DOCUMENT RESUME

ED 123 059 SE 020 407

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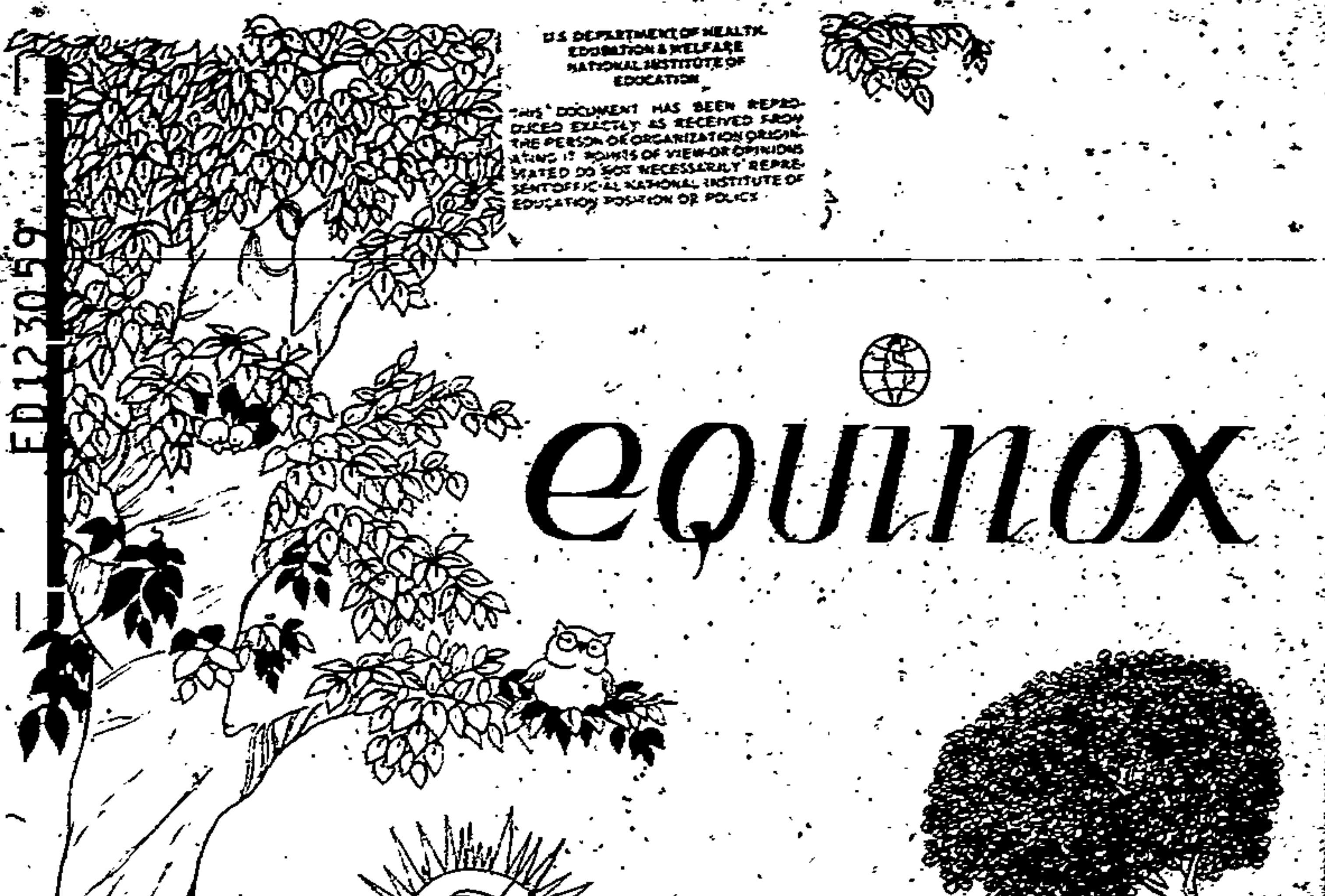
TITLE Equinox. A Model for the Natural Science Education Curriculum for the Ninth Through Twelfth Grades in the Delaware Schools.
INSTITUTION Delaware State Dept. of Public Instruction, Dover.; Del Mod System, Dover, Del.
SPONS AGENCY National Science Foundation, Washington, D.C.
PUB DATE Jan 75
GRANT NSF-GW-6703
NOTE 46p.; For related documents, see SE 019 380 and SE 020 404-406; Best Copy Available; Colored Paper
AVAILABLE FROM Mr. John F. Reiher, State Supervisor of Science and Environmental Education, Department of Public Instruction, John G. Townsend Building, Dover, Delaware 19901 (Free while supply lasts)

EDRS PRICE MF-$0.83 HC-$2.06 Plus Postage
DESCRIPTORS Biological Sciences; *Curriculum Guides; *Natural Sciences; Physical Sciences; *Science Education; *Secondary Education; *Secondary School Science; State Curriculum Guides; State Programs
IDENTIFIERS *Delaware; Del Mod System; National Science Foundation; NSF

ABSTRACT

This publication represents a model for the Natural Science Education Curriculum for grades nine through twelve in Delaware's schools. This guide is meant to serve as a minimal standard for natural science education, but at the same time strives for maximum output of the natural science program. The guide is based on the processes of science education as well as the concepts and attitudes of the biological, physical, and earth sciences. Four basic goals have been identified and a set of terminal objectives has been established for each goal. These goals and objectives provide the framework for the development of district, local, building, or classroom programs. The guide lists eleven major processes of science education, suggests ability levels, and identifies the six major concepts to be included in the natural science curriculum. The minimal objectives for the senior high school have been indicated. These objectives have been broken down by course area, i.e., earth science, physical science, biology, chemistry, and physics. The final section of this guide includes course requirements for science at the high school level, requirements for teaching science, and current educational philosophies that relate to the natural science educational program. (BT)

equinox



A MODEL FOR THE NATURAL SCIENCE EDUCATION CURRICULUM FOR THE NINTH THROUGH TWELFTH GRADES IN THE DELAWARE SCHOOLS.

EQUINOX

A MODEL FOR THE NATURAL SCIENCE EDUCATION CURRICULUM FOR THE NINTH THROUGH TWELFTH GRADES IN THE DELAWARE SCHOOLS.

Developed By

State Department of Public Instruction

in cooperation with

The Del Mod System

January 1, 1975

--Prepared By--

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Preparation of this monograph was supported by the National Science Foundation Grant No. G.W. 6703 to the Del Mod System, P.O. Box 192, Dover, Delaware 19901.

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PREFACE

The development of a scientifically aware generation will have a major impact upon the policies and the policy-making process of a democratic society. Citizens who know their long run. best interests are most likely to promote them through all the means at hand. Being aware is only the beginning. Once a society perceives a need and sets objectives. it then moves to allocate its available resources to the priorities indicated by the goals and objectives. As every elementary economic student knows. the basic resources of the society are natural resources, capital. and human resources. In an earlier age natural resources determined a society's wealth and welfare. especially in the fertility of its soil. Consequently. though natural resources never last their. importance. capital resources: the technology to expand man's. projectivity. rose to prominence.

Now we appear to be entering an age when human resources will dominate. It is a time when the most critical problems of society do not lend themselves to attack based on land. new materials, or machines. The primary tools of this society are the talents and skills of its people. Whatever its problems. the search for peace. the abolition of poverty. the prevention and cure of disease. the reduction of crime or the control of environmental quality. the solutions depend upon dedicated. talented. and well-trained people who understand and who can intelligently use whatever technological tools are available. It is the growing awareness of this new dependency that has pushed the United States economy into an educational investment which has expanded from $6 billion to $65 billion in 25 years. It is the same phenomenon which underlines the emergence of remedial man-power programs to assist those unable to compete successfully in the more sophisticated labor markets. It is the same awareness which has forced us to take a closer look as to what is currently happening in our educational programs and for us particularly the science education program.

Although science education has enjoyed a strong position in the educational hierarchy. little emphasis has been placed on the application of science to society. The major thrust in education today is "career education". As career education is considered as an inter-disciplinary activity. science is often excluded because "science teachers are so busy teaching subject matter they cannot relate to the processes of science and how science applied to the world of work".

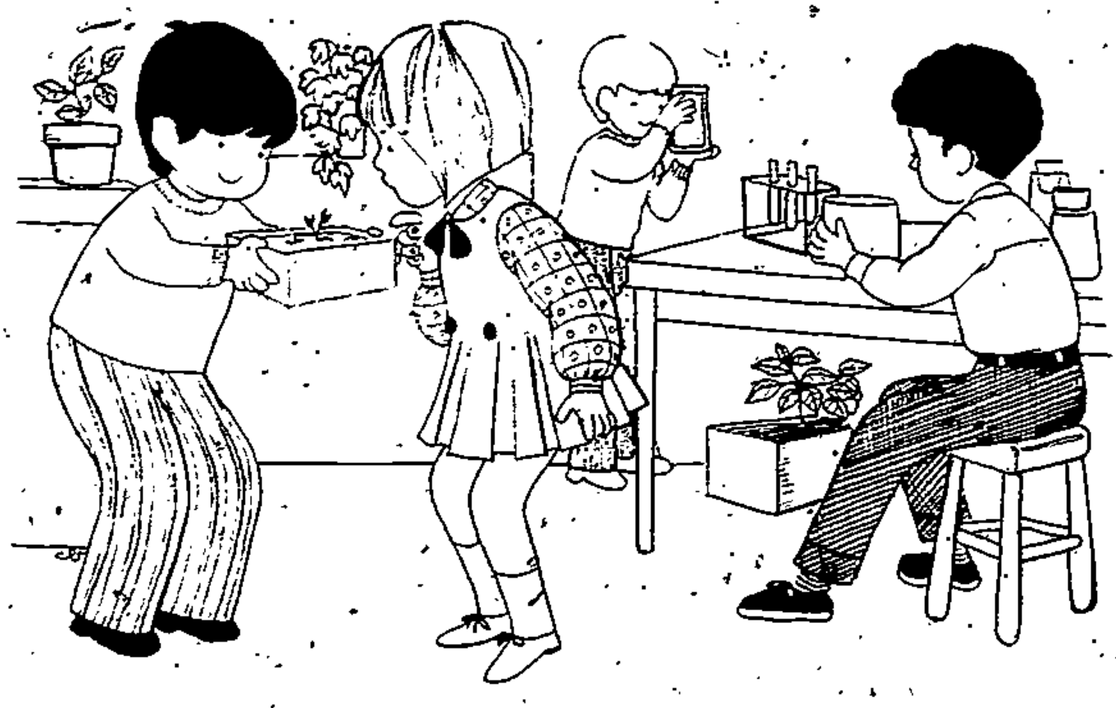
This reaction is unfortunate and highly inaccurate. because any competent science teacher is constantly attempting to make subject matter relavant and pertinent and what better way to make it more meaningful than to relate it to the world of work. If career education is education for a living. then science might rightfully be considered as the prime essential of life. thus, science career education must therefore be a very practical kind of education. How can science teachers continue to teach in ways which fail to bring practicality into science education?

