

DOCUMENT RESUME

ED 178 279

SE 028 472

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 TITLE Individualized Testing System: Performance Objectives, ISCS Level III.
 INSTITUTION Florida State Univ., Tallahassee. Curriculum Study Center.
 SPONS AGENCY National Science Foundation, Washington, D.C.
 PUB DATE 73
 NOTE 131p.; For related documents, see SE 028 460-488

EDRS PRICE MF01/PC06 Plus Postage.
 DESCRIPTORS Academic Achievement; Course Evaluation; *Course Objectives; Elementary Secondary Education; *Evaluation; *Individualized Programs; Junior High Schools; Performance Tests; *Science Course Improvement Project; Science Curriculum; Science Education; Science Materials; Science Tests; Student Evaluation; *Teaching Guides
 IDENTIFIERS *Intermediate Science Curriculum Study; *National Science Foundation

ABSTRACT

This is one of four major subdivisions of a set of individualized evaluation material for Level III of the Intermediate Science Curriculum Study (ISCS) developed as a part of the ISCS Individualized Teacher Preparation (ITP) program. The manual contains a composite list of selected measurable objectives of Level III of the ISCS program. It is primarily a reference book for persons responsible for examining curricula and determining if this program is likely to meet their school system's objectives and needs. The listed objectives are designed to aid in the assessment of students who differ widely in their learning abilities and in the kinds of subject matter which they find difficult. These objectives are divided into eight texts which are subdivided into units. Most units include two or three chapters and the related excursions or resources. Within each unit, the objectives based on the core and the remedial excursions of the student materials are listed in the order of their development in the student materials. These are followed by the objectives for the general and enrichment excursions or the resource objectives. (Author/HM)

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INDIVIDUALIZED TESTING SYSTEM

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Performance Objectives

ISCS LEVEL III



**SILVER BURDETT
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SE 028 472



INDIVIDUALIZED TESTING SYSTEM

ALL LEVELS	Individualizing Objective Testing (an ITP module) Evaluating and Reporting Progress (an ITP module)
LEVEL I	Performance Objectives, ISCS Level I Performance Checks, ISCS Level I, Forms A, B, and C Performance Assessment Resources, ISCS Level I, Parts 1 and 2
LEVEL II	Performance Objectives, ISCS Level II Performance Checks, ISCS Level II, Forms A, B, and C Performance Assessment Resources, ISCS Level II, Parts 1 and 2
LEVEL III	Performance Objectives, ISCS Level III Performance Checks, ISCS Level III, ES-WB, Forms A, B, and C WYY-IV, Forms A, B, and C IO-WU, Forms A, B, and C WW-CP, Forms A, B, and C Performance Assessment Resources, ISCS Level III, ES-WB WYY-IV IO-WU WW-CP

ACKNOWLEDGMENTS

The work presented or reported herein was supported by funds provided by the National Science Foundation. However, the opinions expressed herein do not necessarily reflect the position or policy of the National Science Foundation, and no official endorsement by the agency should be inferred.

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FOREWORD

To implement an educational approach successfully, one must match the philosophy of evaluation with that of instruction. This is particularly true when individualization is the key element in the educational approach. Yet, as important as it is to achieve this match, the task is by no means simple for the teacher. In fact, without specific resource materials to help him, he is apt to find the task overwhelming. For this reason, ISCS has developed a set of individualized evaluation materials as part of its Individualized Teacher Preparation (ITP) program. These materials are designed to assist teachers in their transition to individualized instruction and to help them tailor their assessment of students' progress to the needs of all their students.

The two modules concerned with evaluation, *Individualizing Objective Testing and Evaluating and Reporting Progress*, can be used by small groups of teachers in in-service settings or by individual teachers in a local school environment. Hopefully, they will do more than give each teacher an overview of individualized evaluation. These ITP modules suggest key strategies for achieving both subjective and objective evaluation of each student's progress. And to make it easier for teachers to put such strategies into practice, ISCS has produced the associated booklets entitled *Performance Objectives*, *Performance Assessment Resources*, and *Performance Checks*. Using these materials, the teacher can objectively assess the student's mastery of the processes, skills, and subject matter of the ISCS program. And the teacher can obtain, at the moment when they are needed, specific suggestions for remedying the student's identified deficiencies.

If you are an ISCS teacher, selective use of these materials will guide you in developing an individualized evaluation program best suited to your own settings and thus further enhance the individualized character of your ISCS program.

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THE ISCS INDIVIDUALIZED TESTING SYSTEM

The ISCS individualized testing system for each level of ISCS is composed of four major subdivisions:

1. The ITP modules *Evaluating and Reporting Progress* and *Individualizing Objective Testing*.
2. *Performance Objectives*.
3. *Performance Checks* in three alternate forms, and
4. *Performance Assessment Resources*.

