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ABSTRACT

This science curriculum resource handbook provides background information and techniques of instruction designed for instructors helping students to prepare themselves for the General Educational Development Test in general science ability. It consists largely of fundamental concepts which high school graduates are expected to retain, together with some techniques which may be of use in developing these concepts. There is a section on reading skills in science. (Author/EB)

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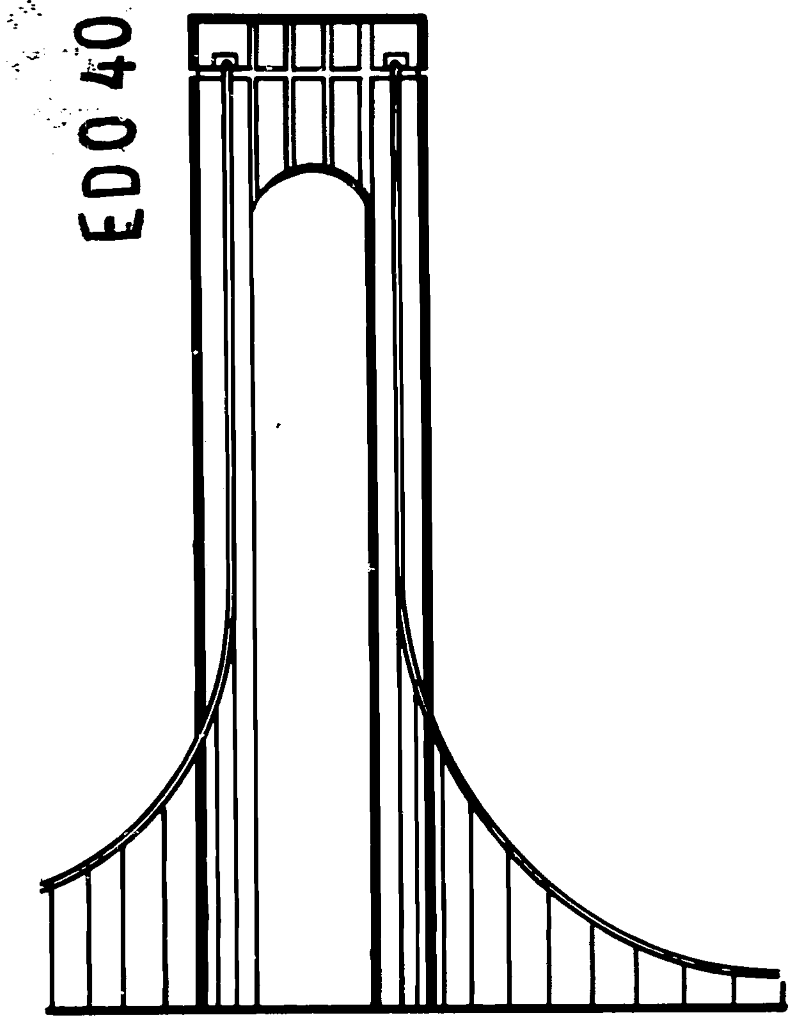

HIGH SCHOOL EQUIVALENCY

Science

PART II: CURRICULUM RESOURCE HANDBOOK

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[TH]E UNIVERSITY OF THE STATE OF NEW YORK/THE STATE EDUCATION DEPARTMENT
BUREAU OF CONTINUING EDUCATION CURRICULUM DEVELOPMENT/ALBANY

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HIGH SCHOOL EQUIVALENCY

PART II:

Curriculum Resource Handbook

SCIENCE

The University of the State of New York
THE STATE EDUCATION DEPARTMENT
Bureau of Continuing Education Curriculum Development
Albany, 1970

THE UNIVERSITY OF THE STATE OF NEW YORK

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Foreword

This science handbook represents a further step by the Department toward the goal of providing adults with realistic personal achievement and its concomitant benefits. Competency in the scientific methods and with the concepts described herein should facilitate the earning of a high school equivalency diploma, an accomplishment which will assume ever greater importance in our increasingly demanding society.

A field test edition of this manual was distributed to a representative sampling of schools for critical comment. Over ninety percent of the responses indicated that the publication was very helpful. Hopefully, this final version reflects the constructive criticism received. Further, it is a continuing responsibility of this Bureau to maintain the currency of, and provide supplementary materials for, the high school equivalency program.

The Bureau expresses appreciation to John H. Edwards (deceased), former Supervisor of Science Education, Niagara Falls Public Schools, who prepared the original draft of these materials, and to R. Allan Sholtes, Guilderland Central Public Schools, who contributed to the planning and design of the project and continued his work as general writer for the high school equivalency materials.

Department personnel who assisted in the planning and review of the manuscript include: Hugh B. Templeton, Chief, Bureau of Science Education; William A. Calhoun and Edward T. Lalor, Associates, Bureau of Science Education, who carefully reviewed the manuscript and made pertinent suggestions for its modification; John P. McGuire, Chief, and John Rajczewski, Assistant, Bureau of Higher and Professional Educational Testing, who actively assisted the project through their analysis of the field test results in relation to the high school equivalency examination. William Jonas, formerly an Associate in this Bureau, and now with the Bureau of General Continuing Education, helped coordinate the project. Barry Jamason, Associate, Bureau of Continuing Education Curriculum designed and prepared the manuscript for publication.

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Message to the Instructor

High School equivalency preparation programs have posed serious problems for those concerned with the development of effective instructional methods in this area. The Department's recent publication, *High School Equivalency Part I: Theory and Design of the Program*, was the first in a series of publications designed to help instructors and administrators in their efforts to develop educationally sound programs of high quality. It provides valuable information concerning the G.E.D.T., program suggestions, and some initial direction for such efforts.

This science curriculum resource handbook provides background information and techniques of instruction designed for instructors helping students to prepare themselves for the G.E.D.T. in general science ability. It consists largely of fundamental concepts which high school graduates are expected to retain, together with some techniques which may be of use in developing these concepts.

In general, topics are not necessarily presented in any particular order of importance in this publication. However, it is anticipated that instructors will:

- Survey the strengths and weaknesses of students in relation to their science understandings
- Group students for instructional purposes
- Establish priorities for each group
- Select topics from this publication for presentation in accordance with these priorities

It should be clearly understood that this publication is not intended to serve as a course of study or curriculum. Most students in these programs already understand many of the concepts presented herein. Furthermore, it is usually not necessary for students to understand all of these concepts in order to succeed in achieving their minimal goals. Nonetheless, it is desirable for students to master as many of them as possible. It is hoped that instructors will use this material to evaluate and improve the quality of their current programs wherever and whenever possible.

JOSEPH A. MANGANO, *Chief*
Bureau of General Continuing Education

MONROE C. NEFF, *Director*
Division of Continuing Education

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READING SKILLS IN SCIENCE

Nature of science text materials

The study of science requires the teaching of much concise material such as definitions, formulas, directions for experiments, descriptions of life cycles in plants, and processes involving inanimate forms. From this information, inferences and generalizations must be made.

Improving comprehension

The instructor should stress the fact that memorization of data does not necessarily mean understanding. He should show the student how to exploit the similarities and differences which exist within the general framework of new material. The procedure of constant self-questioning should be suggested: What is fact? Why is it so? Are there limits to its application? What are these limits?

The instructor should arrange sessions to aid the student in becoming familiar with characteristic passages taken from science articles. He must reserve time for helping the student read certain types of expository materials as in the following:

- Factual details leading to a general conclusion or concept
  - note facts
  - visualize relationships
  - grasp the conclusion
- Details of processes
  - follow time order
  - attend to proper sequence of steps
  - examine diagrams and formulas carefully
- Classification
  - note even the minutest similarities and differences
  - observe accompanying pictures carefully
- Directions for pupil performance
  - read complete set of directions
  - reread for comprehension
  - visualize each step
  - reread as each step is carried out
  - reread for final verification
- Problems for solution
  - determine what is to be found
  - collect known facts
  - ascertain information needed
  - establish sequence of steps to be taken
  - determine how the result is to be verified
- Graphs, charts, tables, diagrams, and pictures
  - note the details of the presentation such as captions, scales, titles, labels, and keys
  - enumerate these informational details

In the first sessions, the instructor should provide specific practice in each of the types mentioned above. At this point, it might be of value to examine the SQ3R technique which is cross referenced in the reading chart on pages vi and vii of this publication.

Since all readers, from the most capable to the least capable, must relate the content of their reading to known data, the instructor should review prior experience with a science topic to increase comprehension of the textbook treatment. On occasions when the instructor wishes to preserve a sense of discovery or give opportunities for inductive reasoning, he should assign the reading following such experiences as demonstrations, field trips, discussions, and the viewing of audiovisual materials. This will enable the less capable readers to better understand the text matter.

Developing vocabulary

The instructor should arrange for vocabulary drills in two areas — the technical and the nontechnical. Technical materials might include such terms as *osmosis*, *photosynthesis*, *neutron*, and *electrolysis*. Nontechnical vocabulary words will be found in general as well as scientific reading. Examples are: *pressure*, *maintain*, *structure*, *circulate*, and *permeate*.

Special attention should also be given to those words or symbols which have meanings in mathematics or in other subjects which are different than the meanings attached to them in science. For example, such words as *inversion*, *base*, *solution*, and *radical*, and such symbols as the plus sign (positive number or symbol for addition in mathematics and symbol for reacts with in Chemistry) or the degree sign (applied to measurement of an angle or to temperature), merit discussion. He should also stress words that have specificity in science as do the following: *culture*, *force*, *property*, *power*, *retort*, and *gravity*.

The instructor might select a technique like one of the following to deal with vocabulary problems:

- At the introduction of a new unit of work, construct a pretest of terms used in the unit. Later, as terms are encountered in the text, pay particular attention to the clarification of terms missed on the pretest.

- Choose new or unfamiliar terms to present on the chalkboard or on a chart. Before beginning the reading, aid students in locating and utilizing contextual clues (as well as diagrams, the glossary, or a dictionary) to arrive at the meanings.

- Present a film or filmstrip depicting a concept that is difficult to verbalize. Prepare preview questions so that students may have a purpose in viewing the presentation. During the subsequent discussion, lead the students to a thorough understanding of the concept presented and the terms which can be used in verbalizing it.

- Ask students to keep notebooks, give oral reports, do exercises, or prepare oral quizzes to provide for repetition of terms and to help assure some degree of retention. Provide written experiences which will aid in the learning of spelling and pronunciation.

- Set up a bulletin board display or an overhead projector lesson which charts metals in ancient times. Show how the Latin names of metals are used in abbreviated form as chemical symbols. For example:

  Ag *(argentum)* - silver
  Au *(aurum)* - gold
  Sn *(stannum)* - tin
  Cu *(cuprum)* - copper
  Fe *(ferrum)* - iron
  Pb *(plumbum)* - lead

Study of roots and affixes

Because many words in science are combinations of Greek and Latin elements, there is value in giving attention to roots, prefixes, suffixes, and the common combining forms. Sample study sheet:

Prefix	Meaning	Example
di	two, twice	diacetate
hemo	blood	hemoglobin
hyper	excessive, over	hypertension
macro	large	macroscopic
micro	small, minute	microorganism, microampere
mono	one, single	monosaccharides
neuro	pertaining to nerves	neurology
thermo	heat	thermonuclear, thermometer

Root	Meaning	Example
aqua	water	aquatic
cand	white, glowing	incandescent
cid, cis	kill, cut	incision, insecticide
gen	birth, kind	generic, genus
anthro	man	anthropology
chrom	color	chromosome
cosm	world, order	microcosm, cosmic

Suffix	Meaning	Example
aceous	pertaining to, resembling	herbaceous
logy	science of	zoology
meter	unit of measure; instrument	centimeter, thermometer
scope	viewing	microscope, stethoscope
ase	denoting ferment	amylase
ate	salt or ester	nitrate
emia	blood condition	anemia
gen	denoting a substance that produces or thing produced	oxygen
ide	denoting a compound name	oxide
um(ium)	denoting an elementary metal	aluminum, sodium

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Science

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High School Equivalency Program

The Science Program

Man's scientific advancement and technological discoveries have amassed a wealth of scientific data. It would be unrealistic to expect the average layman to be familiar with all this information, although he may be knowledgeable in some areas. High school equivalency instructors can expect their students to have far less scientific knowledge at their command than the average layman. Since keeping abreast of mounting scientific information is impossible, the objective of this program is not to learn a body of scientific knowledge to be tucked away in the mind for future reference, but rather to develop and reinforce skills in questioning, exploring, experimenting, observing, measuring, concluding, and communicating.

This is not to say that the learning of basic scientific understandings and relationships and the acquiring of some organized knowledge containing data, relationships, and theories upon which investigations are carried out will not be required. The emphasis, however, is placed upon the skills which are considered vital to the proper development of and appreciation for the scientific attitude.

Improvement of reading skills is the most vital aspect of all phases in the high school equivalency rogram. Pages vi and vii list the basic reading skills with a cross reference to each of the four handbooks on adult reading developed by the Department. Special consideration should be focused upon the area entitled Reading in Science.

TOPIC	CONCEPTS AND UNDERSTANDINGS	SUPPORTING INFORMATION AND INSTRUCTIONAL TECHNIQUES
What Science Is		
• An attitude	Science is an attitude of wonder. • Science satisfies our curiosity. • Science brings the satisfaction that comes from solving a problem. • Science requires the "second look," a review of an unsolved problem to seek new directions.	*Procedure.* For 10 seconds show the class a picture of an accident scene or some similar detailed picture. Have students list their observations. Orally compare observations, noting discrepancies. Discuss the possibility of improving observations by a team effort. Assign picture elements to teams (animate and inanimate objects, male and female actors, etc.). Show a second picture for 10 seconds and note improvement in observation through team approach.
• A method	Science is a method of questioning, exploring, analyzing, and concluding.	
	• Questioning includes first defining the problem and then subdividing it into small enough portions to be testable by experiment or through analysis.	*Procedure.* Have students observe a burning candle and list observations. Compare. Seek hypotheses from the observations. Determine a need for additional apparatus or materials to test some of the hypotheses.
	• Exploring includes the assembling of and the attempt to relate known facts, theories, laws, and principles to the problem. It also includes the collection of data from planned controlled experiments and the collection of information from the literature on similar problems.	*Procedure.* Dissolve sugar in water. Seek hypotheses why the sugar becomes invisible. Separate into two equal portions. Evaporate one half slowly and the other half rapidly. Seek hypotheses for varying size of resulting crystals.
	• Analyzing includes tabulating data to establish an apparent order. It is an attempt to see if an answer to the problem is becoming evident.	*Demonstration.* Pour water from graduate to beaker; pour "heavy" motor oil from graduate to beaker. Note oil is more viscous. Then determine weights of 100 ml. of water, and of 100 ml. of motor oil. Note the greater density of water. *Discussion.* Discuss why an automobile tire may burst when driven at high speeds. Apply the scientific method to the discussion.

TOPIC	CONCEPTS AND UNDERSTANDINGS	SUPPORTING INFORMATION AND INSTRUCTIONAL TECHNIQUES
• Knowledge	Science is a body of organized knowledge.	
	• Science is organized by specialties for intensive skill preparation.	
	• Science is organized as interdisciplinary for broad attacks on complex problems.	
Tools of Science		
• Mathematics	Mathematics is one of the most important tools of science.	*Discussion of distance.* Show meter sticks and yardsticks. Illustrate metric units of millimeter, centimeter, and meter. Describe the kilometer. Illustrate the inch, foot, and yard. Describe the mile.
	• Scientific mathematics uses fundamental units which are reference standards for distance, mass, time, and energy.	*Discussion of mass.* Show some objects and indicate that their mass is the quantity of matter they contain. They would have this same quantity of matter even if they were weightless in space. Then indicate that their weight is a measure of the force resulting from gravity. Their weight would vary according to location on the earth, on the moon, or elsewhere in the universe.
		Discussion of time. Relate the time scale — seconds, minutes, hours, days, years.
		Discussion of energy content. Show a thermometer. Read room temperature. Discuss the boiling and freezing points of water in centigrade and Fahrenheit units.
	• Scientific mathematics uses derived quantities, such as area and volume, pressure, and rates.	*Discussion of derived quantities.* Using metric rulers, measure the area and the volume of an object. Show that two or three dimensions (cm^2, cm^3) are

TOPIC	CONCEPTS AND UNDERSTANDINGS	SUPPORTING INFORMATION AND INSTRUCTIONAL TECHNIQUES
		derived from a fundamental quantity of distance (cm). Weigh a book in grams. Lift it a measured height in centimeters. Illustrate that the derived unit for the work performed is measured in gram centimeters, a product of the force (weight of the book) and the distance (height) through which the force moved.
• Instruments	Scientific tools include instruments for measurement.	*Discussion of scientific instruments.* Illustrate how a television set is an instrument to extend the human senses so that we see and hear events over far greater distances than our regular eyesight or normal hearing range can provide. All scientific instruments are designed to respond to signals beyond human senses and translate the signal into a form which does fall within the range of human senses. Show that a thermometer can give a temperature recording for warm water more accurately than using a finger and estimating temperature by our sense of touch. Show that a microscope will allow us to see things our normal eyesight is not even aware of.
Living things		
• Common traits	All living things have common traits which are different from nonliving things. • Living things move by the flow of cytoplasm or by motion of the organism. • Living things need food for energy, growth, and repair. • Living things need oxygen to produce energy. • Living things need water, since it is their major component.	*Discuss the traits of living things.* Ask for examples of the 7 traits listed, from both the plant and animal kingdom. Describe how cold-blooded animals vary their activity according to the temperature of their surroundings. Finally explain that life coming from life is the only truly unique trait of living things. Many technological devices have been built which move, need oxygen, require moderate temperature, etc., but do not come from life.

TOPIC	CONCEPTS AND UNDERSTANDINGS	SUPPORTING INFORMATION AND INSTRUCTIONAL TECHNIQUES
	• Living things need a moderate range of temperature (0° - 150° Fahrenheit).	
	• Living things respond to their environment when they are stimulated.	
	• Living things reproduce to provide new individuals to replace the ones which die.	
• Adaptations	Living things adapt to the region in which they live.	*Discuss adaptations.* Plants may need a short growing season. Animals may have white fur which blends in with the snow for protection and securing food.
	• They may be adapted to regions of high or low temperatures.	
	• They may be adapted to desert regions.	Plants have long roots and thick stems to conserve water. Animals often sleep during the hot day and are active at night.
	• They may be adapted to life in water.	Water animals have gills to extract dissolved oxygen from water.
	• They may be adapted to life in air.	Birds have hollow bones to decrease their weight and feathers which give their wings a large supporting area of low weight.
• Classification	Plants and animals may be classified by structure in order to study them.	*Discuss classification.* Explain that since there are more than a million kinds of living plants and animals, classification is needed to communicate information about them. Scientific names for plants and animals are based upon the method of classification.
	• Major plant groups are algae and fungi, mosses, ferns, and seed-producing plants.	
	• Major animal groups are single-celled protozoa, animals with outside skeletons (insects), fish, amphibians, reptiles, birds, and mammals.	