All too often science students ask "Why do I have to learn that? I don't need it." This is especially true of terminal students who need to be better prepared for the cold hard world in which they will suddenly sooner or later be thrust. It is also true in many cases of college-bound students who consider science as a foundational course material. Many science educators are constantly and diligently seeking innovating ideas to teaching the subject matter. Unfortunately. their efforts are focused on the subject matter or course content rather than on the students. It is better if they seek ways to stimulate the students in their desire to learn. We contend that if teachers would make existing programs relevant, then students would act positively How does one make a science relevant for the non-academic student when it is difficult enough to maintain the interest of those who may need or want the science courses. but to those who neither want or need it. is is almost impossible.

Science instruction as related to the career education philosophy becomes the answer to many of the problems in teaching today. It is an excellent way to make science relevant. practical. and interesting. It can stimulate the terminal student because he can make use of it without the need of detailed theory. By the same token, it can be used to teach theory and principles to academic students so that it may be understood easily and applied immediately.

In this approach natural science instruction is and must be focused on the student. One of the major goals in science teaching is to have the student develop the process of making decisions. There are invariably rights and wrongs when it comes to making decisions but as citizens we must make decisions. There may well be no real right or wrong for the simple reason that the product must suit the needs of the buyer. These needs may well vary from one individual to another. What might be emphasized in career science is how to evaluate products in light of needs. The goal should be to investigate awareness and relate to self through logical principles of evaluation. Here every person uses the so-called scientific method without really being aware of it for what it is.

We have provided this guide to assist the teachers of natural science, grades K-12, by providing the framework for the development of their local district, building, and classroom program. This should also serve as the framework for the pre-service and in-service training of teachers by the higher education institutions.



THE REASON FOR NATURAL SCIENCE EDUCATION

The purpose of the natural science education program for Delaware's students is to lead to the sequential development of a scientifically literate person. Although this is considered to be the central purpose of natural science education, a single or "best way" of pursuing this goal cannot be specified. The diverse nature of schools, students, and teachers necessitates a variety of programs and approaches.

***To develop a scientifically literate citizenry, the State Board of Education recommends that:

*every student K-12 have an opportunity for many natural science experiences every year.

*that the K-12 natural science experience takes into consideration individual differences of students and reflects the students' emotional, ethnic, moral, geographical, and economic background.

*every teacher of natural science be supplied with adequate facilities, equipment, supplies, and the time to utilize these at the various grade levels of the student.

*that natural science be presented as a unified discipline, integrated and coordinated with other disciplines, such as mathematics, social science, economics, political science, reading, and communication skills.

*increasing emphasis be placed on science processes, conceptional schemes and values, and less emphasis on factual information.

*direct experiences with the natural world or in laboratory (hands on) activities should comprise the major portion of the science program.

*textbooks should facilitate inquiry, rather than being written to replace laboratory (hands on) experiences. The use of recorded material (other media as well as printed material) should be integral parts and dependent upon laboratory experiences. (The materials used will not discriminate against the ethnic, moral, geographical, or sexual background of students.)

*natural science education programs include environmental education that interrelates natural phenomena, environmental influences, science, technology, social implications of science and technology, and economic considerations.

*natural science education programs incorporate the philosophy of career education, emergency preparedness, health (drug and sex) education, but this is not the sole curricular area responsible for these philosophies.

*opportunities for the professional growth of teachers of natural science be considered an integral part of natural science education programs so that teacher's own deeper insights can be brought to bear on the science programs designed for scientific literacy.

*the achievement of scientific literacy should be the basis for setting objectives; for selecting content, learning experiences, methodology, and for developing a system of evaluation.

This guide is meant to serve as a minimal standard for natural science education but at the same time strive for maximum output of the natural science program. The guide is based on the processes of science education as well as the concepts, and attitudes with terminal objectives in areas of the biological, physical, and earth sciences, at the learning levels of K-1, 2-4, 5-8, and 9-12. These are not the day-by-day activities or materials to be used in the accomplishment of the terminal objectives. The development of this aspect of the curriculum is the responsibility of the classroom teacher, students, and coordinated by the building or district curriculm specialists and the State Department of Public Instruction.

PHILOSOPHY OF NATURAL SCIENCE EDUCATION FOR DELAWARE'S SCHOOLS

When a student completes his experience in Delaware's schools, he should have reached a level of proficiency in these four basic goals.

1. Attitude Goal: To develop those values, aspirations, and attitudes which underlie the personal involvement of the individual with his environment and with mankind.

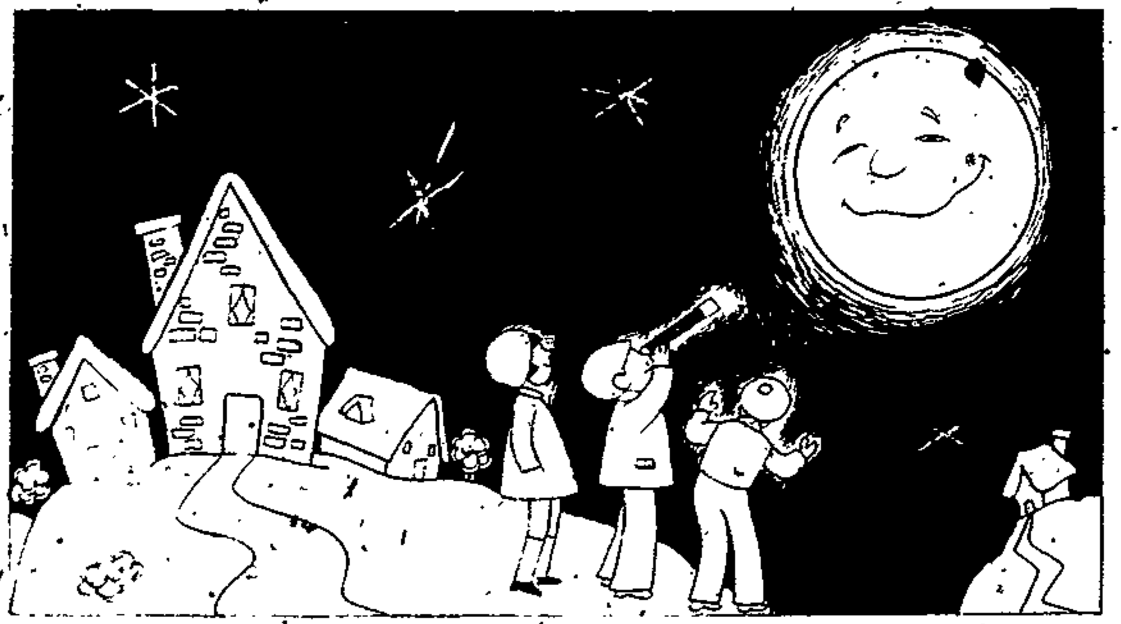
2. Rational Thinking Goal: To develop the rational thinking processes which underlie scientific modes of inquiry.

3. Skills Goal: To develop fundamental skills in manipulating materials and equipment and in gathering, organizing, and communicating scientific information.

4. Knowledge Goal: To develop knowledge of specifics, processes, concepts, generalizations, and unifying principles, which lead to further interpretation and diction of objects and events in the natural environment.

In order to attain these goals, a set of terminal objectives have been established. Each terminal objective is a culmination of a student's science achievement from kindergarten through his high school experience.

The following pages identify the four basic goals and their terminal objectives to serve as a framework for the development of your science program.



ATTITUDE GOAL:

To develop those values, aspirations, and attitudes which underlie the personal involvement of the individual with his environment and with mankind.

The student has a critical attitude toward unsupported inferences, hypotheses, and theories.

The student is intrigued by objects and events in his environment.

The student appreciates the interrelatedness of science, technology, and society.

The student willingly subjects his data and ideas to the criticism of his peers.

The student is aware of and responds in a positive manner to beauty and orderliness in his environment.

The student conducts and reports the results of his scientific investigations in an honest and objective manner.

The student recognizes the limitations of scientific modes of inquiry and the need for additional, quite different approaches to the quest for reality.

The student habitually applies rational and creative thinking processes when attempting to explain discrepant events, when trying to find relationships among seemingly unrelated phenomena and when seeking solutions to science-based problems.

RATIONAL THINKING GOAL

To develop the rational thinking processes which underlie scientific modes of inquiry.

The student formulates tentative statements (inferences, hypotheses, theoretical models) to identify and explain natural phenomena.

The student draws inferences from data and distinguishes between empirical data and inferences.

The student formulates and tests predictions derived from inferences, hypotheses, graphic, and theoretical models.

The student identifies the variables which may materially influence a given interaction in a system and find ways to control and manipulate the identified variables.

The student generates relevant data to verify or define inferences, hypotheses, and theoretical models.

The student senses the existence of discrepant events and problems which arise when he is investigating natural phenomena.

The student uses the processes described under this goal, requisite, manipulative, and communication skills and attitudes, and his functional understanding of the concept(s) involved to design, carry out, and report the findings of an experiment.

The student selects criteria for and develops classification systems and uses his systems and those of others to classify given objects and events.

The student communicates with others, orally and in writing, in a manner that is consistent with his knowledge of scientific conventions and that facilitates the learning of his readers or listeners.

The student records observations accurately and organizes data and ideas in ways that enhance their usefulness.

SKILLS GOAL

To develop fundamental skills in manipulating materials and equipment, and in gathering, communicating, and organizing scientific information.

The student gathers descriptive and quantitative information needed for developing or testing inferences and hypotheses by means of purposeful, objective observations of things and events.