Evaluating and Reporting Progress presents a comprehensive overview, with many refinements, for individualizing the grading and reporting of students' progress, based on both subjective and objective criteria. The module *Individualizing Objective Testing* describes more specifically those ISCS evaluation materials which have objective criteria—the performance objectives, checks, and resources—and it presents practical suggestions for their use. These two modules should be considered prerequisite to successful use of the other ISCS evaluation materials.

Each of the *Performance Objectives* booklets contains a composite list of selected measurable objectives considered important to a given level of the ISCS program. However, many of the long-range goals and aims that are at the heart of the ISCS program do not lend themselves to being expressed as measurable performance objectives. Thus, these booklets should not be construed as being all-inclusive anthologies of all the possible learning outcomes of ISCS.

Each of three *Performance Checks* booklets contains an equivalent but alternative set of performance checks which were developed to assess the students' achievement of the objectives stated in the *Performance Objectives* booklets.

The *Performance Assessment Resources* booklet is a teacher's handbook to be used in identifying the appropriate performance checks with which to evaluate each student. The booklet also indicates how to set up testing situations, correct responses, and give remedial help.

NOTES TO THE READER

This book is a catalog of the ISCS objectives for Level III. It is primarily a reference book for persons responsible for examining curricula and determining if this program is likely to meet their school system's objectives and needs. As a reference book, it will also be useful to those teachers who wish to write additional objectives or performance checks.

Each objective is written in the formal style described in Excursion 2-1 of the module *Individualizing Objective Testing*. As noted in Chapter 1 of that module, each ISCS objective focuses on a specific, directly measurable student action. The objectives are, in effect, operational definitions of students' abilities; that is, they are statements of how to detect and measure what students can do.

As you might expect, ISCS has other important goals and aims that are not listed in this book. They are missing because they are generally not directly measurable, given the practical confines of time and the state of the art of performance testing and measurement. In many cases, their nature is affective, rather than cognitive, and long-term as opposed to short-term. You will find many of these goals and aims discussed in the module *Rationale for Individualization*.

The objectives in this catalog are designed to aid in the assessment of students who differ widely in their learning abilities and in the kinds of subject matter which they find difficult. As stated in the module *Individualizing Objective Testing*, the key to the successful use of this catalog, the related books of *Performance Assessment Resources*, and the various *Performance Checks* is selectivity. This catalog of objectives was not designed so that a specific student or group of students would achieve a fixed percentage of them. Probably no one school system and certainly no one teacher will find all of the objectives in this book appropriate. As with a mail order catalog, one must pick and choose according to his needs.

The objectives listed in this book are divided into texts which are subdivided into units. The relationships among texts, the units, and the chapters of *Probing the Natural World/3* are shown in Table 1. Most units include two or three chapters and the related excursions or resources. You will recall that the number preceding the hyphen in the identification numbers for excursions indicates the chapters to which the excursion is related. Within each unit, the objectives based on the core and the remedial excursions of the student materials are listed first and roughly in the order of their development in the student materials. These are followed by the objectives for the general and enrichment excursions or the resource objectives.

LEVEL III		
TEXT	UNIT	CHAPTERS
<i>Environmental Science (ES)</i>	1	1 and 2
	2	3 thru 5
	3	6 thru 8
<i>Well-Being (WB)</i>	1	1
	2	2 and 3
	3	4 thru 6
<i>Why You're You (WYY)</i>	1	1 thru 3
	2	4 and 5
	3	6 and 7
<i>Investigating Variation (IV)</i>	1	1 and 2
	2	3 thru 5
<i>In Orbit (IO)</i>	1	1 and 2
	2	3 and 4
	3	5 thru 7
<i>What's Up? (WU)</i>	1	1 and 2
	2	3 and 4
	3	5 thru 7
<i>Winds and Weather (WW)</i>	1	1 and 2
	2	3 and 4
	3	5 thru 7
<i>Crusty Problems (CP)</i>	1	1
	2	2
	3	3
	4	4

Table 1

The three types of code numbers used to identify the objectives in this book and the materials which correspond to each of the objectives in the *Performance Checks* and *Performance Assessment Resources* booklets are shown in Figure 1 below.