TOPIC	CONCEPTS AND UNDERSTANDINGS	SUPPORTING INFORMATION AND INSTRUCTIONAL TECHNIQUES
• Green plants make food	Directly or indirectly, all living things survive on food made by green plants.	*Discuss photosynthesis.* Describe the simple overall view that green chlorophyll in the leaf is the catalyst which traps the energy of sunlight and combines CO_2 and H_2O to form glucose. This trapped energy is retained in the glucose, ready for release when the glucose is oxidized by the plant or animal. The by-product of photosynthesis is the oxygen gas which is released into the atmosphere.
	• Green plants make food by chemically combining water from the soil with carbon dioxide from the air.	
	• Nongreen plants survive as parasites or saprophytes, obtaining food from green plants either directly or indirectly.	*Demonstrate mold survival.* Sprinkle some mold in a jar of moist sand and cap for a week. Similarly, sprinkle mold in a jar containing moist bread. Note that the mold will survive only where organic food is available.
	• Foods contain varying proportions of classes of nutrients: carbohydrates, proteins, minerals, fats, and vitamins.	*Discuss nutrients in foods.* Carbohydrates are sugars and starches. They are used for energy with any excess changed to fats for storage (compounds of carbon, hydrogen, and oxygen). Fats are long, carbon-chain organic compounds, used for energy with any excess being stored. Proteins are complex compounds of carbon, oxygen, hydrogen, and nitrogen which break down to amino acids for building and repairing body tissues. Minerals are needed for growth and development; for example, calcium and phosphorous for bones, iron for red blood cells, and iodine for thyroid glands. Vitamins in small amounts become part of important catalysts for body chemistry.
• Energy in man	The energy needed by the body comes first from the sun and is released in the body when nutrients are oxidized.	*Discuss energy from foods.* Describe how the energy of sunlight helps to produce nutrients in the green leaf. These nutrients are used directly by man when he digests crop materials or indirectly when he eats animals that survive on plant life.
	• Foods are digested in the body and are converted into materials of which the body is composed.	

TOPIC	CONCEPTS AND UNDERSTANDINGS	SUPPORTING INFORMATION AND INSTRUCTIONAL TECHNIQUES
	• Carbohydrates are energy foods containing carbon, hydrogen, and oxygen.	*Discuss proteins as energy sources.* Explain that although proteins are digested to form simpler amino acids for rebuilding new cell protein, some protein is also oxidized and releases energy.
	• Fats, high energy foods, are long-chain organic compounds of carbon, hydrogen, and oxygen.	
	• Proteins are complex organic compounds of carbon, hydrogen, oxygen, and nitrogen; they are the building and repairing substances of living cells.	
• Reproduction	Living things must come from existing living things.	
	• Reproduction may be asexual by fission, budding, or spores.	*Discuss asexual reproduction.* Explain that only lower forms reproduce asexually. • Fission is a splitting in two of the original organism (ameba). • Budding is a splitting of the nucleus; however, only a small portion of the cell body splits off (yeast). • Spores are the fragments of a nucleus, each fragment capable of forming a new organism (malaria spores).
	• Reproduction may be sexual in plants, combining hereditary material from different parents.	*Discuss flowering plant reproduction.* Explain that flowers contain both male and female parts. The male sperm is in the pollen grain. When it combines with the egg in the ovule, the fertilized egg develops into the seed.
	• Reproduction may be sexual in animals, combining hereditary material from different parents.	*Discuss animal sexual reproduction.* Explain that the male sperm combines with the egg cell formed in the female ovary. The fertilized egg goes through repeated cell divisions to form the new individual.

TOPIC	CONCEPTS AND UNDERSTANDINGS	SUPPORTING INFORMATION AND INSTRUCTIONAL TECHNIQUES
	• Some beneficial mutations have resulted in the evolution of improved species.	Sexual reproduction may benefit the species by introducing a rearrangement of genetic material.
	• Most mutations are recessive and are disadvantageous to the organism.	
Ecology		
• Environment	Living things affect and are affected by other living things and the environment.	
	• The natural community may be aquatic.	*Discuss the aquatic community.* Explain the kind of life that a water community will support. Describe the interdependence of sea animals and sea plants. A balanced aquarium is a good example of a small scale aquatic community.
	• The natural community may be terrestrial.	*Discuss the terrestrial community.* Describe the differences found in land communities when they are forest, grassland, or desert. Explain that land communities are best described by the climax plant life that finally flourishes in that particular environment. During the change period from simple plant life to more complex, there is a corresponding change in animal life which directly or indirectly feeds on the available plants.
• Balance of nature	A natural balance will eventually be reached in aquatic or terrestrial communities.	*Discuss the energy flow.* Describe the role of chlorophyll in the intake and storage of energy in the green leaf. This energy is consumed by living things which feed on plant food; however, much of this energy is lost heat. The only source of new energy is to repeat the cycle.
	• Energy needed by natural communities is derived from sunlight.	
	• The energy consumed in the cycle must be constantly replaced.	

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TOPIC	CONCEPTS AND UNDERSTANDINGS	SUPPORTING INFORMATION AND INSTRUCTIONAL TECHNIQUES
	• There is a cycle of food intake and decay which produces substances that enable the cycle to be repeated.	*Discuss the matter flow.* Describe how plants use materials from air and soil to make food. When plants are eaten by animals, the materials become part of the animals' bodies. When animals give off wastes, or when they die, decay of the materials returns them to the air and soil for reuse.
• Disturbed balance	The natural balance of a community may be disturbed.	
	• The disturbance may be natural.	*Discuss natural disturbances.* Point out that floods, fires, earthquakes, changes in the climate, and epidemics of disease could each greatly disturb the balance in a community.
	• The disturbance may be man-made.	*Discuss man-made disturbances.* Describe the effect of clearing forests for lumber and making the land available for agriculture. At the same time, clearing forests provides conditions leading to erosion, floods, and the reduction of wildlife. Explain that cultivated lands provide crop foods, but also produce conditions suitable for an increase of insect pests. Pesticides may be used, but these may destroy wildlife and useful insects. Discuss how man disturbs the balance of nature when he builds highways or reservoirs which take up the living area of wildlife.
Conservation		
• Man as a disturbing factor	Most conservation problems come from man's disturbances of natural communities.	*Discuss the need for conservation.* Explain that natural cycles return matter to the environment at a rate equal to the rate of removal. Man often removes materials from an environment and either fails to return them or else returns only harmful or useless material.
	• The human population is increasing, but the supply of resources is decreasing.	
	• Man misuses natural resources.	

TOPIC	CONCEPTS AND UNDERSTANDINGS	SUPPORTING INFORMATION AND INSTRUCTIONAL TECHNIQUES
• Soil	• Soil is damaged by erosion and by depletion of minerals.	*Discuss soil resources.* Explain that soil is the storehouse for minerals needed by plants. Erosion control can be practiced by controlled plowing to decrease water flow damage and by windbreaks and terraces. Depletion control can be accomplished by crop rotation and by chemical fertilizing.
• Minerals	Mineral resources cannot be replenished once they have been depleted.	*Discuss minerals.* Large scale mining is a recent event in the history of mankind. The supply of minerals is exhaustible. Metal scrap recovery and substitution with synthetic plastics will be needed.
• Air	Air pollution is an important conservation problem. • Polluted air can be controlled by proper planning.	*Discuss air pollution.* Explain that the balance of gases in the atmosphere has become disturbed by man's activities. Most of the air pollutants come from smokestacks or automobile exhausts. Reburning waste gases and precipitating out the solids from smoke are methods of control.
• Water	Water resources need to be conserved because the supply is constant and the demand is increasing. • The water cycle in nature is balanced. • The diversion of water for man's use disturbs the natural balance.	*Discuss the water cycle.* Explain that water returns to the land surface as rainfall. Half of this goes back to the atmosphere by evaporation. The other half is divided equally into use by plants, into ground water, and into streams leading to the ocean. *Discuss water conservation.* Water can be made available for re-use. Some methods include filtration, sedimentation, and chemical treatment. Intelligent use of storage reservoirs and the reforestation of areas which had stored considerable water are methods of water conservation. As our need for water increases, the desalinization of sea water may be necessary. The extreme importance of air and water pollution control should be stressed in terms of man's survival. Practical methods of control should be discussed. Specific ways in which individuals can actively participate in and plan for pollution control programs should be emphasized.

TOPIC	CONCEPTS AND UNDERSTANDINGS	SUPPORTING INFORMATION AND INSTRUCTIONAL TECHNIQUES
• Forests	Forest conservation is needed because of human disturbance of natural balance.	*Discuss forest conservation.* Explain that the timber industry has caused the depletion of many forests. The economic value of forests is important to all forms of life.
• Wildlife	Wildlife conservation is needed because food and cover is decreased by man's activities.	*Discuss wildlife conservation.* Hunting and fishing are important for recreation as well as an important part of the economy (furs, food, recreation resorts). Wildlife has great aesthetic value to all people. Legislation for game refuges and the restocking of forests and lakes is needed to prevent the extinction of many species of wildlife.
	• Wildlife can be conserved by providing the necessary vegetation for cover.	
	• Conservation of wildlife includes restocking and providing game refuges.	
Fundamental Systems in Man		
• Organization	The fundamental system structures in man are cells, tissues, and organs.	
	• The cell is the smallest unit of living matter.	*Discuss cells.* Describe and diagram a typical cell. Each cell is adapted to perform its special function in the body. Stain a thin layer of onion skin with iodine and observe it under a microscope. The cell structure will become visible.
	• Tissues are groups of similar cells which perform a specific function.	*Discuss tissues.* Point out that the large numbers of cells grouped together into tissues can divide their work-load. The tissue of the mouth lining or the tissue of a muscle are examples.
	• Organs are groups of tissues which act together to form a system.	*Discuss organs.* Point out that usually different kinds of tissues are needed to form an organ. The nature of the tissues that make up the eye are complex - some transparent, some opaque, some sensitive to light, some muscular.

TOPIC	CONCEPTS AND UNDERSTANDINGS	SUPPORTING INFORMATION AND INSTRUCTIONAL TECHNIQUES
	The fundamental systems in man have complex functions.	
• Sense organs	The senses report information to us from our environment.	*Discuss perception through our senses.* • Vision - Use an eye model to show the cornea, iris, lens, and retina. Trace the path of light rays to form an inverted image on the retina. • Hearing - Use a model of the human ear to show the ear canal, the eardrum, the hammer, anvil and stirrup, the semicircular canals and cochlea, and the auditory nerve. Explain how air vibrations move the eardrum, which transfers the vibrations to the three small bones. These vibrations travel through fluids in the cochlea. Here sensitive hair cells pick up the vibration message and send impulses to the brain where it is interpreted as sound. • Smell and taste - These senses in the nose and tongue depend upon chemical reactions with the material from the environment. Both senses are often used at the same time, so that the source of the message such as taste or smell is often a combination. • Touch - Receptors for the sense of touch are not uniform on our bodies. Fingers and lips are especially sensitive. Reactions to heat or cold, to pressure or pain are protections to the body against possible injury or damage.
• Protection	The skin is the outside covering protecting the inner tissues.	*Discuss the skin.* Describe the two layers of skin, with the inner layer adapted for specific functions. Hair, nails, and skin glands are located in the inner layer.
	The skeletal system supports and protects the body and is adapted for movement.	*Discuss the skeleton.* Describe bone tissue as cells with a hard mineral filler between them. Calcium and phosphorous must be available in the diet to provide the bones with their necessary mineral

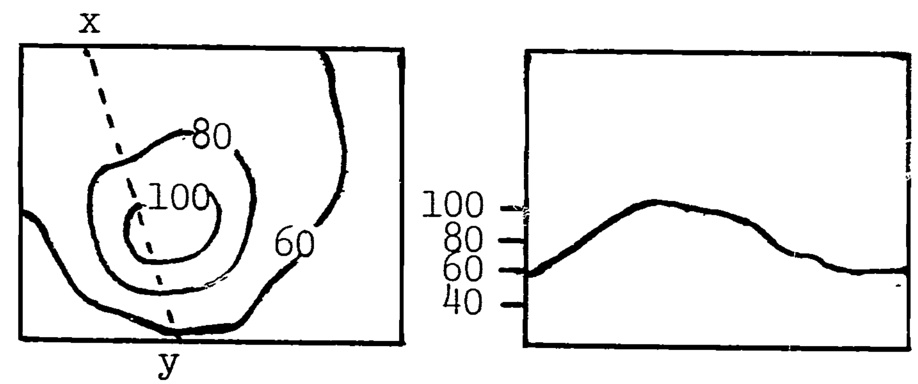
TOPIC	CONCEPTS AND UNDERSTANDINGS	SUPPORTING INFORMATION AND INSTRUCTIONAL TECHNIQUES
		content. Bones are adapted to their function. Some are formed to fit and move with other bones. Some, like the vertebrae in the spine, have cartilage cushions. Bone marrow is an important region for the manufacture of red blood cells.
• Locomotion	The muscle system has the power to produce motion, by contracting and relaxing when stimulated. • The action of banded or striated muscle tissue is voluntary • The action of smooth muscle tissue is involuntary.	*Discuss the muscles.* Explain that some muscles are voluntary, and are controlled by messages under our will. Voluntary muscles are banded (striated) in appearance, and are arranged in opposing pairs in our body. When one voluntary muscle contracts, its opposite member relaxes. This makes muscle control definite. Describe involuntary muscle as smooth in appearance. They are in tissues where automatic action is needed, as in the heart and the digestive system. A large blood supply is needed for the large amount of energy demanded by muscles in action.
• Respiration	The system for respiration takes in oxygen and gives off waste gases from oxidation processes in body cells. Cellular respiration is a complex process involving the energy transfer required for maintaining life.	*Discuss the respiratory system.* Describe the respiratory system as an arrangement of tubes and passageways to bring air to the lungs. The voice box in the throat produces sound by vibrating in the air flow passing through. Explain that the lungs are lined with tiny air sacs, where many small blood capillaries exchange the waste gases for oxygen. Breathing is an automatic act but can be controlled when needed. Smoking irritates the respiratory system and makes it less efficient.
• Circulation	The circulatory system distributes blood to all parts of the body. • The heart is a pump. • Arteries carry blood away from the heart.	*Discuss the circulatory system.* Describe the heart as a pump, pushing blood out at higher pressure than the blood which returns to it. Explain that the arteries take blood away from the heart and they have elastic muscle tissue to stand the higher pressure. Arteries branch to smaller and smaller vessels until finally they lead into the thin-walled tiny capillaries. The capillaries exchange dissolved foods and oxygen for wastes from the cells. They

TOPIC	CONCEPTS AND UNDERSTANDINGS	SUPPORTING INFORMATION AND INSTRUCTIONAL TECHNIQUES
	• Capillaries are thin-walled vessels which allow an exchange of liquids and gases. • Veins carry blood back to the heart. • A special blood circuit is maintained to and from the lungs.	then lead to the veins which return the blood to the heart. Point out that the heart has two separate pumping circuits. Not only does it send blood generally to all parts of the body, but a special side circuit of blood vessels is used to bring blood to the air sac capillaries in the lungs from which they return to the heart to join the general flow. Explain that red blood cells transport oxygen and that white blood cells fight infection.
• Digestion	The digestive system turns nutrients into simpler substances and forms soluble materials for passage through cell membranes. • Enzymes are digestive juices that change insoluble molecules to soluble molecules. • Most digestion occurs in the small intestine.	*Discuss the digestive system.* Describe how food taken in the mouth is crushed to small pieces for greater surface area for digestive juices. Only starch is digested by saliva in the mouth. Explain that digestive gastric juices are released in the stomach but that the stomach is mainly a storage reservoir for gradual movement of foods to the small intestine. Point out that most of the digestion is performed in the small intestine by enzymes. The process of absorption is aided greatly by the large amount of surface area in the small intestines.
• Excretion	Several organs are adapted for the elimination of waste from the body. • Excretion takes place from the skin. • Excretion takes place from the lungs. • Most of the body's excretion takes place from the kidneys.	*Describe the elimination of body wastes.* Explain that the sweat glands in the skin eliminate moisture from the body. This is chiefly a mechanism for temperature control of the body. Explain the transfer of carbon dioxide and water from the blood capillaries of the air sacs in the lung to the chambers of the lungs. When this air is breathed out, the waste gases leave the body. Describe the kidney function as that of filtering out water, urea, and other nitrogenous wastes from the blood. The proper water balance for the body is maintained by the kidneys.
• Nervous system	The nervous system is specialized tissue that may respond to stimuli from the environment. • Some nerves control voluntary body behavior.	*Discuss the nervous system.* Illustrate the special cell structure of a neuron. Describe how this structure

TOPIC	CONCEPTS AND UNDERSTANDINGS	SUPPORTING INFORMATION AND INSTRUCTIONAL TECHNIQUES
	• Some nerves control involuntary body behavior. • The brain has areas for specialized functions.	is adapted to the transmission of impulses. Indicate that messages can travel only one direction in a nerve cell. Explain that automatic body processes are controlled by the sympathetic nervous system. These include respiration, heart beat, digestion, excretion, and secretion. Describe the cerebrum as the brain area for thought processes and sensory impressions, the cerebellum for muscle coordination, and the medulla for involuntary controls.
• Endocrine system	The endocrine system regulates body activities by secreting chemicals through special ductless glands.	
	• Endocrine glands send hormones directly into the bloodstream. • Endocrine glands may control more than one body activity.	*Discuss the endocrine system.* Describe the hormones as catalysts and the large effect of even small amounts of such a chemical. Discuss the major activity of endocrine glands: Pituitary - controls growth Thyroid - controls metabolism Pancreas - controls blood sugar Adrenals - control emergency action Sex glands - control sex characteristics
• Reproduction	The reproductive system creates new individuals by combining male and female sex cells.	*Discuss the reproductive system.* Describe the male and female sex organs as adapted for internal fertilization of the female egg.
	• The male sperm unites with the female egg in the oviduct. • The embryo is nourished by diffusion of material from the mother's bloodstream throughout its development.	Discuss the hereditary contribution from the union of male and female sex cells as a pairing of genetic materials, some dominant and some recessive. Describe the developing embryo as undergoing successive cell divisions with the gradual development of specialized cells and tissue to form the newborn child.