The student constructs and handles laboratory apparatus in a skillful manner, giving due attention to accident prevention.

The student gathers needed data, which have been generated by others from a variety of sources.

KNOWLEDGE GOAL

To develop knowledge of specifics, processes, concepts, generalizations, and unifying principles, which lead to further interpretation and diction of objects and events in the natural environment.

The student demonstrates a knowledge of specifics – facts, convention, sequences, classifications, and criteria.

The student demonstrates a knowledge of the relationships between science and society.

The student demonstrates a knowledge of concepts, generalizations, and unifying principles.

The student knows the major processes and procedures which are employed in scientific inquiry.

PROCESSES OF SCIENCE EDUCATION

In order to determine the level of achievement of students in Delaware's public schools, a set of minimum objectives has been established. Each of these objectives is based on one or more processes that give a definite indication of a student's progress.

PROCESS ➡ OBJECTIVE

Following is a list of the eleven major processes that have been identified which includes the great majority of student activities that are appropriate for K-12 school experiences. Along with the term associated with each process is a short descriptive paragraph to help clarify the intended meaning of the terms.

These processes are not listed to imply use of the program, Science. A Process Approach (AAAS), but are the processes used for any natural science or environmental education program.

PROCESS - Observing

Observations can be made in a variety of ways using all of the senses. Where direct sense experience is not adequate for making needed observations, indirect methods are used. Objects and events may be observed with respect to many qualities and quantities. When observations are made to accumulate data from which inferences will be drawn, the precision of the observations is critical. Precision is often improved by making quantitative observations. Observations are influenced by the experience of the observer.

PROCESS - Classifying

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

PROCESS - Inferring

Inference, while based on observations, requires evaluation and judgment. Inferences based upon one set of observations may suggest further observation which in turn requires modification of original inferences. Inference leads to prediction.

PROCESS - Predicting

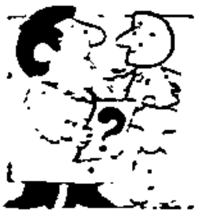
Prediction is the formulation of an expected result based on past experience. The reliability of prediction depends upon the accuracy of past observations and upon the nature of the event being predicted. Prediction is based upon influence. Progressive series of observations and, in particular, graphs are important tools of prediction in science. An experiment can verify or contradict a prediction.

PROCESS - Measuring

Measuring properties of objects and events can be accomplished by direct comparison or by indirect comparison with arbitrary units which, for purposes of communication, may be standardized. Identifiable characteristics which can be measured may be interrelated to provide other quantitative values that are valuable in the description of physical phenomena.

PROCESS - Communicating

In order to communicate observations, accurate records must be kept which can be submitted for checking and rechecking by others. Accumulated records and their analysis may be represented in many ways. Graphical representations are often used since they are clear, concise, and meaningful. Complete and understandable experimental reports are essential to scientific communication.



PROCESS - Interpreting Data

Interpreting data requires the application of other basic process skills -- in particular, the processes of inferring, predicting, classifying, and communicating. It is through this complex process that the usefulness of data is determined in answering the question being investigated. Interpretations are always subject to revision in the light of new or more refined data.

PROCESS - Making Operational Definitions

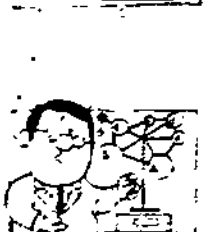
Operational definitions are made in order to simplify communication concerning phenomena being investigated. In making such definitions it is necessary to give the minimum amount of information needed to differentiate that which is being defined from other similar phenomena. Operational definitions may be based upon the observable characteristics of the phenomena and upon the operations to be performed. Operatonal definitions are precise and, in some cases, based upon mathematical relationships.

PROCESS - Formulating Questions and Hypotheses

Questions are formed on the basis of observations made and usually precede an attempt to evaluate a situation or event. Questions, when precisely stated, are problems to be solved through application of the other process of science. The attempt to answer one question may generate other questions. The formulation of hypotheses depends directly upon questions, inferences, and predictions. The process consists of devising a statement which can be tested by experiment. When more than one hypothesis is suggested by a set of observations, each must be stated separately. A workable hypothesis is stated in such a way that, upon testing, its credibility may be established.

PROCESS - Experimenting

Experimenting is the process of designing data-gathering procedures as well as the process of gathering data for the purpose of testing a hypothesis. In a less formal sense, experiments may be conducted simply to make observations. However, even here there is a plan to relate cause-and-effect. In an experiment, variables must be identified and controlled as much as possible. An experimental test of a hypothesis is designed to indicate whether the hypothesis is to be accepted, modified, or rejected. In designing an experiment, limitations of method and apparatus must be considered.



PROCESS - Formulating Models

Models, whether physical or mental, are devised on the basis of acceptable hypothesis or hypothesis that have yet to be tested. Models are used to describe and explain the interrelationships of ideas. In many cases the model implies new hypothesis, if testing these hypothesis results in new information, the model must be altered to include it.

Each of these processes have different levels of difficulty that are based on the age and ability levels of a particular student. With this in mind, the following are the minimum acceptable proficiency levels for students completing the grade levels covered by this guide in a Delaware school.

PROCESS ABILITY LEVELS

MINIMUM STANDARDS AT THE COMPLETION OF THE SCHOOL EXPERIENCE

Observing

Identifying changes in properties and measuring rates of change.
Differentiating constants from variables.
Identifying correlational changes in variables.

Classifying

Setting limits as a means of grouping on the basis of a continuous variable.
Developing classificational schemes of two or more stages of sub-sets having mutually exclusive categories.
Using an accepted classificational system or key to identify objects or phenomena.
Using characteristics observed under imposed conditions as a basis for grouping

Inferring

Stating cause-and-effect relationships from observation of related events.
Identifying limitations of inferences.
Modifying and extending inferences to include discrepant events.
Developing plans to test the validity of inferences.
Using inferences to suggest further observation.
Extending inferences to formulate models.

Predicting

Limiting variation in conditions affecting prior observations in order to improve the accuracy of predictions.
Demonstrating the accuracy of predictions in order to establish the validity of previously held concepts upon which the predictions are based.
Using interpolation and extrapolation as a means for making predictions. Establishing criteria for stating confidence in predictions.

Measuring

Identifying measurable physical quantities which can be used in precise description of phenomena.
Measuring quantities which depend upon more than one variable.
Using and devising indirect means to measure quantities.
Using methods of estimation to measure quantities.

Communicating

Stating questions and hypothesis concisely without ambiguity.
Constructing tables and graphs to communicate data.
Planning for communication of procedures and results as an essential part of an experiment.
Reporting experimental procedures in a form so other persons can replicate the experiment.
Using mathematical analysis to describe interpretations of data to others.
Using tables and graphs to convey possible interpretations of finite data.

Interpreting Data

Describing information as it is displayed on tables or graphs.
Making and explaining inferences from tables or graphs.
Setting criteria for assessing the validity, precision, and usefulness of data.
Comparing sets of related data to test the credibility of inferences and generalizations.
Selecting the most acceptable interpretation from multiple interpretations of the same set of data.
Determining estimated values of statistics from sample data and evaluating probable errors.
Stating criteria for restricting inferences and generalizations to those inferences and generalizations supported by data.

Making Operational Definitions

Stating minimal observable characteristics required for an operational definition.
Establishing the criteria for operational definitions according to the use intended for the definitions.
Evaluating the suitability of operational definitions.
Describing the limitations of operational definitions.
Using mathematical relationships in making operational definitions.
Formulating operational definitions of experimental parameters such as system boundaries, data gathering procedures and interactions of variables.

Formulating Questions and Hypotheses

Separating broad questions into parts which, when answered, will contribute to a comprehensive explanation.
Asking questions or stating simple hypotheses which can be tested.
Stating hypotheses in forms which suggest the variable to be manipulated.
Differentiating between hypotheses which must be tested qualitatively and those which can be tested quantitatively.
Stating negative hypotheses in an attempt to eliminate variables.

Experimenting

Identifying relevant variables in an experimental situation.
Maintaining an accurate record of experimental procedures and results.
Controlling those variables not a part of the hypothesis being tested.
Identifying sources of experimental error.
Describing the limitations of experimental apparatus.
Describing the limitations of the experimental design.

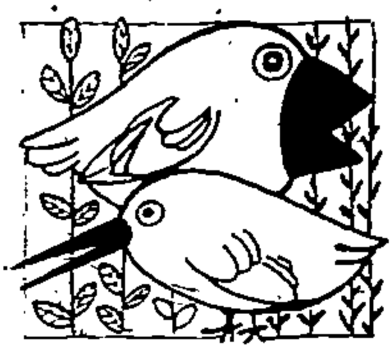
Formulating Models

Constructing a physical representation, a drawing, or a mental image to explain observed phenomena.
Extending physical or mental models to include related phenomena.
Modifying existing models to include new observations.
Formulating physical or mental models idealizing observed conditions in order to minimize variations
Devising tests for the credibility of an existing model.
Stating limitations for models.

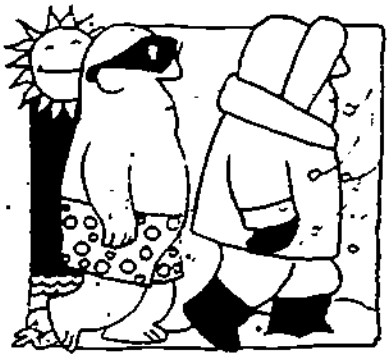
CONCEPTS OF SCIENCE EDUCATION

Concept ➡ Process ➡ Objective

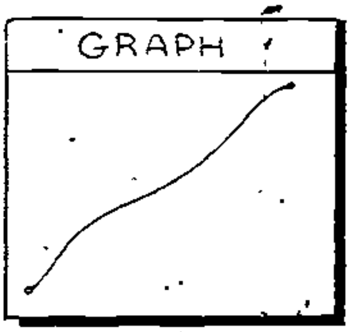
Moving up the ladder each process is based on a conceptual scheme, thus allowing each objective to be developed under the concepts. Six major concepts have been identified for inclusion in the natural science curriculum in Delaware's K-12 schools. These concepts are defined as follows.



Diversity: The vast number of natural phenomena which can be observed display a wide variety of similarities and differences.