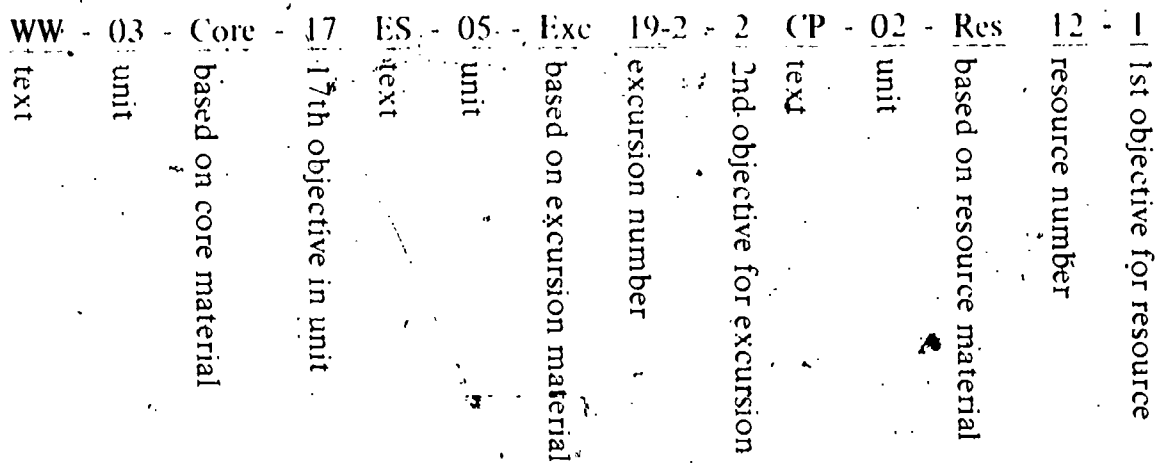


Figure 1

Environmental Science

ES

Given two maps showing patterns of the spread of diseases in the Middle Ages and today and asked to explain why diseases now tend to break out in many different locations at the same time, whereas in the Middle Ages disease seemed to spread slowly outward from a central point, the student applies the concept that diseases are caused by germs which may be carried by people, animals, or objects from one place to another by stating an explanation which includes the idea that because there is much more rapid and frequent movement of people, animals, and objects over long distances now than in the Middle Ages, diseases can now spread more rapidly.

ES
01-Core-1

Given a map of an area and the dates that an epidemic first reached cities in that area and asked to chart the movement of the epidemic by sketching lines of best fit on the map for each of the dates given, the student applies the procedure for drawing lines of best fit by drawing smooth lines indicating those areas affected at the same time.

ES
01-Core-2

When asked whether a disease which spreads from one person to another would be likely to spread more rapidly in a large city or in a rural area and to explain why, the student applies the concept that communicable diseases are likely to spread more rapidly in densely populated areas by stating that the disease would be likely to spread more rapidly in a city than in a rural area and the essence of the concept.

ES
01-Core-3

When asked whether an epidemic of a disease like the Black Death could possibly occur today and to explain his answer, the student applies the concept that the crowded and unsanitary living conditions which encourage the spread of disease do exist today by stating that an epidemic could occur and the essence of the concept.

ES
01-Core-4

When asked to list two or more conditions which would favor the spread of an epidemic throughout an area, the student recalls that epidemics are favored by the misuse of the environment by listing the notion of at least two of the following: (1) overcrowded living conditions, (2) unsanitary living conditions, (3) improper disposal of garbage, (4) improper disposal of sewage, and (5) infestation of rats and other vermin.

ES
01-Core-5

Given a situation in which a doctor is hired to assist the government of a country in reducing the spread of disease and a list of possible government projects to that end and asked to select the project that is likely to reduce the amount of disease most quickly and to explain why, the student applies the concept that the spread of contagious disease is usually encouraged by the prevalence of overcrowded and unsanitary living conditions by selecting the course of action which involves eliminating those problems and stating the essence of the concept.

ES
01-Core-6

When asked to define *components* in regard to systems, the student recalls that the components of a system are the things (objects or kinds of matter) that influence each other within a system by responding to that effect.

ES
01-Core-7

ES 01-Core-8	Given a system and asked to list three of its components, the student <u>applies</u> the concept that a component is an object (or substance) which affects <u>other</u> parts of a system by <u>listing</u> three things in agreement with that concept.
ES 01-Core-9	When asked to define <i>system</i> , the student <u>recalls</u> that a system is a set of objects that influence each other by <u>stating</u> the effect of that definition.
ES 01-Core-10	Given a labeled diagram of a system which shows the input and output of a specified component of the system and asked to list three labeled components of the system, the student <u>applies</u> the concept that a component is any object which is part of a system, including the matter input to and output from a specified component of the system, by <u>listing</u> any three components of the system.
ES 01-Core-11	When asked to explain why the output of organisms does not seem to accumulate, the student <u>applies</u> the concept that the output of an organism is usually input for other organisms by <u>stating</u> an explanation that includes that notion.
ES 01-Core-12	Given a description of a component of a system and a list of possible input and output of this component and asked to select from the list two things which are input to the component and two things which are output, the student <u>applies</u> the concept that those things which the component removes from its surroundings are the input to a component and those things which it adds to its surroundings are the output of a component by <u>selecting</u> two things which are input and two which are output of the component.
ES 01-Core-13	Given that the term <i>producer</i> is often used to describe certain living things and asked to define the term <i>producer</i> , the student <u>recalls</u> that a producer is a living thing which is able to use energy directly from the sun to produce chemicals and thus store the energy in its body by <u>responding</u> to that effect.
ES 01-Core-14	Given an illustration of and a sentence describing two consumers and asked to state the biological definition of the term <i>consumer</i> , the student <u>recalls</u> the definition that a consumer is an organism which cannot get the energy it needs directly from the sun but must get its energy either by eating plants or by eating other animals by <u>stating</u> the effect of the definition.
ES 01-Core-15	When asked to state the biological meaning of the term <i>decomposer</i> , the student <u>recalls</u> the definition that a decomposer is an organism which produces chemical and physical changes in the waste materials and dead bodies of plants and animals and as a result these waste materials can be used by living plants by <u>stating</u> the effect of the definition.
ES 01-Core-16	Given an illustration of an ecosystem and descriptions of some of its components and asked to name the producers, consumers, and decomposers, the student <u>classifies</u> as a producer a living thing that can use energy directly from the sun and store it as chemical energy, as a consumer a living thing that depends on other