TOPIC	CONCEPTS AND UNDERSTANDINGS	SUPPORTING INFORMATION AND INSTRUCTIONAL TECHNIQUES
The Earth's Surface		
• Changes	The surface of the earth is continually undergoing change.	
	• Destructional forces wear away and remove land features.	*Discuss destructional and constructional forces.* Describe the effect of weathering and erosion on land surfaces.
	• Constructional forces raise the crust and form new land features.	Point out that crustal movements, earthquakes, and volcanoes rebuild the land surfaces.
• Bedrock	The bedrock of the earth breaks down to form mantle rock.	
	• Most of the earth's surface is mantle rock.	*Discuss mantle rock.* Describe the loose fragments of mantle rock as ranging from giant boulders to tiny grains. Bedrock may be found at the surface, as noted in mountains or cliffs.
	• Soil is broken mantle rock containing organic materials.	
• Minerals	Minerals are crystalline uniform substances that make up the composition of rocks.	
	• Minerals can be identified by their physical and chemical properties.	*Discussion of mineral identification.* Describe how minerals may differ in hardness, cleavage, streak, lustre, color, specific gravity. They may also react differently with acid treatment, and many give characteristic colors when heated in a bunsen flame.
	• Minerals are nonrenewable natural resources.	Discuss minerals as the raw materials for the metals of our technological society.
• Rock types	Rocks are composed of minerals and are classified according to their origin.	*Discuss and show samples of rock types.* Name and show typical samples of the three rock types:

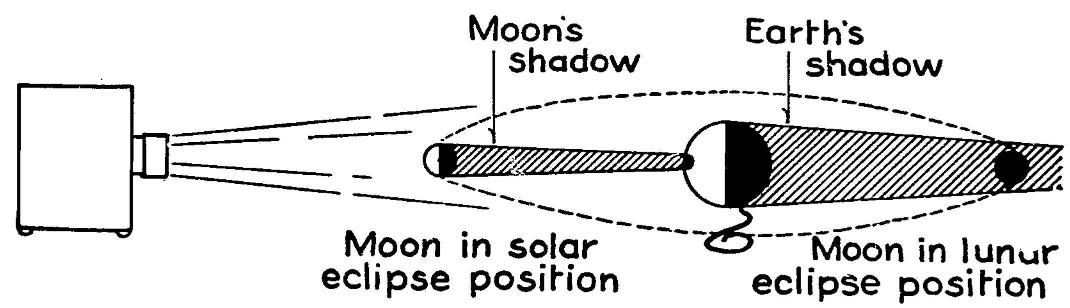
TOPIC	CONCEPTS AND UNDERSTANDINGS	SUPPORTING INFORMATION AND INSTRUCTIONAL TECHNIQUES
	• Igneous rocks are formed by cooling of hot molten material from the interior of the earth.	Igneous: granite, pumice, obsidian, basalt
	• Sedimentary rocks are made from broken rock fragments, minerals crystallized out of solution, and remains of plants and animals.	Sedimentary: sandstone, shale, limestone
	• Metamorphic rocks are made by heat or pressure or chemical change of either of the other rock types.	Metamorphic: slate, quartzite, marble
• Oceans	The oceans are the chief reservoir of the earth's water content.	
	• The oceans cover 3/4 of the earth's surface. • Sea water is about 4% salt. • The oceans are a valuable source of minerals, plants, and animals.	*Discuss the economic value of the ocean.* Point out that desalinization of ocean water may eventually be needed to provide enough fresh water. Describe the fish resource as food, as well as the potential of harvesting ocean algae as a food source. Describe the mineral extraction of magnesium from sea water.
• Topographic maps	Topographic maps represent on paper the three dimensions of the earth's surface.	*Demonstrate topographic maps.* Use topographic maps (U.S. Geological Survey) to explain contour lines, directions, scale, symbols. Explain the meaning of the contour interval as the difference in elevation between two adjacent contour lines.
	• Contour lines are used to show the variations in height of the land features.	
	• The maps are bounded by the lines for latitude and longitude.	
	• Symbols are used to represent man-made or natural features.	

TOPIC	CONCEPTS AND UNDERSTANDINGS	SUPPORTING INFORMATION AND INSTRUCTIONAL TECHNIQUES
	• A topographic profile diagrams a cross section along any line selected on a topographic map.	*Diagram a topographic profile.* Line xy is shown as the profile. 
Changes in the Earth's Surface		
• Destructional forces	The earth's surface is changed by destructional forces. • Destructional forces move material from the land surface into the oceans. • During the moving process, the material may temporarily deposit on the land. • Weathering by the atmosphere makes rocks crumble and decay. • Continued weathering turns mantle rock to soil. • Ground water from rainfall causes erosion, chiefly by dissolving the rock material. • Running water from streams causes most of the erosion on the land surface.	*Discuss weathering.* Describe the physical aspects of weathering by freezing of water in cracks and by uneven expansion of rock minerals. Explain the chemical weathering effect of oxygen by new compound formation of different bonding ability. Carbon dioxide from the air dissolves in water to form acid which attacks rocks. Acids are also produced by wastes from organic life. Demonstrate physical weathering by plunging a rock heated by a bunsen flame into cold water. *Discuss erosion.* Point out that ground water is moved by gravity and sinks to form the water table of a region. Explain that running water erodes by friction and by transportation of small particles. Conservation requires slowing some streams to reduce erosion. Discuss how winds would be most effective on desert erosion, since only small particles can move. Describe the deposits left by glaciers when they stop and retreat during changes in the climate of the earth. Demonstrate glacial erosion by dipping an ice cube in sand and rubbing the sanded cube against a piece of limestone rock.

TOPIC	CONCEPTS AND UNDERSTANDINGS	SUPPORTING INFORMATION AND INSTRUCTIONAL TECHNIQUES
	• Wind erosion is effective where there is scarce vegetation. • Glaciers cause erosion by moving rock fragments as cutting tools.	
• Constructional forces	The earth's surface is changed by constructional forces. • Earth movements raise the land continents and the oceans recede. • Erosion of land materials and their deposit in the oceans changes the balance of forces below the earth's crust and the land rises. • Cooling and shrinking of the crust of the earth can cause the surface to wrinkle.	*Discuss evidence of constructional forces.* Explain the appearance of strongly folded and broken rock on mountain sides as evidence of strong lifting forces. Describe how regions with large cracks (faults) are also regions where earthquakes and volcanoes occur. *Discuss the causes of constructional forces.* Explain the evidence of the theory of isostasy (the unequal pressure due to erosion) which requires mountain ranges to be located near continental edges; some of these do exist. Whether the earth is still in the cooling and shrinking stage, thereby causing significant forces, is not certain.
• Age of earth	The age of the earth can be determined by examining the rock record. • Fossil remains of ancient plants and animals are clues to the time of rock formation in which they are found. • The relative age of sedimentary rocks can be determined by their position, with the oldest rock at the bottom. • Radioactive changes in rocks are the best clues to the age of the earth. • The earth is about 5 billion years old.	*Discuss the rock record.* Describe how high temperatures and pressure during the formation of igneous and metamorphic rock make fossil remains unlikely. Fossils are found in sedimentary rock. The remains of long extinct species are clues to the date of the rock formation. Intrusions of magma from the molten interior are of more recent origin. Explain how evidence of ancient volcanic action can help date the rocks. Describe how the known decay rate of radioactive materials may be used to date the rocks by comparing the remaining quantity of the parent radioactive element with the daughter elements formed from it.

TOPIC	CONCEPTS AND UNDERSTANDINGS	SUPPORTING INFORMATION AND INSTRUCTIONAL TECHNIQUES
• Geological history	The geological history of the earth is classified by long time periods (eras).	
	• The origin of the earth involved the condensation of gaseous material into solids.	
	• The four major time periods in the earth's history are Pre-Paleozoic, Paleozoic, Mesozoic, and Cenozoic.	*Discuss geologic eras.* Explain the events in each era: Pre-Paleozoic era (4500 million years) - cooling of the crust, formation of continents and oceans, and the beginning of life all took place in this era. Paleozoic era (375 million years) - this was a time of ancient life, the age of invertebrates, fishes, and amphibians; many coal deposits were formed. Eastern mountain ranges were formed in this era. Mesozoic era (155 million years) - this period had much change in land forms; it was the age of reptiles. Cenozoic era (70 million years) - this recent life era was the time of mountain forming on the Pacific coast and a period of frequent glaciers; mammals developed.
The Solar System		
• Members	The solar system includes the sun and the planets, moons, and comets controlled by the gravitation of the sun.	*Discuss the Copernican Theory.* Explain that the long history of the theory of an earth-centered universe was difficult to dislodge. When Copernicus proposed his evidence for a sun-centered solar system, science began to be free of prejudice and superstition. Describe the rotation of the earth as causing night and day, and the earth's revolution on its tilted axis as causing the seasons.
	• The sun is the center of the solar system.	
	• The planets revolve around the sun in nearly circular orbits.	
	• The moon has a nearly circular orbit around the earth.	

TOPIC	CONCEPTS AND UNDERSTANDINGS	SUPPORTING INFORMATION AND INSTRUCTIONAL TECHNIQUES
• The moon	The moon is the earth's closest neighbor in space. • The density of the moon is similar to that of rock. • The gravity force on the moon is one-sixth that on earth. • The phases of the moon are apparent effects of its revolution around the earth. • The period of revolution of the moon around the earth is about one month. • The moon has a great effect on the earth's tides.	*Discuss the moon.* Describe the distance of the moon as 240,000 miles, a distance that could be travelled in 15 hours by our present rockets. Explain that the moon is nearly half as dense as the earth and is only 2% of the volume of the earth. Illustrate new moon and first and last quarters by shining a flashlight on a globe. Explain that gravitational attraction between the moon and the oceans creates the tides as the earth rotates on its axis. Although the sun is larger and has more gravitational force, its effect on the tides is weaker than that of the moon, because of the great distance of the sun.
• The sun	The sun provides most of the earth's energy. • Life energy comes from the sun. • The sun is a star.	*Discuss the sun.* Describe the distance of the sun as 93 million miles, its diameter as over 100 times that of the earth. Although the sun is gaseous, it is so large that its mass is more than 300,000 times that of the earth. Gaseous surface movement on the sun produces sunspots. These reach a maximum in 11 year cycles and interfere with radio communication.
• Eclipses	Eclipses occur when the shadow of the earth or the moon falls on the other. • The lunar eclipse occurs when the moon moves into the earth's shadow. • A lunar eclipse can occur only at full moon and only when the sun, earth, and moon are in a straight line.	*Demonstrate lunar and solar eclipses.* Using a flashlight, a basketball, and a baseball, illustrate the shadow of the lunar and solar eclipses.



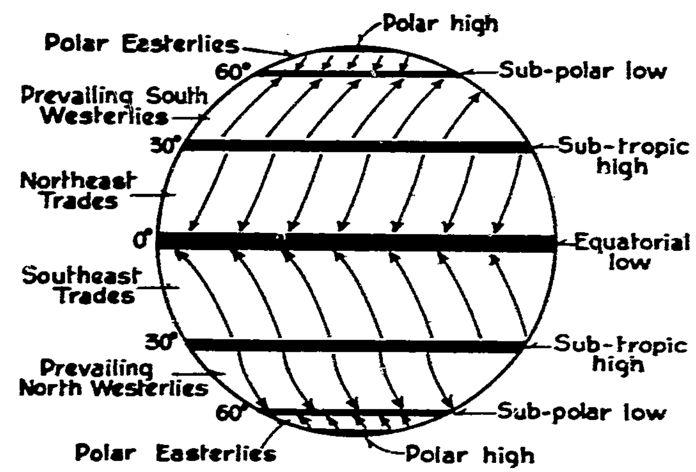
TOPIC	CONCEPTS AND UNDERSTANDINGS	SUPPORTING INFORMATION AND INSTRUCTIONAL TECHNIQUES
	• A solar eclipse occurs when the earth moves into the moon's shadow. • A solar eclipse can occur only at new moon and only when the sun, moon, and earth are in a straight line.	
• Planets	The planets shine by reflected sunlight. • Nine solar planets have been discovered. • Planets revolve around the sun in nearly circular orbits.	*Discuss the planets briefly.* Mercury - closest to the sun, no atmosphere, smaller than the earth. Venus - nearly Earth-sized, dense cloud layer, high surface temperature. Earth - the planet on which we live. Mars - farther from the sun than the earth, may have vegetation. Jupiter - the largest planet, several moons, cold surface. Saturn - similar to Jupiter, has rings of solid particles in orbit around it. Uranus, Neptune, Pluto - furthest from the sun.
• Comets and meteors	Comets and meteors are part of the solar system. • Comets have extremely oval orbits. • Comets are mostly gaseous. • Meteors are small bodies visible when they cause friction with the earth's atmosphere.	*Discuss comets and meteors briefly.* Describe how the pressure of sunlight keeps the tail of a comet pointing away from the sun. Explain that meteors are considered left-over debris from comets.
Principles of Space Travel		
• Location	Space travel uses long known scientific principles.	*Discuss direction on the earth.* Describe latitude as measurement in degrees north or south of the 0° latitude equator to 90° latitude at the north or south pole. Describe longitude as measurement in

TOPIC	CONCEPTS AND UNDERSTANDINGS	SUPPORTING INFORMATION AND INSTRUCTIONAL TECHNIQUES
	• The location of direction on the earth has the earth's rotation as a reference point.	degrees east or west of the Prime Meridian (through Greenwich, England) to a maximum of 180° east or west.
	• Latitude is the north-south location reference. • Longitude is the east-west location reference. • Earth location methods may be adapted for space location references. • Hour circles for space are comparable to longitude. • Angles of declination for space are comparable to latitude.	*Discuss direction in space.* Describe how a projection of the earth's surface to an imaginary celestial sphere provides a similar grid to our earth surface lines of latitude and longitude. Explain that the hour circles locate points east and west and that declination angles measure points north and south.
• Propulsion	Space vehicle propulsion depends on the principle that for every action there is an equal and opposite reaction. • The force providing the action may be from chemical or nuclear sources. • Chemical propellants are fuels with high energy oxidizing agents. • Nuclear engines depend on the thrust from heated gases.	*Discuss rocket propulsion.* Explain that: • The rocket pushes on the gases, and the gases push the rocket. • Each force is unbalanced, and the gases and the rocket both accelerate. • The larger the force the greater the acceleration. • The rocket does not push against the air. • The acceleration takes place in a vacuum.
• Control	Guidance control of space vehicles may be programed or transmitted. • Space vehicles may carry a computer with programs for action to be taken in sequence.	*Discuss guidance control.* Describe the value of rudders and other air controls during the brief flight through the atmosphere. In free space, gas jets control the position of the craft. Inertial guidance using a gyroscope and an accelerometer provides an internal feedback circuit which constantly adjusts the altitude of the space craft.

ERIC

TOPIC	CONCEPTS AND UNDERSTANDINGS	SUPPORTING INFORMATION AND INSTRUCTIONAL TECHNIQUES
	• Radio signals may be sent to alter the flight path of rockets.	
• Orbits	The flight path of a space vehicle may orbit the earth (or another solar system body). • The inertia of a space vehicle tends to keep its motion in a straight line. • The force of gravitation pulls a space vehicle toward the surface of the earth. • The resultant from inertia and gravity determines the flight path. • At high enough velocity (escape velocity) a space vehicle may leave an earth orbit and travel toward outer space. • At low enough velocity (re-entry velocity) a space vehicle may leave an earth orbit and return to the earth's surface.	*Discuss flight paths of space vehicles.* Explain that the escape velocity for a space vehicle depends on the force of gravity. On the earth, the escape velocity is about 25,000 miles per hour. Describe the need for retro rockets to slow the orbital velocity to begin re-entry into the denser atmosphere of the earth. Special heat shields are needed to prevent the heat generated by air friction from destroying the space vehicle.
Weather		
• Atmosphere	Weather is a result of conditions in the earth's atmosphere. • The atmosphere is a mixture of gases. • Life depends on the oxygen content of the atmosphere. • Plants return oxygen to the atmosphere.	*Discuss the atmosphere.* Explain that air is approximately 20% oxygen, 80% nitrogen, but that the small amounts of water vapor and carbon dioxide gas have great effects on the weather.

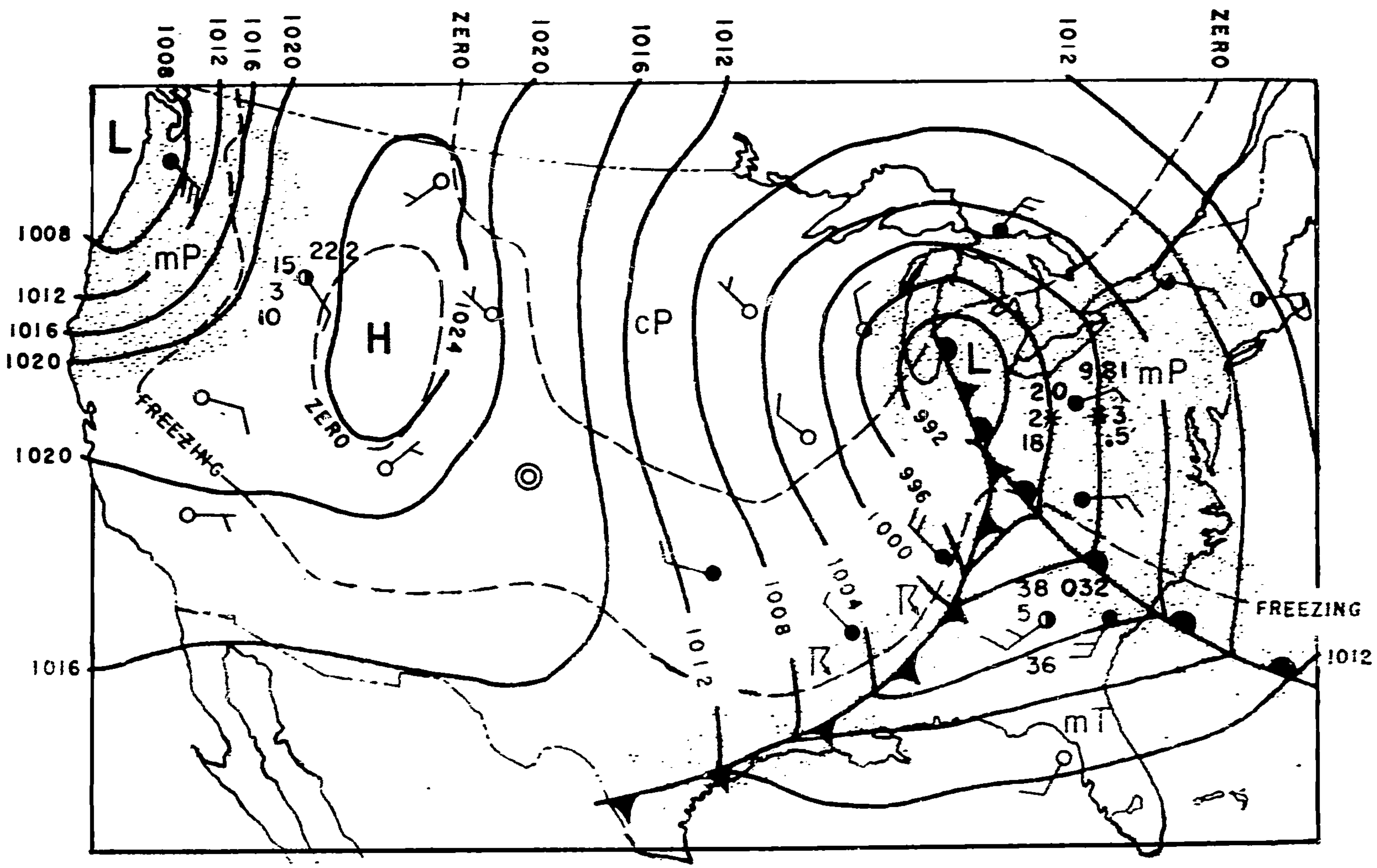
TOPIC	CONCEPTS AND UNDERSTANDINGS	SUPPORTING INFORMATION AND INSTRUCTIONAL TECHNIQUES
	The unpolluted atmosphere is a natural resource which must be restored and conserved. Pollution of the atmosphere is affecting the health and food supplies of living things.	*Discuss atmospheric pollution.* Show its effects on a large scale. Point out the problem of exhaust systems in automobiles, citing products of combustion given off. Light a candle and hold a tin cover several inches above the flame. Observe the deposit on the cover. Point out how the products of combustion bring about a change in the composition of the air.
• Circulation	Atmospheric circulation is caused by the unequal distribution of heat energy in the air. • The sun radiates energy in the form of light which is converted to heat at the surface of the earth. • The heat energy from the sun is absorbed differently on different types of land and sea surfaces. • The energy returned to the air by conduction and radiation depends on the amount originally absorbed. • Forces due to varying air pressure move air from high to low pressure areas. • The rotation of the earth tends to deflect winds. • Winds in high pressure areas in the northern hemisphere rotate clockwise, viewed from above. • Winds in low pressure areas in the northern hemisphere rotate counter-clockwise, viewed from above.	*Discuss atmospheric heating.* Explain that all electromagnetic energy may be absorbed. The heat energy available in surface areas of the earth returns to the air in proportion to the amount that has been gained. Ocean currents also transport heat energy. *Discuss winds.* Explain that cooler denser air at the poles tends to fall and travel toward the equator; whereas warm, less dense air tends to be pushed up. The warm air travels at higher altitudes toward the poles to replace the cool air which had moved out. This circulation is altered by deflection from the earth's rotation and by the varying heat effects of large bodies of water compared to the adjacent land.