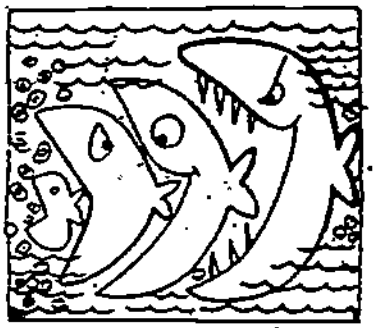


Change. Our environment, living and nonliving, microscopic and macroscopic, is constantly undergoing change.



Continuity: There is constancy in cause-and-effect relationships which precludes any abrupt reversal in natural phenomena.

Interaction. The interactions of living and nonliving matter in an environment and the resulting change of energy determine the nature of the environment.



Organization. Systematic relationships exist in natural phenomena. Systems within systems comprise the universe.

Limitation. Natural phenomena are limited by the fundamental nature of matter and energy There is an overall tendency toward equilibrium in an environment.

Curriculum Area ➡ Concept ➡ Process ➡ Objective

Environmental education is not a separate content area of the natural science programs, it is part of the biological, physical, and earth sciences, with implications for the social sciences.

GOALS & TERMINAL OBJECTIVES

↓

CURRICULUM AREA

↓

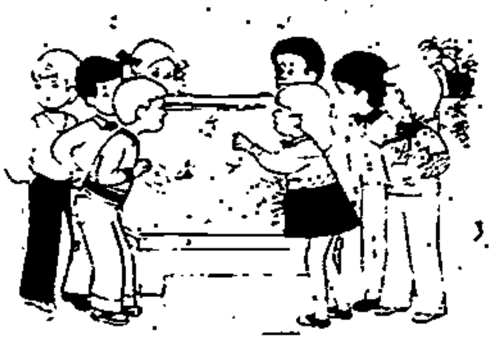
CONCEPT

↓

PROCESS

↓

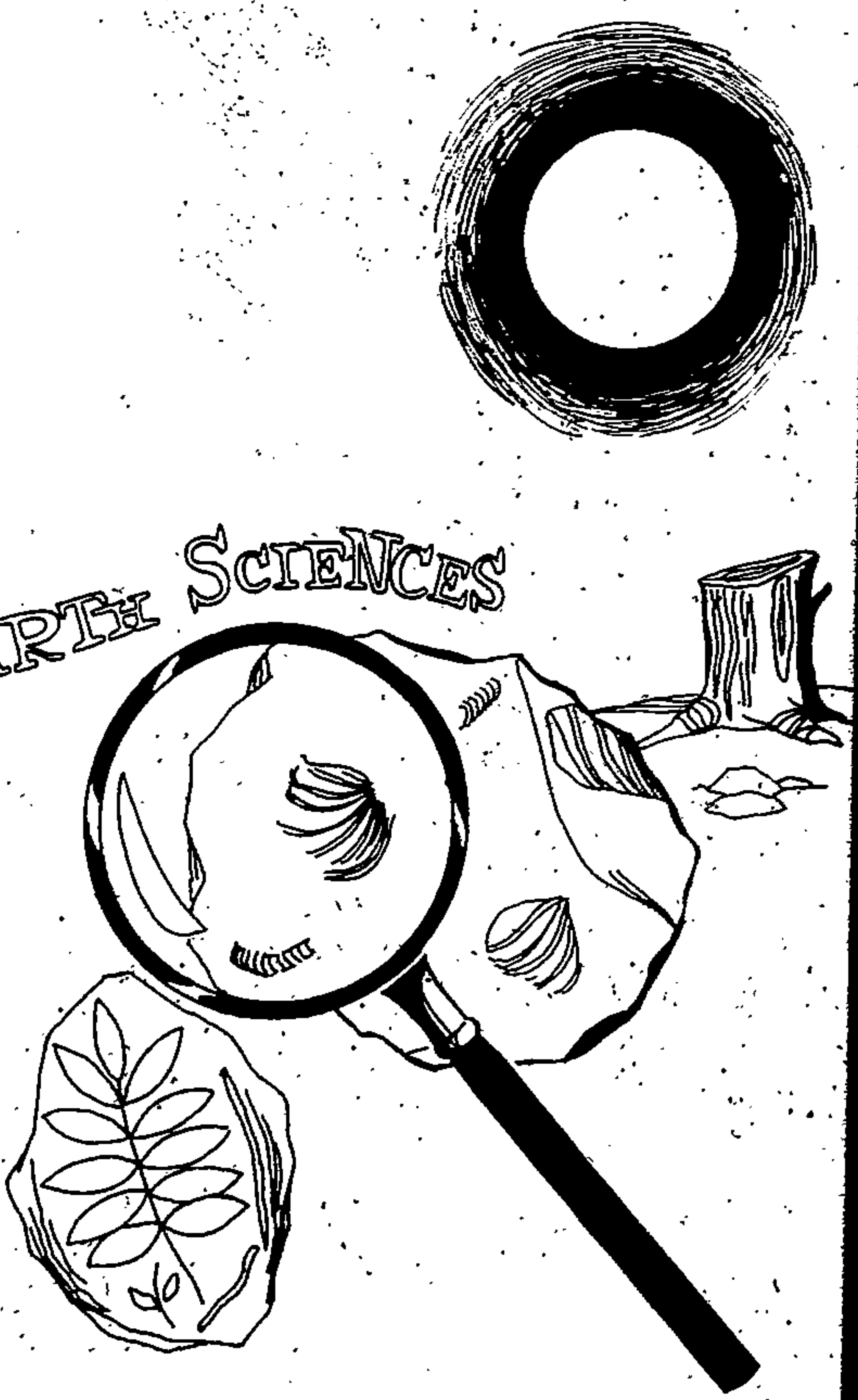
OBJECTIVE



When all this is completed, and the basic objective achieved, the student is then on his way to reaching the long range goals and terminal objectives that should be achieved before graduation.

On the following pages minimal objectives for the senior high school curriculum have been indicated. These objectives have been broken down by course area, i. e. earth science, physical science, biology, chemistry and physics. It should be stressed that these are minimal objectives. However, these objectives should serve as a guide for course development and updating courses precently being taught.

EARTH SCIENCES



EARTH SCIENCE OBJECTIVES

Describe the general conversion of one form of energy to another.

Trace solar energy through its various changes.

Illustrate by using natural examples:
How energy may flow or be stored.
How energy may be transferred or transformed.

Explain why a frame of reference is important in describing the motion (or rest state) of an object.

Describe experiments that support the concepts that:
The earth rotates on an axis.
The earth revolves around the sun.

Cite examples of the relationship among time of day, seasons, and the motion of the earth.

Describe in the student's own words theories for the origin of the solar system and identify at least one major flaw in each.

Describe methods that can be used to find the shape, size, density, etc. of the earth.

Describe some general physical characteristics of the atmosphere, hydrosphere, and lithosphere.

Discuss the relative importance of several common elements of each sphere in terms of abundance and chemical activity.

List the elements that occur in abundance in all three spheres.

Explain the theory for origin of the sun's energy.

Correlate unequal heating, gravitation, and rotation with unequal pressure distribution and convective circulation in the atmosphere.

Describe the effect of in-coming solar energy on the development of the general structure of the atmosphere.

Relate the properties of a gas in terms of temperature, pressure, and volume.

Describe and give examples of moisture (water) in the atmosphere.

Describe, in the students own words, how the lower part of the atmosphere produces the "greenhouse effect".

Relate changes in temperature, pressure, and volume to the production of pressure cells.

Define operationally warm and cold fronts in terms of air-mass movement.

Discuss how geographic location, topography, nearby water, population center, etc. will influence local weather.

Make a 12, 24 and 36 hour weather prediction for his school's locality from weather maps for successive days.

Explain several ways by which waves and currents are generated at or near the hydrosphere-atmosphere boundaries.

Discuss, in his own words, the formation of tides.

Trace the major oceanic circulation patterns on a map of the world.

Describe the major topographic features of continental shelves, continental slope and ocean basins, and suggest hypotheses concerning their origin.

List shoreline features and correlate the production of these features with wave and current activity in shallow water along The Delaware Coastline.

Identify several unfamiliar minerals with an appropriate mineral key.

Identify textural, and compositional features in hand specimens of common rocks.

Explain the origin of metamorphic rocks by discussing the temperature and pressure conditions that may be inferred at increasing depths within the earth's crust.

Describe the environments where sediments may accumulate and how sedimentary rocks are formed.

Trace a particle of matter through the rock-cycle along various paths it may take.

Illustrate with example how geologic processes tend toward an equillibrium state as the earth's surface is modified.

Relate the origin of sedimentary rocks to weathering, mass movement and erosion.

Describe in the students own words how & why an earthquake occurs.

Explain how earthquake (seismic) wave data are used to postulate the general interior structure of the earth.

Cite evidence and explain uplift (emergence) and subsidence (submergence) of crustal blocks not necessarily associated with geosyncline mountains.

Locate the major earthquake and volcanic areas on a map of the world (past and present) and identify areas where future activity might be predictable.

Explain radioactive decay and how it may be used to measure geologic time intervals.

Demonstrate a familiarity with the Geologic Time Scale.

Cite fossil evidence to support the theory that organisms have evolved from simple to more complex forms.

Illustrate by example the use of fossils as tools in interpreting earth history.

