARY INFORMATION
A systematic collection and recording of daily weather conditions is recommended throughout the unit. These daily changes can be used to explain the concepts presented.	
A class collection of daily newspaper weather maps is a valuable aid.	Point out that, as a mixture, the composition is subject to change. For example, around industrial areas and active volcanic areas the percentage of carbon dioxide will increase. The amount of water vapor also fluctuates greatly. Various air pollutants are not included in the average composition.
Start H-10 at this time. See also ESH 6.13 H-2a, H-4, ESH 6.01 may be used	Activity H-6 should be included to emphasize these factors.
	Above the troposphere there are layers where single gases predominate.
	See Namowitz and Stone pp. 432-35
GSH 1631, 1632, 1636	The figure given for the height of the troposphere is an average. It varies from about 3 miles at the poles to about 11 miles at the equator.
GSH 1625	
	In the lower levels of the troposphere (sea level to 10000 ft.) pressure decreases about one inch of mercury for each 1000 feet of altitude.
Review the effect of heat energy on gases	See Namowitz and Stone p 455
ESH 143 6.03 a, b, c, *6.03 d GSH 2663, 2607, 2605, 3607, 3608, 3609 Explain the construction and principles of operation of each type.	

1. Relative Humidity
2. Dew Point

Relative humidity is the ratio of the amount of water vapor in the air compared with the amount the air can hold at the same temperature. The temperature at which the air will become saturated is the dew point.

3. The Water Cycle

The earth's supply of water is continually circulating. This path is known as the water cycle. The essential steps are as follows:

1. Evaporation—occurs mainly from the oceans.
2. Condensation-clouds are formed when water vapor in the air condenses.
3. Precipitation—when water droplets are too large to remain suspended in the clouds, they fall to the ground.
4. Runoff—water flows on and beneath the surface of the earth back to the oceans.

4. Clouds

Clouds consist of visible moisture in the air. They are classified in three groups according to the height of their bases.

a. High clouds

Cirrus clouds are formed highest above the earth's surface. They are thin and feathery, and, because of their great height, are always composed of ice crystals.

b. Middle clouds

The middle group of clouds contain the prefix "alto".

Altostratus—a layer of thin clouds.
Altocumulus—small, puffy clouds

c. Low clouds

There are two types of low clouds.

1. Stratus—low, flat sheets of clouds.
2. Cumulus—thick, puffy clouds with low bases. They may build to great heights.

d. Rain clouds

Clouds from which precipitation is likely to occur contain the name—"Nimbus".
Cumulonimbus—clouds from which thunderstorms originate.
Nimbostratus—dark, flat clouds which produce a long period of precipitation.

5. Precipitation

The common forms of precipitations are:

1. Rain
2. Snow—crystallized vapor
3. Sleet—frozen rain
4. Hail—alternate layers of snow and sleet

D. Winds

Winds are horizontal movements of air across the earth's surface.

1. Causes

Air moves from high pressure to low pressure.

2. Names

Winds are named after the direction from which they blow.

3. Examples

Some of the common examples of winds follow:

1. Land and sea breezes
2. Hurricanes
3. Tornadoes
4. Continental winds—
   a. Polar easterlies
   b. Prevailing westerlies
   c. Trade winds

E. Air Masses

An air mass is a large body of air which has uniform temperature and humidity at any given level.

Air masses are given names which indicate their temperature and humidity.

H - 53 GSH 3620

GSH 2610, 2611, 2613, 2614, 2615, 2616, 2617

ESH 6.09

Namowitz and Stone pp 484-86

The relatively flat bases of clouds indicate the level where saturation is reached. Rising air cools because of expansion. The rate of cooling varies according to the moisture content. Saturated air cools at the rate of 3½°F per 1000 feet. Unsaturated air cools 5½°F per 1000 feet.

Hailstones are formed in cumulonimbus clouds where violent up and down drafts carry the hailstones alternately above and below freezing temperatures. A hailstone is composed of layers of snow and sleet.

GSH 3615, 3616
ESH 6.04, 6.05

H - 36

Land-sea breezes occur because of local pressure differences. During warm days the land absorbs more heat energy. The air above land is warmer than that over water. Air pressure over land is less than over water, and a breeze will blow from sea to land. The reverse is true at night.

1. Formation

Air masses form over areas having fairly uniform surfaces. They take on the characteristics of the source region.

2. Names

Air masses are named according to their properties.

The following are the air masses affecting Buffalo:

1. cP—continental polar—It is formed in Canada and has cool, dry air.
2. cT—continental tropical—It is formed over the southwest desert and has warm, dry air.
3. mP—maritime polar—It is formed over the north Pacific or North Atlantic Ocean and has cool, moist air.
4. mT—maritime tropical—It is formed over the Carribbean Sea and has warm, moist air.