TOPIC	CONCEPTS AND UNDERSTANDINGS	SUPPORTING INFORMATION AND INSTRUCTIONAL TECHNIQUES
• Water cycle	The water cycle is a constant exchange of water between the land surface and the air.	*Illustrate the water cycle.* Boil water in a tall beaker covered by a glass plate. Note the condensation on the bottom of the cover. Some drops large enough to fall will form, simulating rain. Lift the cover with tongs. The escaping steam will form a visible cloud as it cools in the air.
	• Water reaches the atmosphere by evaporation.	
	• Water returns to the land surface by condensing and precipitating.	
	• Clouds and fog are tiny water particles suspended in the air.	
	• The temperature of the air determines if precipitation is rain, snow, or sleet.	
	• Artificial cloud formation can be accomplished by "seeding" with chemicals which encourage tiny drop formation.	
• Air masses	Large air masses reach the same temperature and moisture content as their surface area on the earth.	*Discuss air masses.* Explain that in the northeastern U.S. winter weather is influenced by polar air masses from Canada, whereas in summer the weather is influenced by marine tropical air from the Gulf of Mexico.
	• Air masses may be polar or tropical, continental or marine.	
	• Air masses in the U.S. tend to move toward the east.	
	• Interactions between air masses produce weather variations.	
	• Air in a high pressure region is denser, tends to sink toward the earth, and produces fair weather.	*Discuss high and low pressure regions.* Explain that lows form in the regions between high pressure air masses. The air from the high pressure regions moves in to lift the warm air of the low pressure

TOPIC	CONCEPTS AND UNDERSTANDINGS	SUPPORTING INFORMATION AND INSTRUCTIONAL TECHNIQUES
	• Air in a low pressure region is of lower density, tends to rise, and produces cloudy or stormy weather.	region. Circular patterns of flow result from the effects of the earth's rotation.
	• A front is a zone between two different air masses.	
	• Poorer weather conditions result if a front is formed by two air masses which are very different.	
• Weather conditions	Severe weather results from unstable atmospheric conditions.	
	• Thunderstorms result from the rapid rise of very warm air to much cooler regions.	*Discuss thunderstorms.* Explain that the rapid movement of air in thunderstorms displaces electrons from their atoms. As they build up in one region at the expense of another region, a spark discharge of lightning returns the voltage difference to normal. Thunder is the noise from the rapid expansion of gases caused by the heat of the lightning bolt.
	• Tornadoes are vortex-like, severe, small storms of rapid pressure change and extremely high wind velocity.	*Discuss tornadoes.* Explain that the inside of a tornado has so much lower pressure than the outside region that remaining air pressure in buildings is sufficiently higher to blow out the walls and ceilings.
	• Hurricanes are intense tropical low pressure region storms.	*Discuss hurricanes.* Explain that low pressure storms with winds above 75 miles per hour are classified as hurricanes. The low pressure central "eye" is relatively quiet but the counterclockwise winds near the outside are violent. Hurricanes form over tropical seas and gain their spin from the rotation of the earth.
	• Typhoons are also intense tropical low pressure region storms.	

TOPIC	CONCEPTS AND UNDERSTANDINGS	SUPPORTING INFORMATION AND INSTRUCTIONAL TECHNIQUES
• Forecasts	Weather forecasting depends on comparing relationships of past and present weather conditions.	*Discuss weather forecasting.* Explain that observations of the weather are accurate measurements (pressure, rainfall, temperature, etc.), while weather forecasting is an estimate based on a large number of uncertain variables.
	• The U.S. Weather Bureau collects and analyzes data, and makes predictions.	
	• Weather maps based on accumulated reports give information on weather data.	*Discuss weather maps.* Obtain copies of recent U.S. daily weather maps. Compare individual stations for temperature, dew points, air pressures, wind direction, and wind speed. Locate isobars, fronts, and isotherms.



TOPIC	CONCEPTS AND UNDERSTANDINGS	SUPPORTING INFORMATION AND INSTRUCTIONAL TECHNIQUES
Climate		
• Affecting factors	Climate is the average condition of weather in a region.	*Discuss effects on climate.* Explain that the areas in which the sun's rays are most vertical to the earth's surface receive the greatest concentration of solar energy. Demonstrate that the tilt of the earth's axis results in the shifting of these areas during the course of the year. Explain that conduction and radiation of heat from the earth's surface decreases as the altitude increases. The sun's energy at high altitude is almost entirely transmitted to lower regions. Describe how water has a high heat capacity. The stored heat from summer is slowly released during the winter to temper the climate. The cold water in spring has a large capacity to absorb heat from the surrounding air, thus making the summer cooler.
	• Climate is affected by latitude, being cooler nearer the poles and warmer nearer the equator.	
	• Climate is affected by the tilt of the earth's axis, causing seasonal changes as the area which receives the greatest concentration of the sun's energy shifts from north to south between the Tropics of Cancer and Capricorn.	
	• Climate is affected by altitude, being cooler at greater heights.	
	• Climate is affected by nearness to large bodies of water, bringing cooler summers and warmer winter.	Discuss the effect of compression and expansion of air in releasing and absorbing heat as well as the effect of heat upon the ability of air to hold moisture.
	• Climate is affected by mountain ranges, the windward side being moist, the far side being desert.	
	• New York State has a humid continental climate.	*Discuss New York State's climate.* Describe New York State as having moderate rainfall, hot summers and cold winters. Variations occur with latitude, altitude, nearness to large bodies of water.
	• The study of climate has social and economic value.	*Discuss the social and economic value of climate study.* Explain the residential appeal of a mild but varied climate, where seasonal activities have wide variations. Discuss the growth of urban areas near appealing climate regions. Describe the agricultural belts in the U.S. which depend on the proper climate for growing crops.

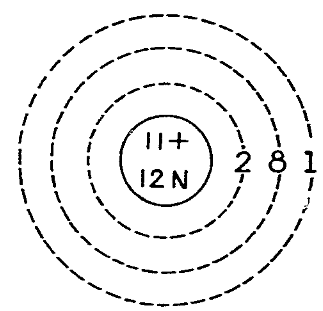
TOPIC	CONCEPTS AND UNDERSTANDINGS	SUPPORTING INFORMATION AND INSTRUCTIONAL TECHNIQUES
Properties of Matter and Changes in Matter		
• General properties	The general property of all matter is that it occupies space and has mass. • Matter may be an element made up only of the simplest substance that can be formed by chemical means. • Matter may be a compound made from chemically united substances. • Matter may be a mixture of substances that are not united chemically.	*Discussion.* Prepare a display of metallic copper, sulfur powder, and copper sulfate ($CuSO_4$). Point out that the elements cannot be recognized in the copper sulfate.
• Physical properties	Matter has physical properties. • Matter can exist in three states — solids, liquids, and gases. • Solids consist of closely packed particles with little movement and relatively low energy content. • Liquids consist of particles far apart with moderate movement and moderate energy content. • Gases consist of particles very far apart with great movement and high energy content.	*Discussion on states of matter.* Fill a jar with marbles. Cover. Shake gently up and down to illustrate particles in a solid. Half fill the jar with marbles. Cover. Shake moderately up and down to illustrate particles in a liquid. Put only 5 marbles in the same jar. Cover. Shake vigorously up and down to illustrate particles in a gas.
• Physical change	Matter can go through physical changes with no change in its composition.	*Demonstration of change of state.* Melt a few grams of Wood's metal in a pyrex test tube. Pour the liquid into a dish. Compare the alloy when changing from solid to liquid and back to a solid.

ERIC

TOPIC	CONCEPTS AND UNDERSTANDINGS	SUPPORTING INFORMATION AND INSTRUCTIONAL TECHNIQUES
	• Matter can undergo a change of state by varying its energy content (changes between solids, liquids, and gases). • Physical changes may be accomplished by magnetic separation. • Physical changes may be accomplished by dissolving the soluble portions. • Physical changes may be accomplished by filtering the insoluble portions. • Physical changes may be accomplished by evaporating the liquid content.	*Demonstration of magnetic separation.* Use a magnet to separate a mixture of iron filings and copper sulfate crystals. Use a small plastic bag over the end of the magnet. The iron will cling to the bag and will drop off when the magnet is removed from the bag. *Demonstration of filtering and evaporating.* Add enough water to a mixture of copper sulfate and iron filings so that the copper sulfate all dissolves. Filter and evaporate the liquid.
• Chemical properties	Matter has chemical properties shown by reactions with oxygen, water, acids, bases, and other substances.	*Demonstrate chemical reactions.* • Heat a magnesium ribbon in a bunsen flame. Note the white powder that forms. • Drop a small piece of calcium metal into water. Heat until the metal dissolves. Test the liquid with red litmus paper. • Drop a small piece of aluminum metal into dilute sodium hydroxide. Warm to dissolve.
• Chemical change	Matter can go through chemical changes that involve energy input or output. • The rate of chemical change can be varied by adding a catalyst. • The rate of chemical change can be varied by changes in concentration. • The rate of chemical change can be varied by control of temperature.	*Demonstration of energy output.* To 3 ml. of cottonseed oil in test tube add 0.5 gm. of sodium peroxide powder. Warm gently. (Caution - long tongue of flame exits from mouth of tube. When heating any substance in a test tube, the mouth of the tube should point away from any observers.)

TOPIC	CONCEPTS AND UNDERSTANDINGS	SUPPORTING INFORMATION AND INSTRUCTIONAL TECHNIQUES
	• The rate of chemical change can be varied by a change in surface area exposed.	
Atomic Structure		
• The atom	The atom is the smallest particle of an element that can retain the properties of the element. • The atom is mostly empty space. • The nucleus is almost its entire mass. • The relative mass standard used for atoms is carbon-12.	*Discuss atomic mass (weight).* The atomic mass (weight) of an atom is a relative mass in comparison to the mass of an arbitrary standard. One standard is the 12.00000 units taken as the mass (weight) of the carbon-12 isotope. Chemists and physicists use this standard. Another standard is the mass number which is based upon the sum of the nucleons (protons and neutrons) each with a mass of one unit. Nuclear scientists use the mass number standard.
• Composition	The atom is composed of protons, neutrons, and electrons. • The nucleus has protons and neutrons. • Protons have a +1 charge and weigh one atomic mass unit. • Neutrons have zero charge and weigh one atomic mass unit. • The nuclear content determines the mass of the atom. • The sum of the protons and neutrons is the atomic mass. • The nuclear protons determine the atomic number. • The atomic number is equal to the number of protons.	*Demonstrate atomic composition.* Present concepts of the composition of atoms using atomic models (three-dimensional). A variety of films is also available for this purpose.

TOPIC	CONCEPTS AND UNDERSTANDINGS	SUPPORTING INFORMATION AND INSTRUCTIONAL TECHNIQUES
	• The electrons are in orbit around the nucleus. • Electrons have a -1 charge and almost zero mass.	
• Atomic models	Simple models can be drawn to illustrate the structure of atoms. • Electrons are distributed in shells. • The inside or K shell can hold a maximum of 2 electrons. • Maximum electron content for the second and third shells are L shell with 8 and M shell with 18.	*Exercise in drawing atomic models.* Using the periodic table, find the atomic number and atomic weight of the first twenty elements. Diagram each atom as in the sodium atom shown below. (See simplified periodic table on page 34F.)
• Chemical shorthand	Chemical shorthand is a convenient way to give information in an abbreviated way. • A symbol gives the name of the element abbreviated to one or two letters. • A subscript indicates the number of atoms in the molecule. • A coefficient indicates the number of molecules present.	*Discussion on chemical shorthand.* Demonstrate the following principles of chemical shorthand. • From the periodic table, name the first twenty symbols. • Mention that the molecules of certain gases have two united atoms (diatomic molecules). Show H_2, O_2, N_2, Cl_2. Show that compounds exist with several atoms. Show $CaCl_2$, H_2SO_4. Name them. Give other examples. • Show that when hydrogen burns in oxygen to form water, coefficients are needed to balance the equation. Show $2H_2 + O_2 \longrightarrow 2H_2O$. Give other examples.

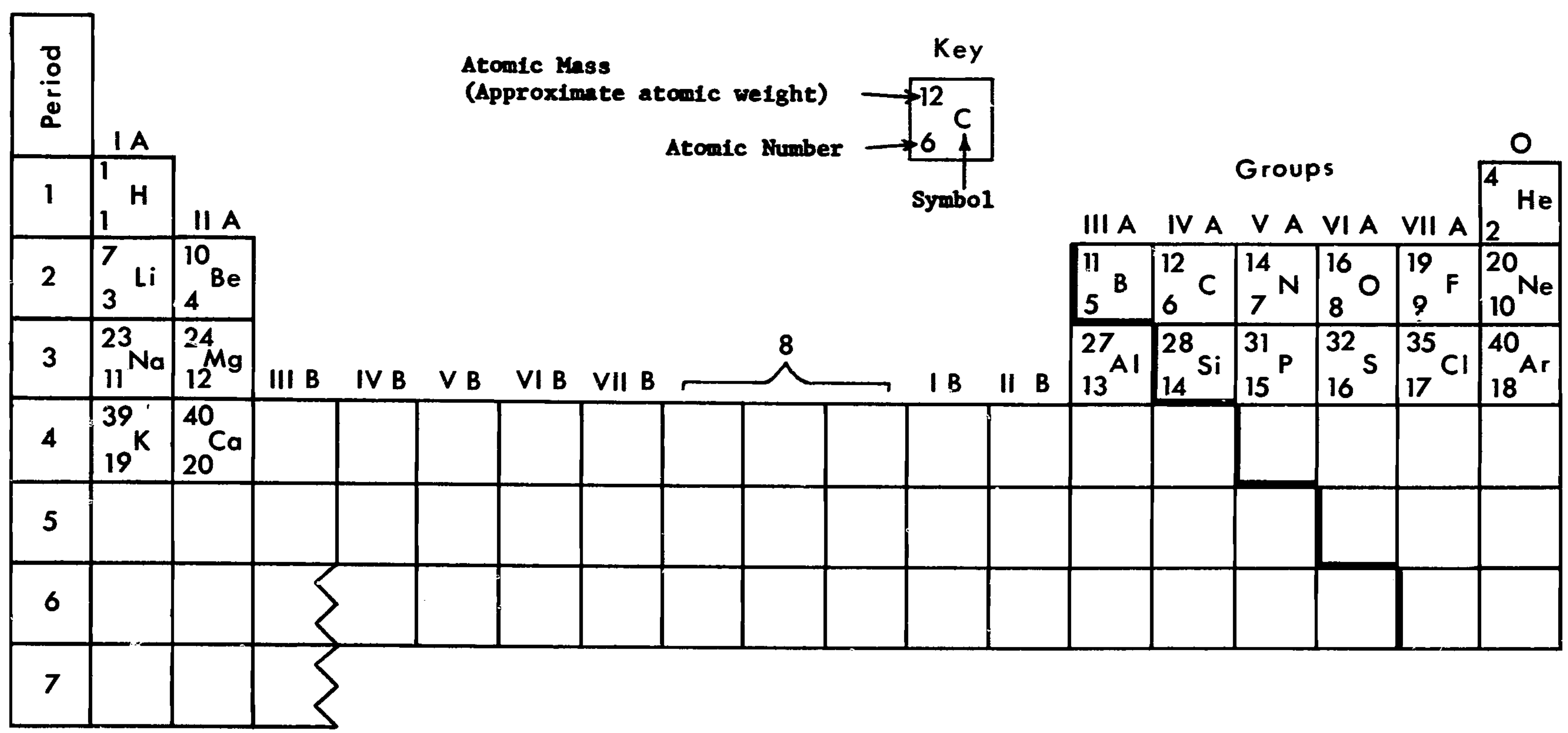


Sodium Atom

Atomic number = 11
Atomic weight = 23

TOPIC	CONCEPTS AND UNDERSTANDINGS	SUPPORTING INFORMATION AND INSTRUCTIONAL TECHNIQUES
• Periodic table	The periodic table is the organization and classification of the chemical elements.	*Discuss the periodic table.* Show the "long form" of the periodic table. Show the location of the zig-zag line before boron, silicon, etc., that separates metals from nonmetals. Show the location of the rare gases group. Discuss the prediction of chemical behavior from the location in the periodic table:
	• Groups are arranged in vertical columns; they indicate similar chemical properties and an identical outermost electron shell for the group.	Groups (vertical) - metal activity increases as you read down the group; nonmetal activity increases as you read up the group.
	• Periods are arranged in horizontal columns; they indicate atoms with the same number of electron shells.	Periods (horizontal) - metal activity increases as you read toward the left in the period; nonmetal activity increases as you read toward the right in the period.

Periodic Table of the Elements



TOPIC	CONCEPTS AND UNDERSTANDINGS	SUPPORTING INFORMATION AND INSTRUCTIONAL TECHNIQUES
Common Chemical Changes		
• Typical reactions	Chemicals may react in many ways.	*Demonstrate typical chemical reactions.* Illustrate the four reaction principles below:
	• Two elements combine to form one compound.	• Burn magnesium ribbon in air. The combination with oxygen forms a white powder. Name and write its symbol.
	• One element replaces another in a compound.	• Place an iron nail in a test tube containing copper sulfate solution. The iron replaces the copper in the solution, and copper forms on the surface of the nail. Name the new compound and write its symbol.
	• Two compounds form two new compounds.	• Mix solutions of barium chloride and copper sulfate. The white precipitate of barium sulfate forms, while the solution forms copper chloride. Write the chemical equation.
	• A compound breaks down to form the elements of which it is made.	• Heat red mercuric oxide in a test tube. A metallic mercury mirror forms in the upper part of the tube. Test for the oxygen given off by inserting a *glowing* splint into the test tube during heating. The splint will flame. Write the equation for this reaction.
Common Compounds and Mixtures		
• Acids	Acids are compounds with the ability to free the H^+ part of the molecule (the H^+ ion).	*Demonstrate acid reactions.* Demonstrate the following reactions:
	• Acids turn blue litmus to red.	• Note that blue litmus paper will turn red if dipped into an acid.
	• Acids form hydrogen gas when reacted with active metals.	• Drop a magnesium ribbon into dilute hydrochloric acid and observe the bubbles of hydrogen gas as the magnesium dissolves to form magnesium chloride. Write the chemical equation for the reaction.