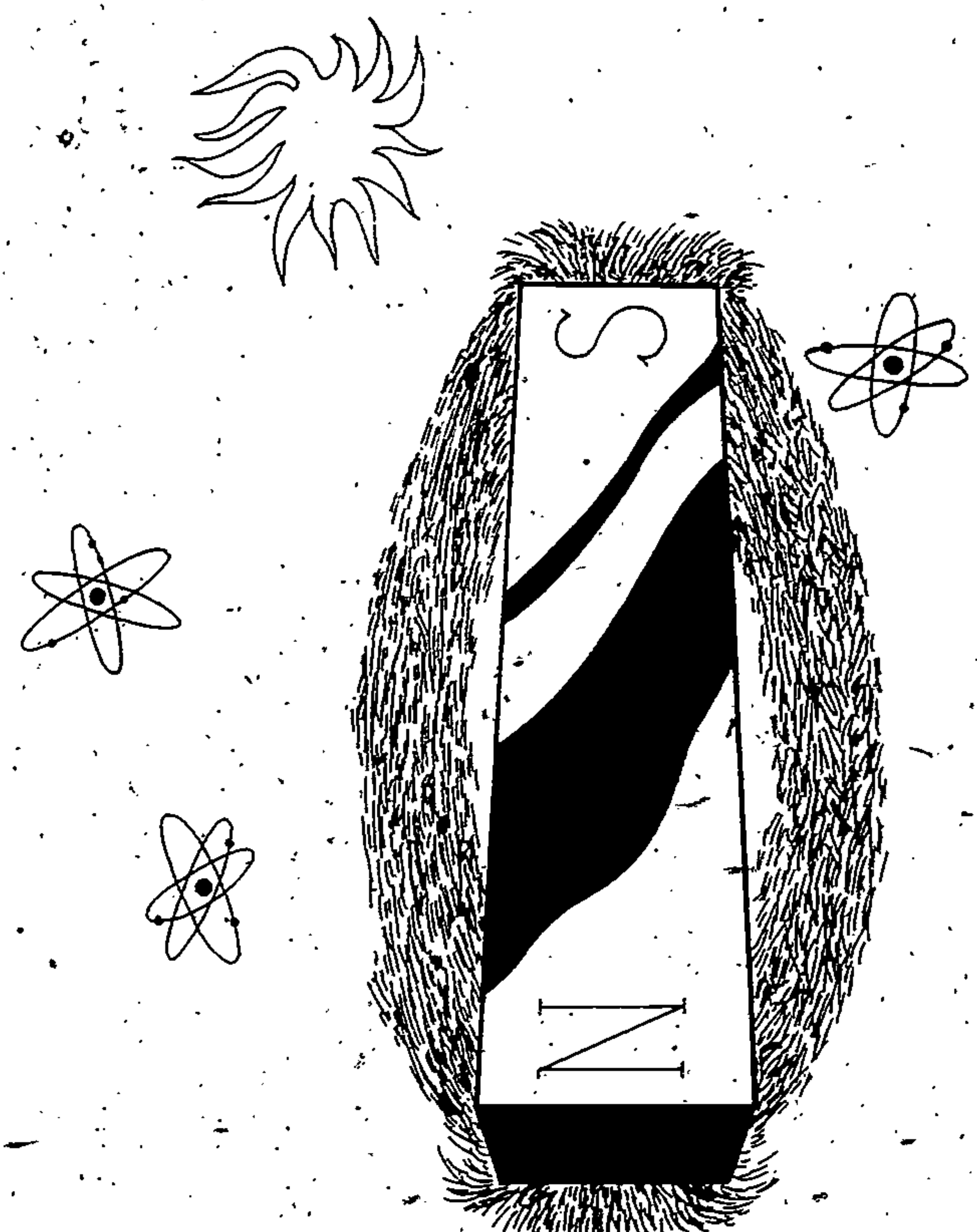
Predict what changes in the earth mean annual temperature may occur (remember the greenhouse effect) and how these changes may affect the natural environment if man's activity constantly increases the abundance of carbon dioxide and dust in the atmosphere.

Distinguish between renewable and non-renewable mineral resources (giving examples of each) and suggest things that may be done to increase man's use of some non-renewable mineral resources after these resources have been used in manufacturing.

Construct hypotheses concerning the possible effects on future changes in the earth's surface of such technological application as damming waterways (both small and large) and underground nuclear explosions, etc.

Demonstrate his knowledge of the earth's position relative to the rest of the solar system and utilize this information to compare and contrast characteristics of the planets.

Identify physical features on the surface of the earth using a i r e a l photography.



PHYSICAL SCIENCES

PHYSICAL SCIENCE OBJECTIVES

Add, subtract, multiply and divide (in base 10) numbers up to three digits.

Translate a word description of a mathematical relationship into mathematical sentence.

Translate a mathematical equation into words.

State whether a given metric measurement is a measurement of mass, volume, or length.

Use correct units with both measured and calculated quantities.

Defend the need for standarized units of measurement.

Convert units within a measurement system such as MKS (meter, kilogram, second).

Convert units in the MKS (meter, kilogram, second) system to units in the CGS (centimeter, gram, second) system and vice versa.

Measure and record time in standarized units.

Determine and record the temperature of a liquid.

Construct a demonstration to distinguish between heat and temperature.

Identify common laboratory apparatus by name.

Use a double pan or triple beam balance to determine the mass of a sample of any solid or liquid taking proper precaution so that the balance is not damaged, none of the sample is lost and the sample is not contaminated. The value reported should be correct within the limits of the precision of the balance used.

Insert a glass tube into a rubber stopper demonstrating ability to use a lubricant and protect himself from possible injury by broken glass.

Heat a liquid in a test tube safely to boiling without any overflow of the liquid.

Read the volume of a liquid in a graduated cylinder and/or a buret and record the measurements.

Use a bulb and pipette to transfer a specified quantity of liquid from a stock bottle to a beaker with an accuracy of 0.1 ml.

Light a bunsen burner and adjust the flame approximately to achieve the desired use.

Use a mercury barometer to measure atmosphere pressure to the nearest millimeter of Hg, convert the reading to normal units of pressure and correctly describe a rationale for accepting this length of a column of Hg as a measure of atmospheric pressure.

Construct an electrical circuit consisting of a power supply (or chemical cell) a switch, a resistance (or chemical cell), a volt meter and an ammeter and determine the voltage and current in the circuit.

Identify those observations that are necessary and sufficient to identify an object or class of objects uniquely.

In a labratory situation find the density of a given sample of a solid, liquid or gas.

Describe properties e.g. density, melting point, boiling point, heat of fusion, heat of vaporization, specific heat, solubility.

Describe a test which would help determine whether a sample of a material that appears to be uniform in composition is a single substance (a free element or compound) or a mixture.

Use a standard reference to locate information such as: (a) the density of an element or compound, (b) the specific heat of an element or compound, (c) the heat of formation of a compound, and (d) the vapor pressure of water as a function of temperature.

Translate a chemical equation into an ordinary English sentence, using only common substances.

Construct a table of data from a graph of the data and a graph from a table of data.

From experimental data for some variable which is a function of another variable, establish a suitable scale, locate points on a graph for each ordered pair and draw a "best fit" curve for the data.

Construct a short word statement to describe what a table or graph communicates about the responses of one variable to the manipulated variable.

Apply rules for interpolation or extrapolation to predict from a graph.

Construct a frequency distribution for a set of observations.

Identify the name of the variable that should be held constant, the one that should be manipulated and the one that will respond to that manipulation in a test of an hypothesis.

State the problem to be researched in researchable terms.

Identify the elements of a problem on which a hypotheses could be based.

Generate hypotheses about the critical element in the problem.

Plan to test hypotheses on the basis of: (1) identifying all the variables possible, (2) selecting a variable to be studied, (3) establishing a proper control, (4) planning for replication, (5) planning systematic observation of descriptive data, (6) identifying sources of error such as measurement, computation tools, instrumentation, etc. and (7) planning a system for processing the data to make it ready for interpretation.

Execute the plan of investigation by (1) collecting, organizing, and analyzing data, (2) presenting findings, (3) using tools properly, (4) recording data accurately indicating the degree of uncertainty, (5) reviewing tools and procedures used and (6) revising procedures where indicated by results.

Evaluate reports of a current social issue of the nature suggested above to determine whether the industry, the public or both have fulfilled their respective ethical responsibilities.

Provide at least one historical example to show the influence that scientific development has had on social thought and/or action.

Provide at least one historical example to show the influence (either positive or negative) that society as a whole has had on scientific development.

Demonstrate a concern or an intellectual interest in scientific development by any combination of activities such as the following: (a) reading science related books or articles which are not required reading, (b) participating in science fairs or development of nature trails, (c) visiting a science museum or science lecture and (d) applying scientific thought to a real problem facing him.


BIOLOGY

Identify by name and function the major structures that constitute plant cells (cell wall, cell membrane, nucleus, chloroplast, vacuole, mitochondria, ribosome, endoplasmic reticulum).

Identify by name and function the major structures that constitute animal cells (cell membrane, nucleus, vacuoles, mitochondria, ribosomes, endoplasmic reticulum, centrisome).

Relate the structure and function of the highly specialized cells. muscle cells, nerve cells, epidermal cells in leaves, red blood cess, white blood cells, and xylem cells.

Describe the functions of various tissues such as: wet membrane-lungs, islets of Langerhans-pancreas, epidermis-skin of mammal, xylem-roots, stems, leaves, & meristem-plants.

Describe the complementarity of the structure and the function of organs using examples such as: heart-circulation of earthworm, grasshopper, and human, brain-nervous system of humans, liver-digestive system of a mammal, uterus-reproduction of humans, intestine-digestion of earthworm, grasshopper, and human, ovary and testes-reproduction of frog, fish, birds, & leaf-photosynthesis in producers.

Describe the major parts of various systems and relate how these structures contribute to the well being of the total organism. Use examples such as the following. roots-corn plant, circulatory-frog, Skeletal-insect, sketetal-mammal, nervous-human, endocrine-human, digestion-cow, excretion-human, & transport-woody plant.

Compare and contrast the nutritional patterns of organisms using examples such as: algae cells paramecia, fungus-mold on toadstool, earthworm, grasshopper, tree, man, parasitic organisms, & symbiotic organisms.

Describe in a given organism the mechanical and chemical processes that change food in its large particle form to the small particle form that is able to diffuse into living cells.

Describe supporting and conflicting evidence of the hypothesis: the larger the size of the mature organism the more complex its systems, using situations such as: circulation in the earthworm and a chordate, gas exchange processes in the paramecium, the insects, and a mammal, reproduction of the paramecium and a rotifier, & circulation of transport in a sponge and a mouse.

Describe the stimulus-response mechanisms in various organisms such as: parameia, euglena, planaria, earthworm, insects, & human.

Design and perform a demonstration to show the effects of tropisms such as: geotropism, hydrotropism, & heliotropism.

Design, perform, and report the results of a controlled experiment to demonstrate the effect on living organisms of varying amounts of the following items such as. water, nitrogen, calcium, phosphorous, light, and heat. Use various kinds of plants, fruit flies, other insects, or small water animals.