F. Fronts

A front is the boundary between two unlike air masses.

1. Warm front

A warm front occurs when a warm air mass displaces a cold air mass.

The following are characteristics of a warm front:

1. Cirrus clouds followed by gradually lowering stratus clouds. Fog may accompany a warm front.
2. Warm fronts have shallow slopes so the changes are gradual and precipitation will last several hours.
3. The approach of a warm front is indicated by falling barometric pressure.

2. Cold front

A cold front occurs when a cold air mass displaces a warm air mass.
The following are characteristics of a cold front:

1. A line of cumulus or cumulonimbus clouds indicates the position of the front.
2. Precipitation is heavy but of short duration. It usually occurs as thunder showers.
3. The barometric pressure starts rising about the time the front passes.

3. Stationary front

A stationary front is the boundary between two different air masses, neither of which is moving. Weather changes associated with a stationary front are minor.

4. Occluded front

An occluded front occurs when a cold front overtakes a warm front.
Weather changes are a combination of those associated with warm and cold fronts.

G. Low Pressure Areas

Low pressure areas often develop as a result of the meeting of two air masses.

Air will spiral toward the center of a low in a counter clockwise fashion.

Low pressure areas are characterized by rising air. This may lead to condensation and precipitation.

H. High Pressure Areas

Clear skies are generally associated with high pressure areas.

ESH 6.28, 6.29

While air masses assume the temperature and humidity characteristics of their source regions, they may be modified by the terrain over which they move. The farther they move from the source, the more severe will be the changes.

ESH 6.36

H - 44

Fronts – The principal reason for the difference in slopes of warm and cold fronts is the density difference between warm and cold air. Because cold air is denser, it will wedge under the warm air and force the warm air out. An advancing warm air mass rides over the dense cold air and tends to "drag" it along. This results in a shallow slope.

Warm front – Typically the warm front precedes the center of the low. Therefore air pressure will fall during its passage. The wind will shift from the southeast to south or southwest.

Additional indications of cold front passage include a wind shift to the northwest, a drop in the dew point and a rapid clearing.

An occluded front is found near the center of the low. In this area, air is rising as in all lows. In addition warm air is being forced upward by advancing cold air. This combination usually results in the most severe frontal type weather.

H - 26, H - 41, ESH 6.38

Fronts are always associated with low pressure areas. Lows are generally formed as a result of the lifting action of a cold, dense air mass on less dense (warm, moist) air. See ESH p. 180-85

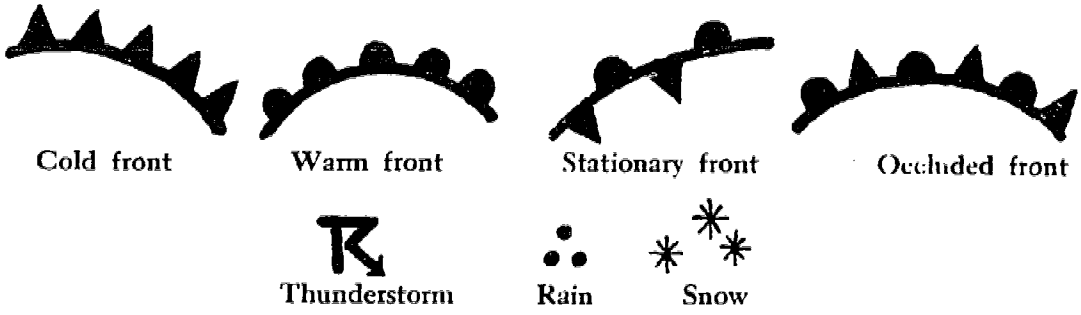
III. Weather Maps

Maps indicating current weather conditions are prepared by the Weather Bureau every 3 hours.

A. Symbols

Symbols are used to express a great deal of weather information in a limited space.

Following are some of the more common symbols:



B. *Station Models

The observed weather conditions from each reporting station are presented as a station model.

C. Isobars

Isobars are lines connecting points of equal air pressure.

IV. Weather Forecasting

Weather forecasts are made on the basis of numerous observations, and on the forecaster's knowledge of weather phenomena.

The weather map symbols for fronts always point toward the direction in which the front is moving.

* ESH 6.14

A complete discussion of station models is found on pp. 526-27 in Namowitz and Stone

An explanation of symbols is also found on the back of the U. S. Weather Bureau's Sunday weather maps.

An excellent review of this unit can be presented by using the collected daily weather maps to explain the basis of the weather bureau's daily forecasts, and to attempt limited, general forecasting by the class.

Complete the discussion of H-10.
H-9, H-12, H-13, H-14