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	• Acids neutralize bases.	• To a small quantity of dilute sodium hydroxide (a base), add red litmus paper. The paper turns blue to indicate the base. Slowly add dilute hydrochloric acid until the paper just barely turns red again. The acid has neutralized the base by forming sodium chloride and water. Write the equation for the reaction.
• Bases	Bases are compounds with the ability to free the OH^- part of the molecule (the OH^- ion).	*Demonstrate base reactions.* Demonstrate the following reactions:
	• Bases turn red litmus to blue.	• Note that red litmus turns blue if dipped into a base.
	• Bases turn phenolphthalein red.	• Add a few drops of colorless phenolphthalein solution to a dilute solution of a base and observe the red color.
	• Bases neutralize acids.	• To a small quantity of dilute hydrochloic acid containing red litmus paper, slowly add dilute sodium hydroxide until the first appearance of blue color on the litmus paper shows that salt and water have formed and that the acid has been neutralized. Write the equation for the reaction.
• Salts	Salts contain the positive ion from the base and the negative ion from the acid.	*Demonstrate formation of a salt.* Show by the equation what happens when sodium hydroxide neutralizes hydrochloric acid. $NaOH + HCl \rightarrow NaCl + H_2O$ because $(Na^+ + OH^-) + (H^+ + Cl^-) \rightarrow (Na^+ + Cl^-) + HOH$. The water formed is so slightly ionized that no ions are usually shown to form.
• Solutions	Solutions are clear liquid mixtures with particles too small to filter or to settle out.	*Demonstrate solutions.* Perform the following activities.
	• There are many solvents which dissolve substances; the substance which dissolves is called the solute.	• Add a small crystal of potassium permanganate to water in a beaker. Stir to dissolve. Add a pinch of white phenolphthalein powder to ethyl alcohol in a beaker. Stir to dissolve. Add water until the

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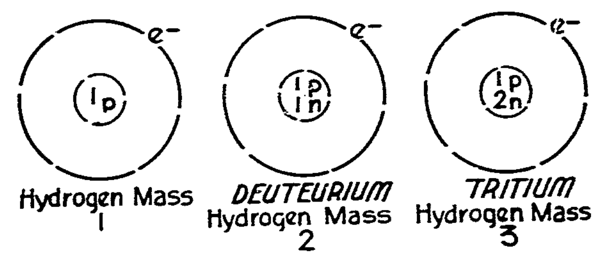
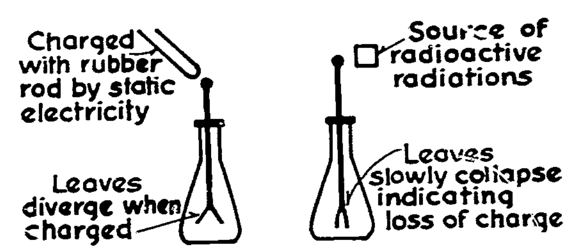
		solubility decreases and a white precipitate is formed.
	• Solubility is rapid with smaller particles.	• Dissolve powdered copper sulfate in water. Compare the time to dissolve a large crystal of copper sulfate in water with the powdered form.
	• Solubility is rapid when stirring and mixing occur.	• Dissolve the same size small crystal of copper sulfate in two test tubes with equal amounts of water. Stir only one test tube and compare the time.
	• Solubility *usually* is more rapid at higher temperature than at lower temperatures.	• Dissolve the same size small crystal of copper sulfate in two test tubes with equal amounts of water. Warm only one test tube and compare the time.
• Suspensions	Suspensions are mixtures of solids and liquids with visible particles large enough to filter or settle out.	*Demonstrate a suspension.* Mix powdered calcium carbonate with water. Allow to settle out. Shake again and filter through filter paper to show the filtrate coming through.
Radioactivity		
• Cause of radiation	Radioactivity results from an unstable nucleus in an atom.	
	• The nucleus of an atom may be naturally unstable.	
	• The nucleus of an atom may be unstable due to man-made causes by bombardment with particles.	
• Isotopes	Isotopes of elements have different numbers of neutrons in the nucleus. Only certain isotopes of an element will be unstable enough to emit particles and/or energy spontaneously.	*Discuss hydrogen isotopes.* Illustrate the nuclei of the isotopes by diagrams: 

TOPIC	CONCEPTS AND UNDERSTANDINGS	SUPPORTING INFORMATION AND INSTRUCTIONAL TECHNIQUES
• Types of radiation	There are three principal types of radiation from naturally radioactive substances.	*Discuss types of radiation.* Demonstrate or describe the following:
	• Alpha particles are helium nuclei.	• Illustrate the positively charged $_2He^4$ by diagram.
	• Beta particles are high speed electrons.	• Illustrate that the loss of the electron $_{-1}{}^0e$ from the nucleus makes the atomic number increase by one. The element has undergone transmutation.
	• Gamma rays are penetrating energy emissions of shorter wave length than X-rays.	• Describe the radiation hazard from gamma rays, since they are the only ones capable of deep penetration of matter.
• Detection of radiation	There are methods of detecting radiation even though it is not noted by human senses.	*Demonstrate radiation detection.* Illustrate the following methods of radiation detection.
	• A photographic film may be exposed by radiation.	• Place a radioactive watch dial against a covered sheet of photographic film for several days. Develop commercially and note the exposed area.
	• An electroscope may be discharged by a radioactive source.	• Charge an electroscope with a rubber rod until the leaves diverge. Bring a radioactive source near the electroscope and note the collapse of the leaves.



	• The Geiger counter is an instrument that measures radioactive intensities.	• School Geiger counters have instruction manuals for conducting simple experiments. Demonstrate several.

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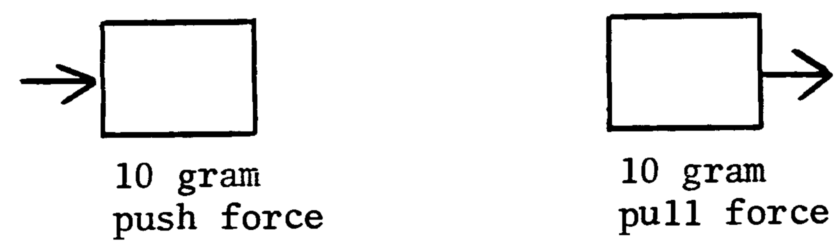
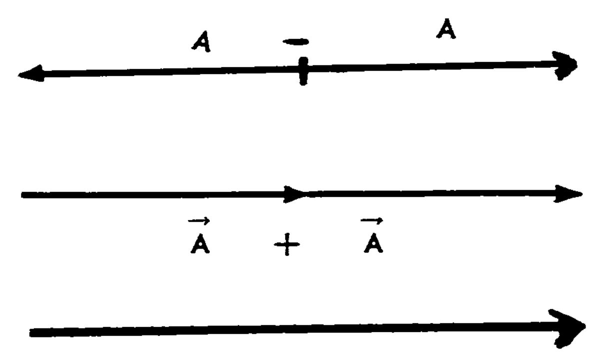
	• The cloud chamber detects radiation as tracks through saturated vapor in a container.	• The diffusion-type cloud chamber requires a bright light source, ethyl alcohol, dry ice. The super-cooled alcohol vapor condenses a cloud track in the path of a radioactive emission. The formation of the vapor track is similar to the one observed from a high altitude jet aircraft on a clear day.
Forces		
• Force as energy	A force is a measurement of energy. • A force is a push or a pull. • A force tends to produce a motion change.	
• Balanced and unbalanced forces	A force has both a direction and an amount. • A vector is an arrow used to indicate the direction and amount of a force.	*Diagrams using vectors.* Explain how to draw vector diagrams. • Illustrate vector forces. 
	• A resultant force is the single force equal to the effect of several different forces acting on an object.	• Illustrate resultant forces.  (a) (b) (c) • Diagram (a) shows two opposed equal forces producing no motion.

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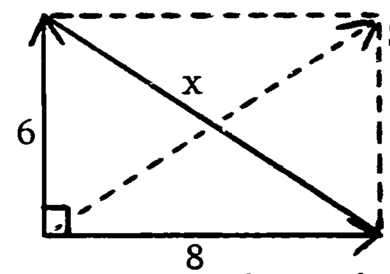
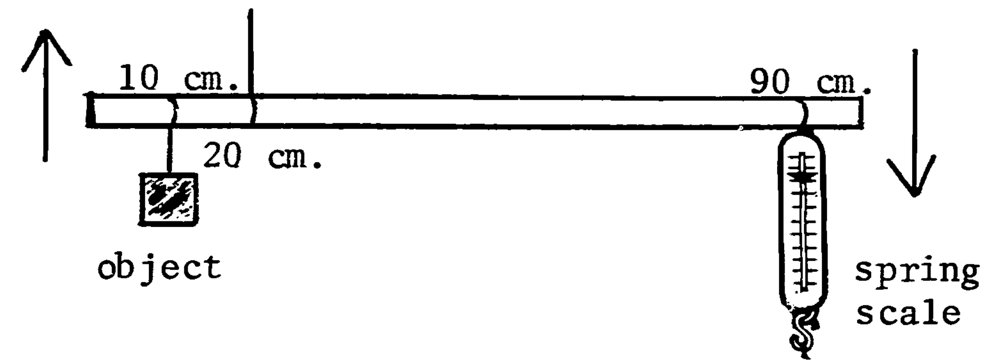
	• An object is in equilibrium if the concurrent forces are balanced.	• Diagram (c) is the resultant force equal to the two separate forces of diagram (b).
	• Unbalanced forces produce changes of motion of an object.	• Diagram (d) shows two forces at right angles. The resultant force may be calculated by solving for the hypotenuse of a right triangle containing the two forces as the legs of the triangle. The direction of the resultant force is shown as the diagonal of the completed rectangle.  Since $(\text{hypotenuse})^2 = \text{side}^2 + \text{side}^2$ then $x^2 = 6^2 + 8^2$ $x^2 = 36 + 64$ $x^2 = 100$ $x = 10$ (the resultant force)
• Gravitation	Gravitation is a universal force of attraction between objects.	*Illustrate the weighing of objects.* Weigh common objects in both English and metric units. Discuss what they would weigh if they were on the moon with only one-sixth of the earth's gravity.
	• Mass is the quantity of matter.	
	• Weight is a measure of the force of attraction between a mass and the earth.	
Forces and Work		
• Measurement	Work is done when a force moves an object through a distance.	*Demonstrate determining work done.* Weigh an object. Lift the object a measured distance. The work performed will equal the product of the force times the distance. For example, if the object weighed two pounds and the distance was three feet, the work performed is 3 ft. x 2 lb. = 6 ft.-lbs.
	• Work units include both force and distance.	
	• Work = force x distance.	
• Energy	Energy is the ability to do work.	
	• Potential energy is due to the position or condition of an	*Discuss potential and kinetic energy.* Make a simple pendulum. When the pendulum swings to its highest

TOPIC	CONCEPTS AND UNDERSTANDINGS	SUPPORTING INFORMATION AND INSTRUCTIONAL TECHNIQUES
	object and is equal to the work input that created the condition.	point, stop and hold it there. Point out that all its energy is now potential. Release and let the pendulum collide with an object at the lowest point of the pendulum swing. The sound created is due to the kinetic energy at the low point of the pendulum swing. Point out that the interrupted swing energy has been transformed into sound (and some heat).
	• Kinetic energy is the energy of the motion of an object.	
	• Energy is neither created nor destroyed during transformation.	
• Power	Power is the time rate of doing work.	
	• Horsepower is a power unit equal to 550 ft.-lbs. per second.	*Determine horsepower.* Walk up one flight of stairs, timing with a second hand. Calculate the horsepower developed by using the formula: $$\text{Horsepower} = \frac{\text{your weight (lbs.) x height of stairs (ft.)}}{\text{550 x time (sec.)}}$$
• Principles of machines	Machines transform work by changing force, distance, speed, or direction. One factor benefits at the expense of another.	
	• Without friction losses, the work put into a machine equals the work put out by the machine.	
	• The work input of a machine equals the effort force times the distance of the effort force.	
	• The work output of a machine equals the resistance force times the distance of the resistance force.	
• Simple machines	Simple machines are variations of the lever or the inclined plane.	*Demonstrate simple machines.* Tie a meter stick to a stand at the 20 cm. mark. Tie an object at the 10 cm. mark. Pull with a spring scale, downward at the 90 cm. mark to lift the object. Measure the distance
	• A common use of the lever has the	

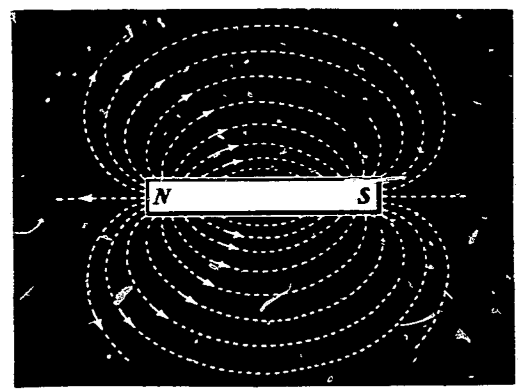
TOPIC	CONCEPTS AND UNDERSTANDINGS	SUPPORTING INFORMATION AND INSTRUCTIONAL TECHNIQUES
	fulcrum between the effort and the resistance.	that the object moves and the distance that the spring scale moves. Measure the reading on the scale.  Note that the object at 10 cm. is 10 cm. from the fulcrum. Note that the effort (the spring scale) is 70 cm. from the fulcrum. Then: weight of object (gm.) x distance object moves (cm.) = reading of spring scale (gm.) x distance scale moves (cm.)
	• The inclined plane is a slanted flat surface with one end higher than the other.	*Discussion of the inclined plane.* Illustrate on the chalkboard a 4 foot inclined plane with one end 1 foot higher than the other. Point out that an object pulled along the plane would travel a distance of four feet to arrive at a useful height advantage of only one foot. What is gained, however, is an effort force only one-fourth as great as the weight of the object being moved.
Forces and Fluids		
• Behavior of fluids	Fluids are liquids or gases which are able to take the shape of the container.	*Demonstrate pressure.* Illustrate the pressure of fluids by performing the following:
	• Fluids may exert pressure which is defined as the force per unit area.	• Remove the screw cap from a large metal can. Add a small amount of water and boil until steam escapes. Remove from heat and recap the can. As the steam cools, air pressure will collapse the can.

TOPIC	CONCEPTS AND UNDERSTANDINGS	SUPPORTING INFORMATION AND INSTRUCTIONAL TECHNIQUES
	• The pressure of liquids increases as density (mass per unit volume) increases and the depth of the liquid increases.	• Punch three holes in the side of an open can. The bottom hole is one inch from the bottom, the next hole two inches, and the last hole three inches from the bottom. Keep the can filled with water and observe the difference in flow due to pressure differences with height.
	• At any point, pressure of fluids is equal in all directions.	
	• Pressure of fluids is not affected by the volume or the shape of the container.	
	• The hydraulic press is an application of fluid pressure transmitted equally in all directions.	
• Buoyancy	Archimedes' principle describes the buoyant force on an object in a liquid as being equal to the weight of the liquid displaced.	*Demonstrate Archimedes' principle.* Demonstrate Archimedes' principle as follows:
	• A submerged object appears to weigh less than it does in air.	• Weigh an object in air by hanging it from a spring balance. Submerge the object in water while still hanging from the scale. Note the decrease in the reading of the scale balance.
	• Floating occurs if the buoyant force equals the weight of the object.	• Fill an overflow can with water to the level of the spout. Float a weighed wooden block in the water, collecting the overflow in a beaker. The weight of the collected water will equal the weight of the wooden block.
• Velocity and pressure relationships	An increased fluid velocity lowers adjacent pressure.	*Illustrate Bernoulli's principle.* Hold a glass tube vertically in a beaker of water. Using a second glass tube, blow air horizontally across the top of the first tube. As the air is blown across, the water will rise in the partially submerged vertical tube.

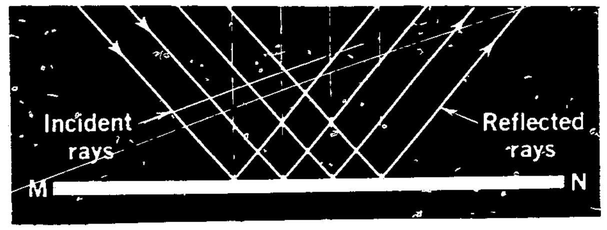
TOPIC	CONCEPTS AND UNDERSTANDINGS	SUPPORTING INFORMATION AND INSTRUCTIONAL TECHNIQUES
Force and Motion		
• Factors of motion	Motion results from an unbalanced force.	*Demonstrate gravitational acceleration.* Perform the following:
	• Speed is measured as the distance covered in a given period of time.	• Drop a small coin and a large metal weight from the same height at the same time. They strike the floor together, indicating that the mass of the object has no effect on its acceleration due to gravity.
	• Velocity includes direction as well as speed.	
	• Acceleration is a change in velocity, expressed as $\frac{\text{distance}}{\text{time}^2}$.	• Drop a sheet of paper flat side up. Then drop it with an edge down. The difference in acceleration is due to air resistance.
• Laws of motion		
	An object resists efforts to change its velocity.	*Demonstrate laws of motion.* • Snatch a piece of paper from underneath a glass of water, after showing that the glass can be dragged along by gently pulling the paper.
	An unbalanced force accelerates an object.	• Read the weight of an object on a spring balance. Abruptly lift the balance and note reading. Continue uniform velocity lift and read weight value. Abruptly lower the balance and read value. Continue uniform velocity during lowering and note reading. Explain Newton's second law.
	Every action has a reaction which is equal in magnitude and opposite in direction.	• Tie a flexible rubber hose with a string at two different points on the hose so that the hose forms a right angle. Attach to a faucet. Gently running water will extend the hose as a reaction to the flowing action of the water.