Relate the role of endocrine secretions to homeostasis.

Describe these aspects of respiration. distinguish between aerobic and anerobic respiration to the effeciency of energy release and the products formed, relate respiration to energy in all living things, & describe the basic chemical changes which occur when sugar is burned and identify the role of each organ or organelle involved.

Describe the action of ciliated or flagelleted motion as it occurs in. single celled organisms, sessile water animals. & special tissues in comples organisms. such as frog epithelium. oviduct, trachael epithelium.

Describe how movement is achieved by muscular contraction in organisms where action involves internal or external skeletons, the action against material or opposing muscles using examples such as: mammalian movement, insect movement, round worm or earthworm movement, perstalsis.

Describe the excretion function by identifying the material secreted, the source of the material, and the disposition of the materials in such organs as. intestines of earthworm, insect, and mammals. lungs of reptiles, birds. and mammals. gills of fishes, kidneys of vertebrates, nephrons of the earthworm, & cell membrane of the paramecium.

Identify and contrast the sequence of events in the mitosis of plant and animal cells.

Describe and contrast fertilization in various organisms such as. mold (Rhizopus), algae (Spirogyria, Oedogonium). a flowering plant, a frog (external fertilization), & a mammal (internal fertilization).

Describe the various processes by which asexual reproduction may occur and cite examples to illustrate such as fission. budding. regeneration. layering, fragmentation, & sporulation.

Relate pH scale to acidity and alkalinity.

Recognize generalized structural formulas and component parts of common chemical substances referred to in biology such as. amino acids, proteins, fatty acids, glycerol, carbohydrates. water, carbon dioxide, & molecular oxygen.

Identify the three basic structural units of nucleic acids. phosphate group, sugar group, and base group. Compare the structure of DNA and RNA.

Describe, by diagrams or models, the process of DNA replication.

By diagrams or models show how a given sequence of amino acids in protein synthesis is determined by the chromosomes (DNA).

Construct a food web diagram that illustrates the dependence of the high level consumers on the low level consumers and producers from a given list of organisms found in a community.

Trace the transfer of energy from one form to another as it moves through a series of organisms (food chain) starting at the source and ending at the final disposal into the non-living environment Use various types of habitats such as. a temperate prairie, a fresh water lake, & a tundra.

Describe the carbon-oxygen-hydrogen cycle as it occurs in the biosphere by relating the role of the various components materials and processes such as: the series of events in photosynthesis which lead to capturing energy, green plants, animals, the series of events in respiration that release energy from food, & conservation of energy in the cycle.

Relate the benefits each of the following groups of organisms give to their communities as they perform the functions by which they maintain themselves. producers, consumers-primary and secondary, & decomposers.

Working from a prepared diagram, describe the nitrogen cycle as it occurs in his own words using correctly the terms. nitrifying, denitrifying, fixing nitrogen, nitrate, ammonia, bacteria, animal wastes, and decomposers.

Describe, by words or diagrams, the process of succession as it occurs in the following situations: a sandy lake shore, a fallen tree, an abandoned field, a small pond, a salt or fresh water marsh, artificial harbors and breakwaters, & lakes behind dams.

By personal observation and investigation, identify a given number of organisms of a designated local ecosystem. Some suggested ecosystems are. the back yard, the vacant lot in the neighborhood, the aquarium in the school room, the herbarium in the school room, or any city park.

Construct a study to investigate the effects of competition for water, light, and nutrients on the characteristics and distribution of organisms in a biome and generalize these results to explain the distribution of organisms in various biomes.

Distinguish between heterotrophs and autotrophs by superficial examination of specimens of the organisms.

Identify the following by microscopic examination of suitable specimens. bacterial colonies, mold, algae, & protozoans.

Describe the general features of the classification system generally used by biologists such as binomial nomenclature, major kingdoms of living organisms, & subdivisions-phyla, genera, species.

Classify, with a key, complete plant specimens into the following categories. monocotyledon, dicotyledon, gymnosperms, fungus, bryophytes, & ferns.

Classify given organisms, both plant and animal, into their correct phyla with the aid of appropriate keys.

Relate meiosis to the prediction of variation of characteristics in offspring, & Mendel's laws of segregation and independent assortment.

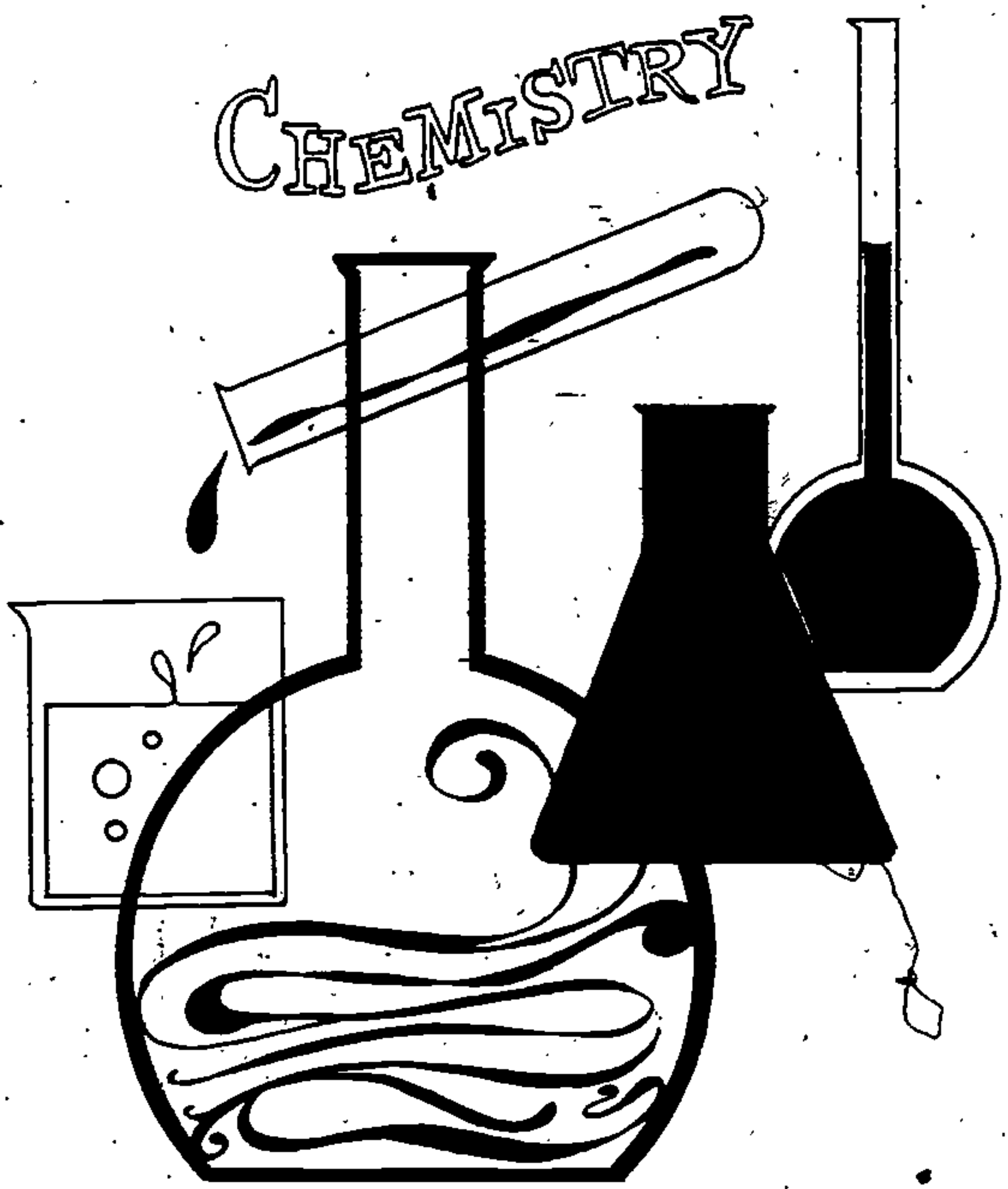
State the major parts of Darwin's Theory of Natural Selection, cite evidence for and indicate the flaws in each part.

Cite examples of adaptation by organisms to their peculiar environment. distinguish between Creative, Darwinian, and Lamarckian adaptation.

Predict the adaptations that may be initiated in various organisms that survive a changing environment.

Describe the relationships between the following items as they occur in various organisms number of offspring, amount of parental care, survival rate, their position in the food web of their community. Cite examples to illustrate the relationships.

Given data from suitable observations of plant growth at various temperatures, plot the data and generalize from its analysis the optimum temperature range for the growth of that organism.


CHEMISTRY

Group the substances in a collection of samples of materials and describe the basis for the grouping.

Describe a procedure that could be used to classify a sample of a material as an element, a compound or a mixture.

Calculate the value of the fourth item, from data provided or collected for any three of the following: the thermal energy (heat transferred to or from) of a substance, the mass of the substance, the heat capacity of the substance and the temperature change of the substance.

Identify a particular substance from a list of common chemicals by using a handbook to find characteristic properties of the chemicals.

Quantitatively separate a solid from liquid by filtration.

Quantitatively separate a dissolved solid from a liquid by evaporation without decomposition of the solid.

Construct a heating curve and/or cooling curve for a given substance from data collected in a laboratory.

Name the elements represented, the number of the atoms of each element, and the mass of each element in one mole of the compound from the formula for any given compound.

Collect evidence in support of the Law of Conservation of Mass in chemical reactions.

Calculate the molecular (formula) weight of a compound for which the formula is given.

Collect experimental data and calculate the empirical formula of a compound.

Write an equation to describe a chemical system that the student has observed.

Construct the chemical system described by an equation.

Write a balanced chemical equation for a reaction involving no more than three reactants or products when given the formulas for the reactants and the product of the reaction.

Calculate the mass, moles, molecules or atoms for any reactant or product in a reaction from the chemical equation for the reaction and the corresponding mass, number of moles, number of molecules, or number of atoms for any other reactant or products.

Calculate mass, moles or volume of any of the gaseous products or reactants from the equation for reaction and the corresponding mass, moles or volume of any of the other reactants or products.

Do successive titrations of three equal samples of standardized dilution which agree within the limits of the uncertainty of measurements of the aparatus used.