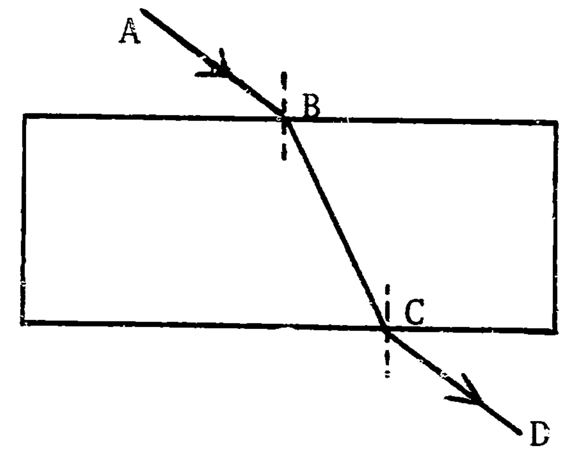
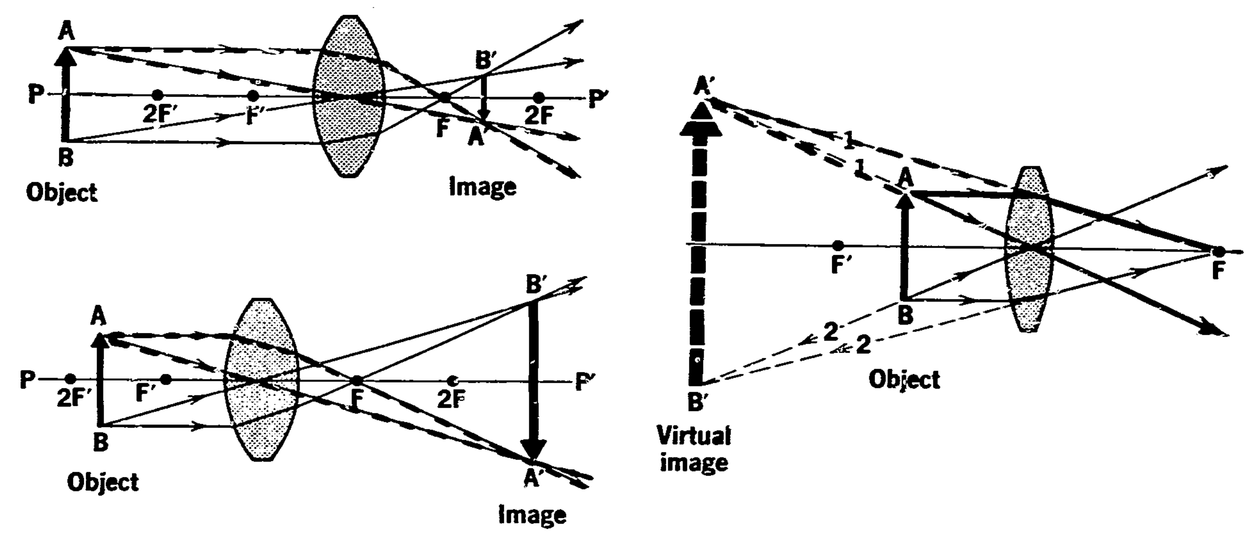
TOPIC	CONCEPTS AND UNDERSTANDINGS	SUPPORTING INFORMATION AND INSTRUCTIONAL TECHNIQUES
Electric Energy		
• Static electricity	Static electricity is made of electric charges in simple random motion, usually called "at rest." • Uncharged objects have equal positive and negative charges. • Charged objects have gained or lost electrons. • An electrostatic force exists between charged objects. • Like charges repel; unlike charges attract.	*Demonstrate electrostatics.* Rub a glass rod with silk. Attempt to pick up bits of paper. Rub a rubber rod with fur. Attempt to pick up bits of paper. Rub two glass rods with silk. Suspend them by strands and bring them near each other. They will repel each other. Rub a glass rod with silk, and a rubber rod with fur. Suspend them with string and bring them near each other. They will be attracted.
	• Electrons may transfer between objects by contact, both objects getting the same charge.	*Demonstrate charging by contact.* Charge a rubber rod with fur and touch the knob of an electroscope. Recharge the rubber rod and bring close to the knob. Note that the leaves diverge.
	• Electrons may transfer by induction; the induced charge is opposite.	*Demonstrate charging by induction.* Charge a rubber rod with fur. Bring the rod near an uncharged electroscope. Touch your finger to the knob of the electroscope. Remove the finger, then the rod. Recharge the rubber rod with fur. Bring the rod close to the knob. Note that the leaves collapse.
• Current electricity	Current electricity is a flow of electric charges. • Electricity is obtained by transformation of other energy. • Chemical energy can provide an electron flow.	*Discussion of electricity by transformation.* Explain that a dry cell actually has moist chemicals reacting with the zinc metal of the case. Electrons freed during chemical reaction travel through wires connected to the terminals. Explain that a generator is water or steam driven and forms an electric current by its magnetic field actions.

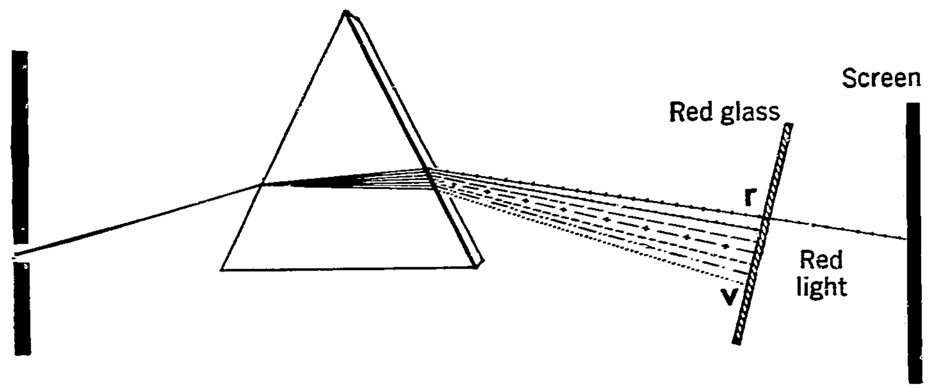
TOPIC	CONCEPTS AND UNDERSTANDINGS	SUPPORTING INFORMATION AND INSTRUCTIONAL TECHNIQUES
	• Mechanical energy can be converted into electrical energy.	
	• Certain substances are good conductors of electricity. • Metals are the best solid conductors. • Solutions of acids, bases, and salts are the best liquid conductors.	*Demonstrate liquid conductor.* Wire a 25-watt lamp so that part of the wire circuit is broken to expose metal ends. Place the broken ends in a beaker. First add dry salt. The lamp will not light. Replace the salt with pure water. Again the lamp will not light. Now combine the salt and water. The lamp will be lighted by the salt solution completing the electric circuit.
	• Gases are conductors when ionized.	
	• Current electricity may be measured for its flow rate, its electromotive force, and its resistance to electron flow. • Voltage is a measure of the potential energy (volts). • Amperage is a measure of the flow rate of the current (amperes). • Resistance is a measure of the flow restriction (ohms).	*Discussion of volts, ohms, amperes.* Discuss house current (110 volt, 220 volt). Show a toaster with ampere rating on its label. Discuss the heat output of the toaster being related to the resistance of the thin wires inside.
	• A relationship in current electricity is expressed as: volts = amperes x ohms	*Application of electrical relationships.* Calculate the amperes in a 110 volt household appliance with a 22 ohm resistance. Show how the formula may be used to solve any unknown if two factors are known.
	• Series circuits contain a single conducting path.	*Demonstrate a series circuit.* Connect a series of lamps so that the current flows through each filament in turn. If one lamp is removed, all the lights go out. Reduce the total number of lamps and note the increased brightness.

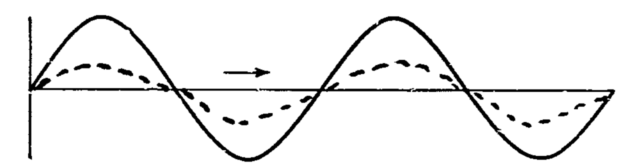
TOPIC	CONCEPTS AND UNDERSTANDINGS	SUPPORTING INFORMATION AND INSTRUCTIONAL TECHNIQUES
	• Parallel circuits offer two or more conducting paths.	*Demonstrate a parallel circuit.* Connect three lamps in individually branched circuits. If one lamp is removed, the other lights remain on. Note that there is no change in brightness.
	• Electric power is the rate of energy use expressed in watts.	*Illustrate lamp power.* Show that a 100-watt lamp is of greater power than a 25-watt lamp, although they may be equal in size.
	• Electric energy is a product of the power times the time it is used, expressed as watt-hour or kilowatt-hour.	*Discuss electric energy.* Point out that the electric meter in the home measures the electric energy consumed. The meter reads units of kilowatt-hours.
Magnetism		
• Magnetic fields	Magnetic fields are regions around a magnet caused by the alignment of electron spins.	*Demonstrate detection of a magnetic field.* Place a sheet of paper over a magnet. Sprinkle iron filings on the paper and tap lightly. The iron becomes magnetized and follows the magnetic field of the magnet.
	• Magnetic materials readily align electrons.	
	• Nonmagnetic materials resist electron alignment.	
	• Magnetic fields surround magnetized objects.	*Demonstrate magnetic field direction.* Place a magnet on a large sheet of paper. Move a magnetic compass around the magnet. Record the N pole direction on the paper at each point. The field will point from N to S on the paper. 
	• A magnetic field may be detected by another.	
	• A magnetic field has a direction indicated by the north pole needle of a compass.	

TOPIC	CONCEPTS AND UNDERSTANDINGS	SUPPORTING INFORMATION AND INSTRUCTIONAL TECHNIQUES
	• The magnetic field around a straight metal conductor (carrying current) is circular.	*Illustrate magnetic fields in electric wires.* Draw diagrams of straight and coiled wires conducting electric current, showing magnetic fields.
	• The magnetic field around a coiled metal conductor (carrying current) forms poles at the ends of the coils.	
• Induced currents	Induced voltage occurs if a metal conductor moves perpendicular to a magnetic field. • If voltage is induced in a closed circuit, an electric current flows. • If a coil of wire rotates in a magnetic field, an alternating current is induced.	*Discussion of electric generators.* Describe the transformation of mechanical energy exerted in crossing the magnetic fields of the generator. Work is needed to overcome the resistance of the fields to this motion. Part of this work is transformed to heat and part to the flow of electric current. Whether the current will be AC or DC depends on the method of output to the outside circuit.
Light		
• Electromagnetic energy	Light is electromagnetic radiation energy in the visible part of the spectrum. • Electromagnetic radiation is the means of energy transfer in free space. • Electromagnetic radiation results from electron acceleration or excitation by heat.	*Discuss electromagnetic energy.* Describe electron acceleration occuring during direction change in AC currents. Energy is given off in the radio frequency range during this acceleration. Describe heated atoms pushing electrons to higher shells. When the electrons return to normal, they also return some energy as electro-magnetic energy, sometimes as light, or heat, or X-rays, depending on the material used and the amount of energy involved.
	• Electromagnetic energy travels at the rate of 186,000 miles per second in a vacuum.	*Discuss the electromagnetic spectrum.* Illustrate the spectrum on the chalkboard by using the diagram on the following page.

TOPIC	CONCEPTS AND UNDERSTANDINGS	SUPPORTING INFORMATION AND INSTRUCTIONAL TECHNIQUES
	• Electromagnetic energy travels as transverse waves, perpendicular to the direction of travel. • Electromagnetic waves are classified by general bands of wavelengths.	Low Frequency — High Frequency Electric Waves | Radio and Television | 1 | 2 | 3 | 4 | 5 | 6 Long Wave Length — Short Wave Length (1) infared (2) visible light (all colors = roygbiv) (3) ultraviolet (4) X-rays (5) gamma rays (6) cosmic rays
• Reflection	Light is reflected when a beam of light strikes a surface. • Light on a surface is also partly absorbed and may be transmitted through the surface. • The angle of incidence of light on a surface equals the angle of reflection.	*Discuss light reflection.* Describe how the amount of light reflected from a surface depends on the color and transparency of the material, on the smoothness or roughness of the surface, and on the angle at which the light strikes the material. 
	• Plane mirrors give virtual images, which are erect, reversed, and appear as far behind the mirror as the object is in front.	*Illustrate a plane mirror image.* Describe the appearance of your image in a mirror when you raise your right hand to your face. The image appears behind the mirror with the left hand to the face.
	• Concave mirrors can reflect parallel rays.	*Discuss concave mirrors.* Describe the principal focus of an automobile headlight as the point of location of the lamp filament. The rays given off from the lamp are parallel.
• Refraction	Refraction or bending of light occurs when light enters another material at an oblique angle. • When light enters a medium of	*Demonstrate and describe refraction.* Place a thick glass plate on paper and sight pins A and B in the diagram by looking through the glass. Line up pins D and C according to where they appear in the sight line. Draw lines AB and CD. Remove the glass and draw a connecting line.

TOPIC	CONCEPTS AND UNDERSTANDINGS	SUPPORTING INFORMATION AND INSTRUCTIONAL TECHNIQUES
	higher optical density, both its speed and wave length are reduced. • When light enters a medium of lower optical density, both its speed and wavelength are increased.	 Place a pencil in a glass of water. Note that the pencil appears to be bent where it enters the water.
	A convex lens is thicker in the middle than at the edges; therefore, it will converge light rays.	*Discuss convex lenses.* Describe a convex lens as a variation of two prisms placed base to base. The same principle of refraction will take place with light in both cases. The position of the light source in front of the lens determines the image. Diagram these cases: 
	Dispersion is the separation of white light into its component colors.	*Illustrate dispersion.* Use a white light source to form a color spectrum through a prism. Note the order of colors from violet to red. Note that dispersion may also occur in any portion of the electromagnetic spectrum or in sound waves.

TOPIC	CONCEPTS AND UNDERSTANDINGS	SUPPORTING INFORMATION AND INSTRUCTIONAL TECHNIQUES
• Color	The color of light depends on the wavelength of the light.	*Discuss reflected color.* Note that if white light makes an object appear green, then all other colors of the spectrum must have been absorbed by the reflecting material. Only green was not absorbed and was free to reflect and be observed. If all white light is absorbed, the object appears black. If all white light is reflected, the object appears white.
	• The color of reflected light depends on the color of the incident light and on the nature of the reflecting surface.	
	• The color of light transmitted through transparent materials depends on the color of the incident light and the nature of the absorbing substance.	
Sound		
• Sound transmission	Sound is mechanical energy produced by vibrating matter.	
	• Sound travels in compressional waves.	*Demonstrate compressional waves.* Suspend a coiled spring (a "slinky") between two supports. Pinch together a few coils at one end of the spring, and release. The pulse will travel to the far end of the spring and return as a reflected wave. Note the direction of vibration of the pulse in the direction of travel of the wave.
	• The frequency of sound waves (vibrations per second) determines the pitch.	
	• Sound requires a medium through which to travel.	*Demonstrate sound through a medium.* A door bell hooked up in a bell jar arranged on a vacuum pump plate will show a decrease in sound intensity as the air is removed from the bell jar.

TOPIC	CONCEPTS AND UNDERSTANDINGS	SUPPORTING INFORMATION AND INSTRUCTIONAL TECHNIQUES
	• The loudness of sound depends on the amplitude of the sound waves.	*Diagram a low and high amplitude wave.* 
• Sound waves	Sound waves may be reflected.	*Discuss sound reflection.* Point out that the design of auditoriums and music halls requires allowance for proper sound reflection. Detection by sonar for depth measurement at sea depends on timing the reflection of sound waves.
	• Delayed sound reflection produces an echo.	
• Resonance	Resonance is a vibration in a material caused by the energy of a sound wave.	*Discuss resonance.* Describe the sound in an organ pipe as the resonance of the column of air in the tube. Most musical instruments make some provision for resonance to enrich the tone.
	• In order to resonate properly, the material must have the same vibration rate as the sound wave.	
Heat Energy		
• Heat from motion	Heat is the internal energy from the motions of the molecules of a substance.	
	• Heat transfer is the exchange of internal energy from one substance to another.	
	• Heat may be measured in units called calories.	*Discuss the calorie.* Define the calorie as the heat needed to raise the temperature of one gram of water 1°C. Food Calories refer to the heat energy available if the food is oxidized (1000c = 1C).

TOPIC	CONCEPTS AND UNDERSTANDINGS	SUPPORTING INFORMATION AND INSTRUCTIONAL TECHNIQUES
• Temperature	Temperature is a measure of the average kinetic energy of the molecules of a substance.	
	• Temperature is measured by comparison with a standard, as the boiling and freezing points of water.	*Discuss temperature.* The standard indicating the freezing and boiling points of water are marked on a thermometer with intervals marked between these fixed points. For centigrade thermometers the fixed points are 0° and 100° with 100 intervals. For Fahrenheit thermometers, the fixed points are 32° and 212°, with 180 intervals between. Cite examples which show the conversion from one scale to another.
	• Thermometers indicate temperature related to a standard.	
• Heat transfer	Heat may be transferred from a high temperature body to a low temperature body, but not the reverse.	
	• Conduction transfer is by particle to particle within the substance.	*Demonstrate conduction.* Hold a six inch wire in a bunsen flame. Note that soon the end of the wire held in the hand shows an increase in temperature.
	• Convection transfer is by current flow in liquids or gases.	*Demonstrate convection.* Place powdered chalk in a beaker of water and heat. Note the current flow as the water is heating.
	• Radiation transfer of heat occurs by infrared electromagnetic waves.	*Demonstrate radiation.* Use a triangular prism to form a spectrum from a very strong light source. Hold a thermometer in the blue, yellow, and red portions for a minute each and note the temperature change. Then hold the thermometer in the dark area just beyond the red. Note the increased temperature in this infrared portion of the electromagnetic spectrum.

TOPIC	CONCEPTS AND UNDERSTANDINGS	SUPPORTING INFORMATION AND INSTRUCTIONAL TECHNIQUES
• Heat conservation	Conservation of heat energy is maintained when heat flows from one body to another. • The heat lost by the warmer body is equal to the heat gained by the cooler body.	*Discuss heat conservation.* Describe the effect on the temperature when hot water is mixed with cold water. Point out that the heat lost by the hot water is all gained by the cold water.

NOTATIONS OF THE INSTRUCTOR

SAMPLE TEST QUESTIONS

Directions (1-13): In the space provided on the answer sheet, write the *number* of the word or expression that, of those given, best completes the statement or answers the question.

1. In some cases, important scientific discoveries have come about quite by accident. In some cases, they have come about because a brilliant scientist had a brilliant "hunch." Most of our scientific knowledge, however, is the result of painstaking work and logical planning by trained scientists. Scientific inquiry of this kind demands curiosity, persistence, caution, and, above all, a desire to know the truth.

   According to the paragraph above, most scientific achievements are the result of

   1 luck
   2 brilliance
   3 hard work
   4 ambition

2. Deliquescence is a term applied to the property of certain substances to take up water from the air to form a solution. We have all noticed that common table salt often gets sticky and clogs the holes of a salt shaker when the weather is damp. This occurs, not because pure sodium chloride is deliquescent, but because common table salt contains a very small amount of magnesium chloride which possesses the property of deliquescence to a very high degree.

   From the selection above, we can conclude that

   1 chlorides in general are deliquescent
   2 magnesium chloride will form a solution in damp air
   3 pure salt is soluble in water
   4 common table salt is a mixture of many compounds

3. There is no blue pigment in the blue feathers of the bluejay. Tiny air bubbles dispersed throughout the solid matter of the feathers are responsible for the scattering of light that makes the feathers look blue. Similarly, there are no blue pigments in the irises of blue eyes; the blue color is the result of the physical structure of the iris. In such cases, the blue color is called structural blue. Green or gray eyes are the result of the combined effect of structural blue and yellow and brown pigments.

   Which can best be concluded from the selection above?

   1 All blue pigments are man-made.
   2 The color green in plants results from a combination of structural blue and certain pigments.
   3 The colors in birds' feathers are the result of the physical structure of the feathers.
   4 Color may be caused by either physical structure or pigments.

4. As late as 1855, aluminum sold at $90 per pound. In the 1870's it cost $12 per pound. In 1886, as the result of a new process using sodium, the price was reduced to about $2 per pound. Even this price was too expensive for aluminum to be put to general use.

   About this time, however, a young American named Charles Martin Hall discovered that aluminum could be isolated by electrolysis. When this process was commercialized in 1889, the price of aluminum was reduced to about 20 cents per pound.

   According to the selection above, Charles Martin Hall's process was important chiefly because it

1 was less expensive than previous processes
2 was the first industrial use of electricity
3 extracted pure aluminum for the first time
4 required no chemicals

5. If a manufacturing chemist were asked to name the most important acid, he would probably say, "Sulfuric acid." The consumption of sulfuric acid is an index to the industrial development and prosperity of a country. Sulfuric acid is a dense, syrupy liquid with a boiling point of 338° C. In concentrated form, it contains about 2 percent water. Ordinary dilute sulfuric acid is made by adding one part concentrated sulfuric acid to six parts of water. It is important to note that the dilution should be made by adding the concentrated acid slowly to the water while stirring. If the water is poured into the concentrated acid, a very violent reaction occurs in which steam is produced and the acid is spattered.

For the student who is going to work with sulfuric acid in the laboratory, the most important point in the selection above is that

1 in concentrated form, sulfuric acid is a very dense liquid
2 sulfuric acid is an index to the industrial development and prosperity of a country
3 sulfuric acid is used more than any other acid in manufacturing processes, because it has a very high boiling point
4 extreme care should be taken in mixing concentrated sulfuric acid with water

6. There are many factors that influence the degree to which an individual will perfect his ability to control and use his muscles. These factors include physical size, health, nutrition, and mental development. In addition, the individual's performance is affected by the opportunity he has to practice a skill, fears resulting from earlier unsuccessful attempts, and attitudes of the society in which he lives. There is little doubt, for example, that one reason why girls generally perform less well in sports than they might is that they are not often encouraged to do so and, in fact, are sometimes actively discouraged.

Which statement is best supported by the selection above?

1 Success in physical activities is usually a sign of high intellectual ability.
2 Successful athletes are likely to be hard-working, confident, and eager to succeed.
3 An individual cannot succeed in athletics if he is afraid of failure.
4 In physical activities, as opposed to mental activities, an individual can be successful if he is sufficiently motivated.

7. The terms *anoxia* and *hypoxia* are often confused. In scientific terminology, *anoxia* refers to a complete absence of oxygen in the environment and *hypoxia* refers to an oxygen deficiency in the body tissue.

From the paragraph, it can be concluded that the term *hypoxia* would occur more frequently than *anoxia* in the study of

1 physics
2 space engineering
3 biology
4 astronomy

8. Some scientists believe that the evolutionary process probably tends to operate less successfully with the passage of time. They reason this way: When the first amphibians evolved and crawled out of the ocean to live on land, they presumably had little if any competition for food.

The next amphibians that landed in that area had to endure the same hardships and, in addition, had to compete against the first ones, who had a head start in adapting to the land environment. Eventually the newest arrivals have little chance of surviving long enough to reproduce their kind and become a species instead of being individual "freaks."

Which conclusion is best justified on the basis of the reasoning explained in the selection above?

1 The first creatures to evolve as land animals had an advantage which became increasingly difficult for other evolving creatures to overcome.
2 The first amphibians were better adapted to a land environment than were the amphibians that evolved later.
3 Modern civilization, with its emphasis on such developments as housing and road-building, has limited the food supply available for newly evolving species of animal life.
4 Practically all of the first amphibious species to evolve have now become extinct.

9. Carbon monoxide is poisonous because it unites very readily with hemoglobin and forms a very stable compound. To the extent that the supply of hemoglobin in the blood is united with carbon monoxide, it is not available to transport oxygen. Therefore, the victim suffers from oxygen starvation. The best treatment is a series of blood transfusions, which supply the victim with fresh hemoglobin.

According to the selection above, hemoglobin in the blood normally serves as a

1 carrier of oxygen
2 stable compound in the blood
3 manufacturer of nutrition for the body
4 protection against blood poisoning

10. From the atmosphere water falls upon the earth's surface as rain, snow, hail, and sleet. Some water evaporates or is taken up by plants, some runs off immediately into streams, and the rest sinks into the ground. Much of the water that sinks into the ground comes to the surface at a lower elevation and forms runoff streams. Streams carry excess water from the land to the sea. From the sea, water is returned to the atmosphere.

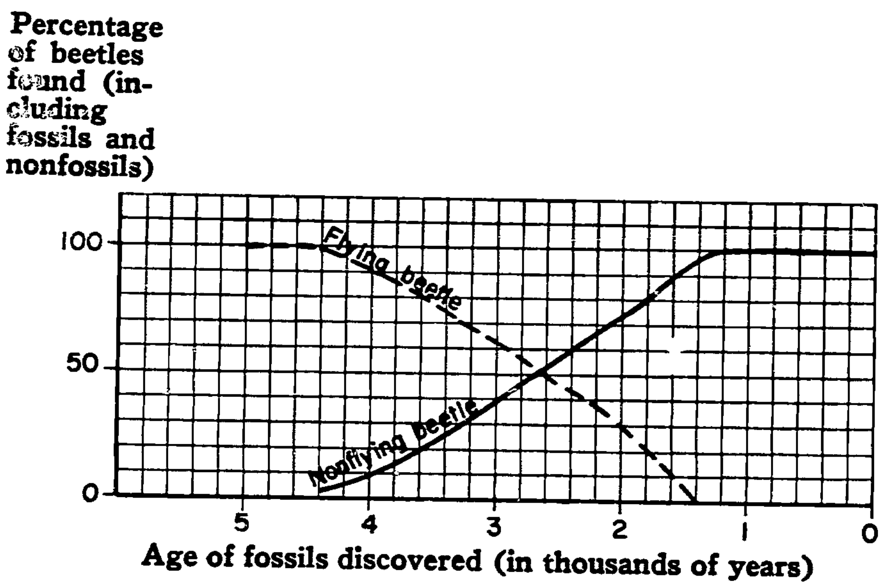
Which statement about the movement of the waters of the earth is most clearly justified by this selection?

1 It is a series of events that occur in more or less the same sequence over and over again.
2 It takes place to a greater degree on the land than in the atmosphere or the oceans.
3 It is primarily a means of carrying the excess water from the land back to the oceans.
4 It takes place chiefly under the ground rather than in the form of runoff streams on the surface.

11. Peruvian Indians who live in the Andes Mountains usually have a much higher red corpuscle count than persons living at sea level. This condition is beneficial to the Indians because it compensates for the

1 high concentration of carbon dioxide at high altitudes
2 short growing season at high altitudes
3 comparative scarcity of oxygen at high altitudes
4 inadequate food supply in the area

12. A study of beetles on an isolated oceanic island formed by volcanic action and far from any other land shows that all beetles that are presently on the island are incapable of flying. A study of the different rock strata of the island shows that the island was once populated with flying beetles. The graph shows the probable change in population over a period of 5,000 years.



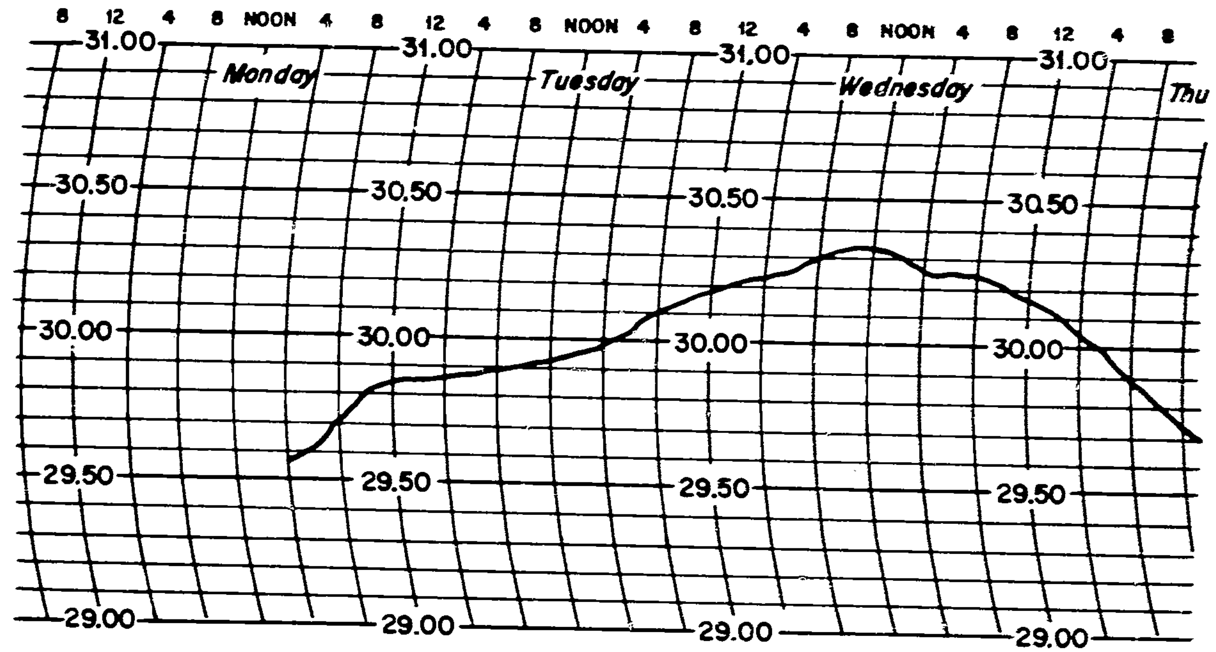
A possible conclusion to be drawn from the graph is that, on the island today, the genetic material which controls the development of flying beetles

1 is still present in the population
2 has been eliminated from the population
3 has been isolated due to natural barriers
4 will appear again since it is the dominant gene

13. Which is the procedure for separating a mixture of salt, sand, and water?

1 Filter the mixture and then evaporate the filtrate
2 Filter the mixture and then evaporate the residue.
3 Cool the mixture and then filter it.
4 Heat the mixture and then filter it.

Directions (14–16): Base your answers to questions 14 through 16 on the chart below, which is an atmospheric pressure record for part of a week. Write the *number* preceding the word or expression that best completes *each* statement or answers *each* question.



14. When was the above record started?

1 8 a.m. Sunday
2 8 p.m. Sunday
3 4 a.m. Monday
4 4 p.m. Monday

15. What is the lowest pressure recorded on the chart?

1 29.50 inches
2 29.58 inches
3 29.70 inches
4 29.74 inches

16. When did the greatest pressure change take place?

1 between 4 p.m. Monday and 8 p.m. Monday
2 between midnight Monday and 4 a.m. Tuesday
3 between 8 a.m. Wednesday and noon Wednesday
4 between 4 p.m. Wednesday and 8 p.m. Wednesday

Directions (17-37): Below *each* of the following passages you will find one or more questions or incomplete statements about the passage. Each question or statement is followed by five words or expressions numbered 1 through 5. Select the word or expression that most satisfactorily completes *each in accordance with the meaning of the passage* and write its *number* in the space provided on the answer sheet.

PASSAGE A

Materials of construction of aircraft have gone through many cycles. For several years after World War I and in spite of the Zeppelin duralumin development, aluminum was suspect as a structural material. The famous specification 100-A of the Navy prohibited the use of aluminum in any structural part of aircraft. This is a pertinent example of how too-rigid specifications, based on what was good practice in previous years, can prevent future development.

Today we face a similar situation in prohibitions against Fiberglas or plastic stressed structures because it is so difficult, theoretically, to calculate and check the stressed condition. Yet plastics may well have as great a future in aircraft structures as dural stressed-skin "monocoques" and wing panels had thirty years ago. We hardly need to recapitulate how metal took over from wood and replaced a material that just could not stand the weathering difficulties of day-in, day-out air operation compared to aluminum alloy, so long-lasting and reliable. Now alloys—titanium and others—are also beckoning alluringly, like Fiberglas, for a chance to show their worth. Also "sandwich" materials are most promising. Will we still be slow to pick up the ball?

17. The tile below that best expresses the ideas of this passage is:
1 The defects of aluminum in aircraft construction
2 Resistance to change in aircraft construction
3 Specification 100-A
4 The inadequacies of wood as structural material
5 The future of Fiberglas

18. As used in the passage, the word "recapitulate" (second paragraph, line 10) most nearly means
1 reckon
2 complain
3 admit
4 verify
5 recount

19. We may most safely conclude that the author's chief purpose in writting this passage is to
1 point out the superiorities of aluminum
2 suggest the limitations of plastics
3 encourage the willingness to experiment
4 show why aluminum was once suspect
5 point out the value of specifications

20. The author's attitude toward the new materials for aircraft construction is one of
1 grudging admiration
2 qualified approval
3 qualified opposition
4 definite opposition
5 indifference

21. The author's thesis in the passage can be expressed as
1 we can learn everything from the past
2 progress is a painless procedure
3 it is easier to build than to destroy
4 we should profit from experience
5 being conservative has its advantages

PASSAGE B

Lamarck's theory of evolution, although at one time pretty generally discredited, has now been revived by a number of prominent biologists. According to Lamarck, changes in an animal occur through use and disuse. Organs which are specially exercised become specially developed. The need for this special exercise arises from the conditions in which the animal lives; thus a changing environment, by making different demands on an animal, changes the animal. The giraffe, for instance, has developed its long neck in periods of relative scarcity by endeavoring to browse on higher and higher branches of trees. On the other hand, organs that are never exercised tend to disappear altogether. The eyes of animals that have taken to living in the dark grow smaller and smaller, generation after generation, until the late descendants are born eyeless.

The great assumption made by this theory is that the effects of personal, individual effort are transmitted to the offspring of that individual. This is a doctrine that is very much in dispute among modern biologists.

22. The title below that best expresses the ideas of this passage is:
   1 Why Lamarck's theory is valid
   2 A changing environment
   3 The modern biologist
   4 The Lamarckian theory
   5 An attack on Lamarck's theory

23. According to the passage, most scientists today regard Lamarck's theory of evolution as
   1 controversial
   2 disproved
   3 accepted
   4 important
   5 misunderstood

24. The author's chief purpose in writing this passage was to
   1 discredit other theories of evolution
   2 indicate how heredity influences environment
   3 show why animals become extinct
   4 explain a concept of biology
   5 encourage the acceptance of Lamarck's theory

25. Which pattern do the ideas of this passage follow?
   1 general to particular, only
   2 particular to general, only
   3 general to particular to general
   4 particular to particular to general
   5 general to general to particular

PASSAGE C

Thomas Gold, director of Cornell University's Center for Radiophysics and Space Research, which operates the Arecibo observatory, then outlined the argument that the pulsars are, in fact, fast-spinning neutron stars. The latter consist of a tight ball of neutrons, the electrically neutral particles of the atomic nucleus. A normal atom can be likened to the solar system in that it consists largely of open space with a tiny, very dense nucleus in its center and electrons flying about it at various distances. In a neutron star there is no such space. It is believed to form when a star considerably larger than our sun (which is 864,000 miles in diameter) burns up its fuel and collapses into an object 10 miles wide. With none of the thermonuclear reactions that make a star shine, such a star would be invisible at any great distance. Mr. Gold noted that three of the most perplexing features of the pulsars could be explained if they were neutron stars: their rigid pulse rate, the unusual tempo of that rate, and the absence of obvious visible sources for the emissions. There are many highly rhythmic phenomena in astronomy, such as the spin of the earth and the movement of two stars around one another. But rhythms of a second or less are difficult to explain except in terms of small, extremely dense bodies--namely neutron stars.

26. The atomic particles chosen by Mr. Gold in his attempt to explain pulsars are
   1 electrons with a negative electric charge
   2 atoms with a positive charge
   3 electrically neutral particles
   4 atoms with large dense nuclei

27. Our ability to see a neutron star
   1 is simple since the star is very bright
   2 is difficult because it is too small
   3 is impossible since it has no thermonuclear reactions
   4 depends upon the star's rate of spin

28. The unusual tempo and rigidity of the pulse rate together with the apparent absence of obvious visible sources have led Mr. Gold to conclude that the signals are coming from
   1 the collapsed matter of a star which has burned up its fuel
   2 intelligent beings signalling from space ships in outer space
   3 the instruments in the Arecibo observatory at Cornell University
   4 a cloud of largely open space with a tiny, very dense nucleus in its center and electrons flying about at various distances

29. Based on this passage, we could conclude that there is evidence of
   1 intelligent life existing on several planets
   2 the total absence of intelligent life except on the earth
   3 nothing which proves or disproves the existence of intelligent extra-terrestrial life
   4 intelligent human beings on neutron stars

30. As a result of reading this article, we must agree that
   1 a pulsar is a neutron star
   2 a pulsar has a diameter of 10 miles
   3 Dr. Gold has offered the only possible explanation for pulsars
   4 a reasonable explanation of pulsars fits in with other observed astronomical phenomena

PASSAGE D

The microscopic vegetables of the sea, of which the diatoms are most important, make the mineral wealth of the water available to the animals. Feeding directly on the diatoms and other groups of minute unicellular algae are the marine protozoa, many crustaceans, the young of crabs, barnacles, sea worms, and fishes. Hordes of the small carnivores, the first link in the chain of flesh eaters, move among these peaceful grazers. There are fierce little dragons half an inch long, the sharp-jawed arrowworms. There are gooseberrylike comb jellies, armed with grasping tentacles, and there are the shrimplike euphausiids that strain food from the water with their bristly appendages. Since they drift where the currents carry them, with no power or will to oppose that of the sea, this strange community of creatures and the marine plants that sustain them are called plankton, a word derived from the Greek, meaning wandering.

31. According to the passage, diatoms are a kind of
   1 mineral
   2 alga
   3 crustacean
   4 protozoan
   5 fish

32. Which characteristic of diatoms does the passage emphasize?
1 size
2 feeding habits
3 activeness
4 numerousness
5 cellular structure

33. According to the passage, which prey on other sea creatures?
1 sea worms
2 young crabs
3 barnacles
4 euphausiids
5 marine protozoa

34. The reader may most safely conclude from this passage that plankton
1 was given its name by Greek fishermen
2 is a valuable source of mineral wealth
3 is composed of animal and vegetable life
4 cannot be seen by the naked eye
5 is most often found where the currents are strongest

PASSAGE E

A two-part experiment in biology was performed in a laboratory. An account of this experiment follows:

A A number of corn kernels were cut in half and placed with the cut surface down on a medium of agar containing 1% starch. After several hours, the kernels were removed and dilute iodine was poured over the agar. Result: The areas previously covered by the kernels became brownish in color. The rest of the agar turned blue-black.

B The same experiment was then repeated, except that the cut kernels were boiled for 20 minutes before being placed on the starch agar medium. Result: All of the area, including that previously covered by the kernels, turned blue-black when dilute iodine was applied.