For a given sample of a compound calculate any two of the following from its correct formula · the number of moles of the compound in the sample, the number of moles of any one element in the sample, the number of molecules (formula units) in the sample or the number of atoms of any one element in the sample.

Calculate for a gaseous sample the value of the fourth item from data for three of the following. the number of moles in the sample, the pressure of gas in the sample, the volume of the sample, the temperature of the sample.

Describe in qualitative terms how Kinetic Theory accounts for. differences in gases and liquid. pressure of a gas, evaporation, difference in diffusion rates for gases and liquids, the ordinary observation that the boiling point increases with molecular weight, & the relationship between the rate of diffusion and molecular weight.

Identify those assumptions of the Kinetic Theory that are not true of real gases and describe at least one false prediction that could be made based on the theory.

Describe qualitatively what occurs during the phase change from a solid to a liquid in terms of energy, temperature, distance between particles, arrangement of particles and motion of particles.

Calculate the change in energy when a given substance at a given temperature is changed to some new temperature in another phase when given the specific heat of the substance in each phase, the heat of vaporization, and the heat of fusion of the substance.

Describe experimental evidence to support the concept that atoms contain subparticles that possess electrical charge.

Assign oxidation numbers to each element in a compound or radical.

Demonstrate a procedure for finding the approximate size of molecules and atoms.

Identify from a list of chemical equations those which represent oxidation-reduction reactions.

For any reaction involving oxidation and reduction, identify the reactant that is oxidized, the reactant that is reduced, the product of the oxidation and the product of the reduction.

After conducting an investigation using lab equipment, strips of various metals and aqueous solutions of corresponding metal ions. write equations for the half reactions which occur when any of the metal strips are placed in any solution containing one of these ions and order the resulting half reactions in decreasing order of ease of oxidation.

Design and demonstrate a procedure for obtaining electricity from a chemical system using two metals and aqueous solutions of their salts.

Construct a safe and adequate electric circuit for measuring the electrical variables of various combinations of half-cell reactions.

Select any metal/metal ion half-cell as a standard, and measure the potential of at least two other metal/metal ion half-cells relative to the chosen standard.

List examples and reactions involving oxidation and reduction that are necessary for human existence and/or physical comfort.

List examples of reactions involving oxidation and reduction that are detrimental for human existence and/or physical comfort.

Conduct an investigation to determine those conditions that affect the rate of oxidation of some material.

Use the results of the investigation to propose a procedure for eliminating (or slowing) some oxidation such as the rusting of water pipes and/or for inducing (or speeding up) oxidation such as the rusting of metal cans.

Construct an operational definition of acids and bases, use it to classify common substances found in the home.

Distinquish between concentration of an acid and strength of an acid.

Identify properties that are a periodic function of the atomic number from a list of properties such as melting point, atomic radius, atomic weight, density, ionization energy, & heat of vaporization.

For any of the properties listed, describe the trend observed as you move across a period or down a column in the periodic table, such as: atomic radius, electronegativity, & ionization energy.

Designate the number of electrons in each orbital of an atom or simple ion in its ground state.

Describe how the emission of hydrogen provides evidence for the theory that the energy of the electron of an atom is quantized.

Identify the chemical family to which an atom belongs from data about the orbital occupancy of the outer or valence electrons.

Write the electron configuration for an atom in its ground state from its atomic number.

Constrict a Lewis (electron-dot) structure for any compound given its formula and, in complex cases, the structural arrangement.

Calculate the number of protons, neutrons, and electrons for an atom given the atomic number and the mass number of the atom.

Identify those atoms which are isotopes of the same element given the atomic and mass numbers of various atoms.

Determine the number of moles and the molarity of each species present in an ionic solution formed by adding a known mass of solute to form a known volume of solution.

Determine the resulting concentration of each dissolved species when two soltuions are mixed. Any precipitation and dissociation should be considered complete.

Predict whether two given atoms form an ionic, polar or non-polar covalent bond given values of electronegativity.

Predict the type of bonding for a substance from experimental data such as solubility, electrical conductivity (when fused or in solution) and melting point.

Describe the qualitative effect on the rate-of-reaction of a change in temperature or concentration.

Predict the change that will result in a system at equilibrium when any of the following occur the concentration of one of the components is changed, the pressure of the system is changed, the thermal energy is changed or a catalyst is added to the system.

Write the equilibrium constant expression from the equation for a reaction.

Compute the equilibrium constant given the equation, the amount of each component at equilibrium and the volume of the system.

Compute the predicted concentration of each dissolved species and amount of precipitation when two solutions are mixed.

From a list of reactions and their equilibrium constants, rank the reactions in order of decreasing concentration of products at equilibrium.

Describe how the nature of the chemical bonds in a solute related to its solubility in various solvents.

Trace of history of various applications of chemicals in the everyday activities of home and industry and identify various environmental problems that have resulted from these applications, include in this discussion how attempts to correct one environmental problem have often led to the development of another.

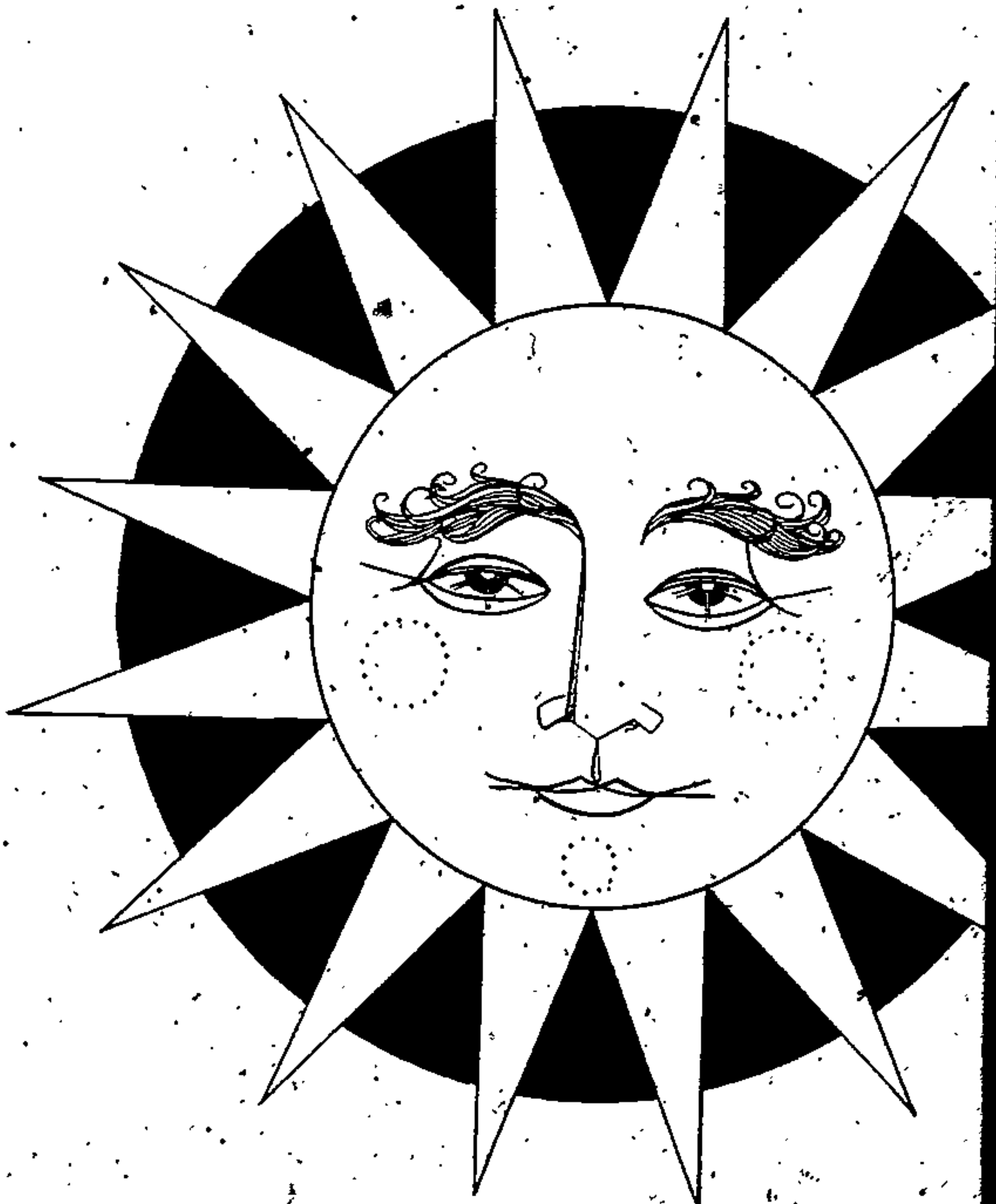
Use the detergent, pesticide, packaging and/or fertilizer industry to illustrate how man's use of chemical knowledge to improve his well-being has led to other problems for him and identify types of data that should be analyzed and projected in the future before any new product should be marketed for mass consumption.

Construct a test of a hypothesis about a chemical system or phenomenon.

Describe observations that could support a hypothesis and those that refute a hypothesis about a chemical system or phenomenon.

Construct a report of a test of a hypothesis about a chemical system of phenomenon which. is written so that it can be understood by a competent reader, provides all data which are relevant to the hypothesis, presents the data in an orderly manner and provides reasonable conclusions based on the data reported.

Write equations to represent nuclear transformation resulting in natural decay of radioactive materials.



PHYSICS

Distinguish between distance and displacement.

Solve selected problems involving distance and displacement concepts using estimation for the magnitude and accepted units for the answers.

Combine distance (and displacement) intervals with time intervals to derive new physical concepts which better explain observed phenomena. speed, velocity and acceleration.

Distinguish between instantaneous and average speed, instantaneous and average velocity, and instantaneous and average acceleration.

Construct graphs of speed vs. time; distance vs. time, and acceleration vs. time.

Interpret the above graphs using areas and slopes as the representation of physical quantities.

Define force in terms of mass and acceleration.

Identify friction as a force.

Define momentum in terms of mass and velocity from empirical data.

Combine the physical quantities of force, mass, distance, etc. and relate them to the Newtonian synthesis (Newton's three laws of motion and universal gravitation.)

List various physical properties as scalar or vector quantities.

Formulate a model of electricity to explain selected electrical phenomena.