35. In part A of the experiment, the result indicated that
1 sugar was no longer present in the areas which had been covered by the corn kernels
2 sugar was no longer present in the areas which had not been covered by the corn kernels
3 starch was no longer present in the areas which had been covered by the corn kernels
4 starch was no longer present in the areas which had not been covered by the corn kernels

36. A conclusion drawn from this experiment would be that raw corn kernels may contain
1 digestive enzymes
2 dilute iodine
3 starch solution
4 fats

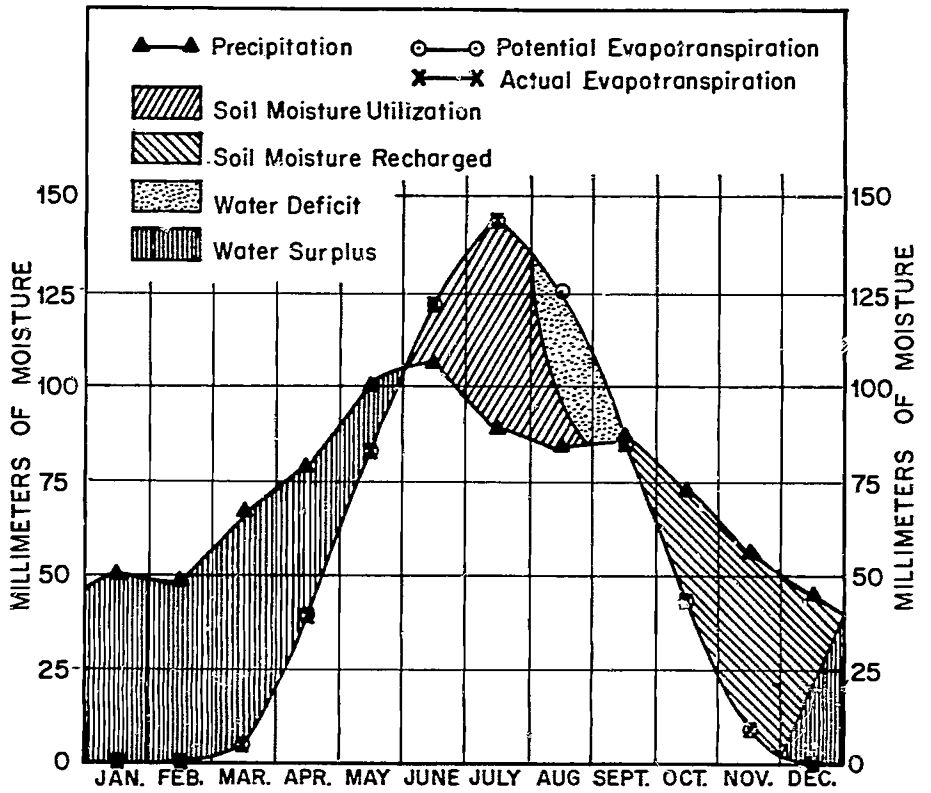
PASSAGE F

A study of the death rates of policy holders of a large life insurance company showed the following:

	Deaths per 100,000	
	1911	1957
Tuberculosis	224.6	6.7
Communicable Diseases of Childhood	58.9	.1
Cancer	69.3	136.2
Heart Disease	156.4	256.2

37. The study shows most clearly that
1 cancer of the lungs is increasing
2 people are living longer
3 children are safer from communicable diseases
4 better housing can reduce deaths from tuberculosis

Directions (38-41): Base your answers to questions 38-41 on the water budget diagram for Rockford, Illinois shown below. Write the *number* preceding the word or expression that best completes each statement or answers *each* question.



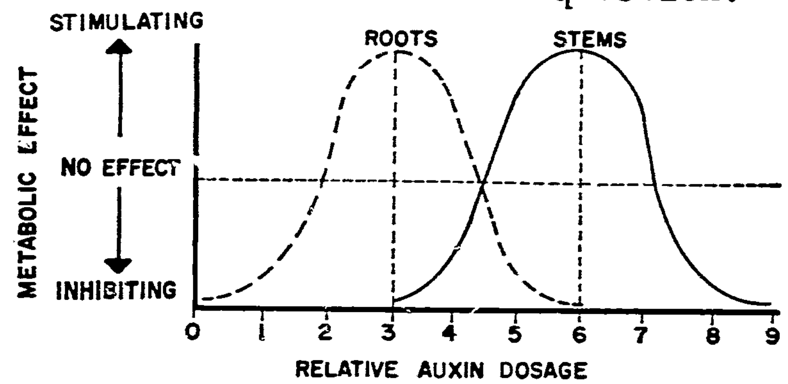
38. A water deficit occurred in Rockford, Illinois, during
    1 February   3 August
    2 June   4 December

39. During how many months of the year did Rockford have a water surplus?
    1 10   3 6
    2 8   4 4

40. During which month did the potential evapotranspiration equal the precipitation in Rockford?
    1 March   3 September
    2 January   4 November

41. During which month was the soil moisture recharge the greatest?
    1 December   3 October
    2 November   4 August

Directions (42-44): Base your answers to questions 42-44 on the graph shown below. Write the *number* preceding the word or expression that best completes each statement or answers *each* question.



42. According to the chart, a relative auxin dosage of about 4.5 has
    1 little effect of stimulation or inhibition upon either roots or stems
    2 a great inhibitive effect upon both roots and stems
    3 a great stimulative effect upon both roots and stems
    4 an inhibitive effect on roots and a stimulative effect on stems.

43. The graph indicates that the growth of both the roots and the stems of a plant is
    1 stimulated rather than inhibited during most of the life of the plant
    2 stimulated to abnormal growth by too much auxin and inhibited by too little auxin
    3 stimulated to abnormal growth by too little auxin and inhibited by too much auxin
    4 inhibited by either too much or too little auxin

44. Which relative auxin dosage is most effective in stimulating the growth of roots and at the same time inhibiting the growth of stems?
    1 1   3 3
    2 6   4 9

Directions (45-58): Below *each* of the following passages you will find one or more questions or incomplete statements about the passage. Each question or statement is followed by five words or expressions numbered 1 through 5. Select the word or expression that most satisfactorily completes *each in accordance with the meaning of the passage* and write its *number* in the space provided on the answer sheet.

PASSAGE G

In these lower and warmer latitudes the rate of melting just equalled the rate of advance. The ice front at such a time would appear stationary, but would actually be in a state of dynamic equilibrium where the motion forward was equalled by the melting backward. Under such conditions the load of debris which the ice carried would all be dumped at one place to form a large pile of till in the shape of an irregular, hummocky ridge, or terminal moraine. Such a pile would keep growing as long as ice was pushed forward to take the place of that which melted. The melt water from the glacier would only have one direction to go, away from the ice front, and as it streamed away it would carry a great deal of sand and gravel which it would spread out as an apron-like deposit, or outwash plain. The hilly northern side of Long Island which extends from Brooklyn to Montauk and Orient Points marks the southernmost limit in this area reached by the ice sheet. The land to the south of this moraine was never covered by ice. The flat plain which slopes very gently from the ridge area southward to the sea, is the outwash plain. It is composed primarily of layers of sand and gravel, the mud probably having been carried still further southward to lie beneath the present sea level.

45. During the Ice Age, a state of "dynamic equilibrium" existed when
 1 the debris carried by the ice was dumped
 2 the ice moved forward as fast as it was melted
 3 the forward movement of the ice sheet ceased
 4 the terminal moraine was reached by the ice sheet
 5 the glacial ice slowed down

46. The hilly northern side of Long Island was formed by
 1 the sand and gravel which form the outwash plain
 2 huge boulders of glacial ice
 3 upheavals caused by the warmer climate
 4 the steady forward movement of the terminal moraine
 5 the accumulation of rock fragments carried by the ice

47. Land that was never covered by the ice sheet will be found
 1 at Montauk and Orient Points
 2 on the southern shore of Long Island
 3 north of Long Island
 4 beneath the terminal moraine
 5 north of the outwash plain

48. As the water from the ice sheet melted, it
 1 flowed northward in only one direction
 2 carried sand and gravel, but not mud
 3 formed Montauk and Orient Points
 4 advanced at a rate equal to that of the ice sheet
 5 deposited sand and gravel south of the hummocky ridge

PASSAGE H

The fossil remains of an animal once common in Africa have now been found in Antarctica. Since the animal, the hippopotamus-like reptile called Lystrosaurus, could hardly have swum between the two continents, the discovery points to the probability that Africa and Antarctica once were joined together. In the larger context, this is one more piece of evidence in the massive collection of data from many fields supporting the general theory of continental drift, the notion that the seemingly solid and stable continents have really behaved over the eons like rafts floating in directions commanded by wind and wave.

Nothing less than a revolution in geological thinking is involved, along with striking vindication of the ideas of a German meteorologist, Alfred Wegener, whose pioneering notions were largely scoffed at up to the time of his death nearly a half-century ago. Initially impressed by the way the eastern coast of South America and the western coast of Africa seemed to fit into each other, he evolved the theory of Pangea, of the time when all the world's land formed one vast continent that eventually broke up into the present continents which drifted away from each other.

Later researchers found evidence suggesting two original supercontinents. One, Gondwanaland, consisted of what are now South America, Africa, India, Australia and Antarctica; the other, Laurasia, spawned North America, Greenland and Eurasia. But many scientists now believe that Gondwanaland and Laurasis were indeed once joined in a Pangea that began breaking up some 200,000,000 years ago.

Wegener, it now appears likely, did for geology what Copernicus did for astronomy, providing a pattern that brings order and understanding to a vast collection of seemingly unrelated facts.

49. In this passage the author's chief purpose is to:
   1 present facts
   2 disprove a theory
   3 give an opinion
   4 criticize a scientist
   5 support a hypothesis

50. Which of the following ideas is not presented by the author:
   1 continents can be moved by the wind
   2 the theory of Pangea was once ridiculed
   3 the theory of continental drift proves all continents are shifting westward
   4 Lystrosaurus was native to Africe and Antarctica
   5 Africa was once joined to South America

51. The main idea expressed in the passage is:
   1 Wegener's findings support the discoveries of Copernicus
   2 an authentic fossil is at least 200,000,000 years old
   3 prehistoric animals are proof of biological evolution
   4 fossils are found most frequently in cold climates
   5 present continents were once part of a single land mass

52. The theory of continental drift asserts that:
   1 Africa and Antartica were once joined together
   2 continents shift in position
   3 all the world's land was once a Pangea
   4 there were originally only two super continents
   5 astronomy has provided vital geological evidence

53. In the passage the author states that:
   1 the geological age of the earth is 2,300,000,000 years
   2 Wegener was born in Berlin, Germany
   3 Gondwanaland and Laurasia may once have been joined

4 South America is joined to North America by Central America
5 Copernicus discovered that the earth revolves around the sun

PASSAGE I

Catalysts resemble the "philosopher's stone," which ancient alchemists dreamed would transmute base metals into gold. Though catalysts cannot change one element into another, they do enable the modern chemist to create new materials by breaking up or rearranging the molecules of other.

Catalysts are somewhat mysterious agents, and it is only in recent years that the chemists have learned much about them. They remain mysterious to the layman because catalysis is not apparent in his everyday life.

For years industrial chemistry made use of many catalysts without completely understanding the nature of the reactions which took place. Today more than ten million tons of sulfuric acid are consumed annually in the United States. Most of this sulfuric acid is produced synthetically with the aid of a catalyst.

A catalyst of granulated iron oxide keeps whole populations from starvation, because it makes possible the synthesis of cheap ammonia. Ammonia is converted into the life-giving nitrate fertilizers.

Most housewives have used hardened vegetable oils as substitutes for lard. This big food industry became possible only when a nickle powder was developed as a catalyst which would cause solidfication of the liquid when hydrogen gas was blown into it.

DDT, the best known of the insecticides, is manufactured with the aid of an acid catalyst.

The petroleum industry is the largest user by far of industrial catalyst. Catalysts put the manufacture of high octane gasoline on a mass production basis. Catalytic reactions perfected in the petroleum industry have pushed back the frontiers of knowledge and revealed new possibilities for the exploitation of natural materials and the creation of synthetic substances.

54. The ideas of this passage are developed by
1 definitions
2 deductions
3 comparisons
4 contrasts
5 examples

55. Catalysts help chemical reactions by
1 changing one element into another
2 liquefying solids
3 rearranging molecules
4 creating new materials
5 using synthetic substances

56. The author feels that the process of catalysis is
1 obvious
2 mysterious
3 perfected
4 artificial
5 expensive

57. The word exploitation as used in the last sentence of the passage means
1 employment
2 saving
3 discovery
4 squandering
5 substitution

58. Catalysts are necessary
1 as substitutes for lard
2 to manufacture insecticides
3 in all chemical reactions
4 to mass produce high octane gasoline
5 to convert ammonia into fertilizer

ERIC

ANSWERS TO SAMPLE TEST QUESTIONS

Science

1.	(3)	16.	(1)	31.	(2)	46.	(5)
2.	(2)	17.	(2)	32.	(1)	47.	(2)
3.	(4)	18.	(5)	33.	(4)	48.	(5)
4.	(1)	19.	(3)	34.	(3)	49.	(5)
5.	(4)	20.	(2)	35.	(3)	50.	(3)
6.	(2)	21.	(4)	36.	(1)	51.	(5)
7.	(3)	22.	(4)	37.	(3)	52.	(2)
8.	(1)	23.	(1)	38.	(3)	53.	(3)
9.	(1)	24.	(4)	39.	(3)	54.	(5)
10.	(1)	25.	(3)	40.	(3)	55.	(3)
11.	(3)	26.	(3)	41.	(2)	56.	(2)
12.	(2)	27.	(3)	42.	(1)	57.	(1)
13.	(1)	28.	(1)	43.	(4)	58.	(4)
14.	(4)	29.	(3)	44.	(3)		
15.	(2)	30.	(4)	45.	(2)		

NOTATIONS OF THE INSTRUCTOR

Useful Instructional Materials - Annotated

TEXTBOOKS, WORKBOOKS, AND REVIEW BOOKS

Listed is a supplemental collection of textbooks, workbooks, and review books which may be used for study and reference along with pamphlets and other learning devices suitable for adult use in the high school equivalency program. No specific endorsement is intended for any of the items listed. Many publishers are willing to supply examination copies for interested teachers or directors. Annotations give some information on content and possible usefulness.

Concise course in general science. Cambridge.
Chapters on air, water, weather, electricity, and heredity.

Graphic survey of science. Keystone.
Core material of the ninth grade course. Sections on transportation, automobiles, appliances, and space travel. Many diagrams and exercises.

Handbook of basic science. Cambridge.
Easy reading on all phases of science. There are seventy-two chapters on earth science, life science, physical sciences. There are completion sentences at the end of each chapter for interpretation. A separate booklet of practice tests accompanies the handbook.

Introduction to general science. Cambridge.
Introductions to biology, human biology, earth science, and physical science. Each section has completion, multiple-choice, and essay questions.

Physical science, advanced series. Holt. (Holt adult basic education)
An exploration of physical science. Topics are drawn from the fields of chemistry and physics. Covers atomic theory, heat, light, sound, matter, energy, machines, measurement, and force.

Reading comprehension in the natural sciences. Cowles. (High school equivalency examination preparation series)
Stress is placed on reading for contextual meaning and toward acquisition of the special vocabulary for the sciences. There are practice reading passages and diagnostic tests.

Reading for comprehension, books 1 and 2. Cambridge.
Wide range of slow-to-average reading passages to help improve comprehension and speed. Book one has selections on poetry, social studies, science, and inventions. Book two has selections on nature.

Review text in general science. Amsco.
Designed to cover the science requirements in grades 7-9. There are ten chapters on the main course areas of energy, gravity, and magnetism, with illustrations and questions at the end. There is a section of final review questions.

Unit review of general science. Cambridge.
Covers biology, chemistry, physics, meteorology, oceanography, health, safety, automobiles, space, and science. Each chapter has illustrations as well as extensive completion tests and selection tests. There is a glossary of science terms and a biographical reference section on scientists.

Visualized general science. Keystone.
Essentials of general science for ninth grade students. Applies scientific principles to everyday facts. Visual material and exercises.

Work-a-text in earth science. Cambridge.
Material on geology, weather, space flight, oceanography, and meteorology. Easy to read and comprehend. There are review texts and activities.

Work-a-text in life science. Cambridge.
The introduction covers the tools and techniques of science. There are chapters on life activities of plants, animals, humans. Others deal with the changing world, ecology, and conservation.

Work-a-text in physical science. Cambridge.
A beginning, simplified course in chemistry and physics. There are review tests and activities.

PROGRAMED AND SELF-DIRECTED MATERIALS

Programed and self-directed materials may be particularly useful in High School Equivalency classes because they make it possible for the instructor to work efficiently with students of widely varying educational backgrounds and needs. The following is a partial listing of such materials that are currently available. No effort has been made by the Bureau to evaluate these materials. Inclusion here is not intended as an endorsement of any specific item on the list. Most publishers are willing to provide examination copies to interested directors and teachers upon request. The instructor will have to evaluate the materials he intends to use in the light of the particular needs of the individual students who are to use them. Annotations give some information on content and possible usefulness.

Be a better reader series, books 1-6. Prentice-Hall.
This series by Nila Banton Smith helps in improving basic reading skills and in developing special skills needed in reading science, mathematics, social studies and literature in junior and senior high school. There is practice in reading science diagrams and formulas.

Chemistry for junior high: TEMAC programed learning. Encyclopedia Britannica Press.
An introduction to chemistry for junior high school. Deals with states of matter, changes in matter, elements and compounds, the language of chemistry. Describes how to read and use the periodic table.

General science programed learning laboratory. Macmillan.
A teacher's guide and resource book is included with each programed text. The resource book enables the student to set his own pace and the teacher to assign individual work. Experiments and quiz questions are included. The six programs are: Motion, Force, Energy and Work, Simple Machines, Earth, Light: Flow and Energy.

General science series. Teaching Materials Corp.
Four volumes which may be used as programed texts for junior high and as review for senior high. Biology and Chemistry (TM401) is 2113 frames, 491 pages, with a study time of 15-25 hours. Measurement, Meteorology, and Astronomy (TM403) is 1916 frames, 450 pages, 18-20 hours. Sound, Light, Electricity, and Communications (TM404) is 1823 frames, 445 pages, study time 10-20 hours. Work and Machines (TT402) is 1200 frames, 278 pages, study time 8-15 hours.

Latitude and longitude. Coronet.
For grades 5-7.

Learning to learn. Harcourt.
Mature students may want to use section 4, Mastering the Content, How Learning Styles and Subject Requirements Differ, on science and mathematics.

Addresses of Publishers

Amsco School Publications, Inc.
315 Hudson St.
New York, N.Y. 10013

Cambridge Book Company, Inc.
45 Kraft Ave.
Bronxville, N.Y. 10708

Coronet Instructional Films
65 E. South Water St.
Chicago, Ill. 60601

Cowles Education Corp.
Look Building
488 Madison Ave.
New York, N.Y. 10022

Encyclopedia Britannica Press
425 North Michigan Ave.
Chicago, Ill. 60611

Harcourt, Brace & World, Inc.
757 Third Ave.
New York, N.Y. 10017

Holt, Rinehart & Winston, Inc.
383 Madison Ave.
New York, N.Y. 10017

Keystone Education Press
387 Park Ave., S.
New York, N.Y. 10036

Macmillan Co.
866 Third Ave.
New York, N.Y. 10022

Prentice-Hall Inc.
70 Fifth Ave.
New York, N.Y. 10011

Teaching Materials Corp.
Division of Grolier, Inc.
575 Lexington Ave.
New York, N.Y. 10022

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