Use this model to describe other electrical phenomena.

Discuss the monetary value of electrical energy used in some selected segment of society (e.g. the home, the community, a given industry) and compare the cost of that energy with the cost of providing the same amount of energy by some other means.

Trace the path of an elementary charge through various circuits such as. series, parallel and combinations of a simple nature.

Perform an investigation to determine the nature of the force field around a charged object.

Discover, state, and apply a rule for determining the direction of a magnetic field around an electric current.

Demonstrate how the forces on electric currents in magnetic fields are employed in meters and motors.

Describe a transformer and explain its operation in terms of induced current and EMF.

Demonstrate or cite evidence for the relationship between the force on a charged object, its velocity through a magnetic field and the strength of the fields.

Identify the kinds of energy. mechanical, electrical, thermal, chemical, and electromagnetic exhibited in complex systems.

Trace a transfer of energy through a cycle involving two or more changes in kind from diagrams, pictures, or demonstration.

Derive an expression for translational kinetic energy using mass and velocity.

Demonstrate energy conservation using interactions which involve a change in energy forms.

Apply the principle of conservation of energy and momentum to predict the behavior of objects involved in an elastic collision.

Identify selected periodic motions such as: pendulum, uniform circular motion and spring oscillator.

Relate periodic motions to wave motions such as. sound, light, radio, microwave, ultra-sonics and heat.

Compare and contrast the wave model and particle model in describing energy transfer and other phenomena.

Identify properties of elementary particles such as. electron, proton, neutron and positron in terms of mass, size, charge and energy level.

Describe the relationship between gravitation and/or electric field strength and distance: (inverse square relationship).

Cite evidence to support the law of conservation of energy for the microscopic as well as macroscopic state.

Test the laws of reflection, refraction, diffraction and interference for light in the laboratory.

Extend these findings to enough other members of the electromagnetic family to show the close relationships between the members of that family.

Order the commonly recognized segments of the electromagnetic spectrum according to wavelength or frequency.

Demonstrate total internal reflection.

Demonstrate the principle of super-position of waves, construct a model to explain its effects and use it to explain various phenomena in sound, water, and light waves.

List several practical applications of electromagnetic energy to daily existence.

Relate the energy content of the various segments of the photo-electric spectrum to frequency or wavelength.

Discuss the transparency of various materials to various segments of the electromagnetic spectrum including a discussion of such phenomena as the greenhouse effect, snow-blindness, Becquerel effect, & radio reception.

Describe the condition necessary for electromagnetic wave amplification by stimulated emission of radiation (maser and laser) and discuss some present and potential beneficial used of this phenomena.

Discuss the properties of the elementary types of radiation (alpha, beta and gamma).

Use both the wave and particle models to describe various phenomena involving electromagnetic radiation.

Solve a simple example of $E = mc^2$.

Describe in simplified general terms the operation of an atomic particle accelerator.

COURSE REQUIREMENTS FOR SCIENCE AT THE HIGH SCHOOL LEVEL

The State Board of Education requires that a student must accumulate 18 credits in order to graduate. A total of 10 1/2 credits are prescribed by the State Board. Although only one credit is required in the area of SCIENCE, it is recommended that further consideration be given to exposing students to elective programs in the area of SCIENCE which meet a variety of interests and contribute to improved scientific literacy.

Although credit has been generally designated in the form of a carnegie unit which represents 120 hours of classroom instruction under the direction of the teacher, following examples accord variations as to providing the minimal instructional requirement:

1. 144 instructional periods per year based on a class session of 50 minutes in length.

2. 160 instructional periods per year based on a class session of 45 minutes in length.

3. 180 instructional periods per year based on flexibly arranged class sessions of varying duration which exceeds the minimum number of hours.

It should be emphasized that each secondary school endeavor to proceed beyond the minimum requirements necessary to assure the providing of adequate instructional time. Where achievement becomes the essential basis for instruction, variable class length is si[illegible]

Requirements For Teaching Science

AT THE SECONDARY LEVEL

Requirements for the Standard Certificate

A. Bachelor's degree from an accredited college and:

B. General Education-
Satisfactory completion of Bachelor's degree

C. Professional Education-

1. Completion of a program in teacher education in the area of Natural Science

-OR-

2. Minimum of fifteen (15) semester hours including human development, methods of teaching, and clinical and/or field experience including student teaching at the appropriate level (7-12) and:

D. Specific Teaching Field-

1. Major in the field of endorsement

-OR-

2. Completion of program in teacher education in the field of endorsement

-OR-

3. Completion of at least the total semester hours indicated for each area listed below:

a. Chemistry	42 semester hours
These should include at least one course in inorganic, organic qualitative, quantitative and atomic structure	24 semester hours
Biology	3 semester hours
Physics	3 semester hours
Mathematics	6 semester hours
Earth Sciences	3 semester hours
*Environmental Education	3 semester hours
b. Physics	45 semester hours
These should include at least one course in classical thermodynamics, electronics, atomic and nuclear physics	24 semester hours
Biology	3 semester hours
Chemistry	3 semester hours
Mathematics	9 semester hours
Earth Sciences	3 semester hours
*Environmental Education	3 semester hours
c. Earth Science	39 semester hours
These should include at least one course in geology, geography, climatology, meterology, oceanography, and astronomy	24 semester hours
Biology	3 semester hours
Chemistry	3 semester hours
Mathematics	3 semester hours
Physical Science	3 semester hours
*Environmental Education	3 semester hours
d. Biology	39 semester hours
These should include at least one course in botany and zoology, ecology, genetics, bio-chemistry, and physiology	24 semester hours
Chemistry	3 semester hours
Physical Science	3 semester hours
Earth Science	3 semester hours
Mathematics	3 semester hours
*Environmental Education	3 semester hours

NOTE: A degree from a College of Agriculture will meet all requirements for the area of Biology; thus, secondary Natural Science certification in Biology.

*Environmental Education: Teachers in the areas of science are required to complete adequate course work in the area of Environmental Education. Adequate course work is defined as including the following:

History and philosophy of the conservation movement

Appreciative understanding of the wide variety of natural resources

Importance of conservation of natural resources in a national and international setting

Relationship of supply of natural resources and economic structure

Natural resource management: Techniques, need for, and types of controls

Role and importance of resource use planning for the future

CURRENT EDUCATIONAL PHILOSOPHIES THAT RELATE TO THE NATURAL SCIENCE EDUCATION PROGRAM

Right to Read (Science and Reading)

It is our belief that every area of the elementary school curriculum, including natural science, should contribute to the reading program. Children's experiences in science should help them learn how to read in other areas. Conversely, as children develop general reading and communication skills these will contribute to their development in natural science.

Reading is essentially the recognition of relationships between symbols and objects or events.

The emphasis in the natural Science program is on first-hand experiences with concrete materials. Children handle and study rocks, plants, animals, magnets, etc. These are concrete objects and primary experiences to which symbols can be related. Words and sentences take on meaning for childen when they signify objects that they have handled and experiences in which they have taken part.

Thus the natural science program is an integral part in building a sound reading and communication skills program.

Career Education

The main thrust of career education is to prepare all students for a successful life of work by increasing their options for occupational choice, by eliminating barriers - real and imagined to attaining job skills, and by enhancing learning achievement in all subject areas and at all levels of education.

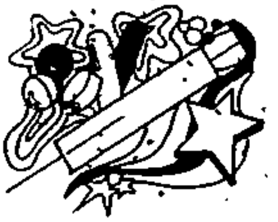
Career education recognizes critical decision points at which students must be prepared and equipped to decide whether to pursue a job, seek further education, or choose some combination of both.

The implementation of the world of work ideas should be an intrinsic part of any science curriculm. The development of curriculum materials including this idea is recommended and the focus of career education at the elementary lever (K-4) is Carrer Awareness; Middle or Junior High School level (5-8) is career exploration, and Senior High (9-12) the world of work.

Health Education

In depth health education as such is not considered part of the natural science program. This is an area where there are basic relationships to the biological sciences, but the proper way to bathe, brush teeth, and cut fingernails is not natural science as such.

Drug Education



The importance of learning about drugs, their use and abuse is essential. The education of students in this area draws a fine line between natural science and health education. The natural science objectives are not specifically realted to drug education. There are basic relationships with the physical (chemistry) and biological sciences.

Emergency Preparedness

This is an area of importance in preparing the student to be a productive member of the community. The natural science objectives are not specifically related to emergency preparedness. There are basic relationships for the application of the earth sciences.

Field Trips and Outdoor Education

The outdoor classroom has a multitude of opportunities for natural science education programs. The use of the immediate area about the school for application of the various aspects of natural science education is strongly recommended. A guide as to how to utilize these areas has been prepared by the Department of the Interior, and the local soil conservation groups in cooperation with the State Department of Public Instruction. Copies of this guide are available from the office of the State Supervisor of Science and Environmental Education.

The use of field trips to various locations in the State and the surrounding areas is recommended when the field trip is an integral part of the learning situation. There is a great deal of planning and preparation required if the field trip is to be a meaningful experience. The field trip should provide an excellent means for the application of natural science to the other learning areas such as social studies, art and communication skills. (We should note that a field trip requiring a two hour bus ride, then spending a half hour at a site and a two hour return trip has questionable value).

Science Fair

The display of student projects and activities is an excellent method of building interest in the natural science program among the students and parents of a particular school or school district.

Particularly in grades K-6 judging should not be conducted for the award of prizes in any form. Each student should receive some type of recognition for his efforts.

The fair should not be just for natural science, but be a multidiscipline event where the talents and efforts of the students in all areas are presented.

Non-science Theory in Science Instruction

Throughout his recorded history, man has been vitally concerned to find out all that he can about his universe. He has explored it in many ways, raised questions about it, designed methods by which he could increase and organize his knowledge, and developed systems to aid him in understanding and explaining his own origin and nature and his place in the universe. Among these systems are philosophy, religions, folklore, the arts, and science.

Science is the system of knowing about the universe through data collected by observation and controlled experimentation. As data are collected, theories are advanced to explain and account for what has been observed. The true test of a theory valid in science is threefold: (1) its ability to explain what has been observed; (2) its ability to predict what has not yet been observed; and (3) its ability to be tested by further experimentation and to be modified as required by the acquisition of new data.

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