living things for energy, and as a decomposer an organism that chemically changes waste materials and dead organisms into products that can be used by plants by so naming each organism.

ES
01-Core-17

Given a description of a situation in which one person has a small but detrimental effect on his surroundings and asked to explain why governments sometimes pass laws making these small actions illegal, the student applies the concept that although the effect of the actions of a single person may be unimportant, the combined actions of many people may produce effects that are disastrous to the surroundings by stating an explanation that includes the idea that a government passes laws to deter large numbers of individuals from performing individual actions which would have a serious cumulative effect on the surroundings.

ES
01-Core-18

Given a description of an object and its surroundings and told that the object will not influence its surroundings and asked whether it is true that the object will not influence its surroundings and to explain the reason for his answer, the student applies the concept that any object influences its surroundings if it takes something from them, adds something to them, or just occupies space by responding negatively and with the essence of the concept.

ES
01-Core-19

Given a list of four situations in which one thing influences another and asked to indicate for each of the influences whether it is a direct or an indirect influence on the living organism specified, the student classifies an influence as direct if one thing physically acts on the other and as indirect if the influence is produced through a change in the surroundings by writing *direct* or *indirect* for each situation correctly in at least three of the four situations.

ES
01-Core-20

Given a diagram of a system said to be balanced and asked to predict what would happen if a deliberate change were made in one of the components or if there were new input damaging to one of the components in the system, the student applies the concept that producing a change in one part of a system may produce changes in other parts of the system by stating a prediction that implies the essence of the concept.

ES
01-Core-21

Given a description of a proposal which would upset the environmental input-output balance and asked to state at least two ways in which the environment would be affected by pollution if that proposal were to be carried out, the student applies the concept that if the environmental input-output balance of a subsystem is changed, the whole system can be drastically upset by predicting at least two of the following: (1) damage to the food and water sources of fish, wildlife, and humans, (2) damage to the breeding grounds of fish and wildlife, and (3) the loss of an area of natural beauty.

ES
01-Core-22

Given a statement to the effect that the average person in an industrial nation puts a far greater strain on the environment than does a person in a nonindustrial nation and asked to explain why, the student generates an explanation based on the concepts that the input and output of all organisms affect the environment and that the

average person in an industrial nation has greater input from and output to the environment than does a person in a nonindustrial nation by stating the effect of those concepts.

ES
01-Core-23

Given a list describing several organisms involved in various activities and asked which will likely affect the environment, the student applies the principle that an organism by its very existence affects the environment by taking things out of it and adding other things to it by selecting the option "all of the above."

ES
01-Core-24

Given an illustration and a description of an ecosystem and asked to describe the input and output of gases in that ecosystem, the student applies the concept that green plants take carbon dioxide and some oxygen from the air and release large quantities of oxygen into the air, whereas animals take oxygen from the air and release carbon dioxide into it by stating the gaseous input and output of the components in agreement with the concept above.

ES
01-Core-25

When asked to list three output products from the human body and two things which are input to the human body, the student applies the concepts that output is something produced by a component of a system and input is something taken in or used by the component by listing as output three of the following: urine, solid waste, carbon dioxide, and heat, and as input, two of the following: oxygen, food, and water.

ES
01-Core-26

Given a system in balance and asked what would happen if one part of the system were altered in some way, the student applies the concept that altering a component of a system which is in balance may produce changes in the other components of the system by responding to that effect.

ES
01-Core-27

Given ample opportunity to work with materials on a laboratory activity of more than one day's duration and asked to observe the cleanup period at the appropriate time, the student chooses to close the laboratory activity period promptly upon receiving notification of the time by immediately ceasing the laboratory activity, returning materials in usable, clean condition to storage places, and participating in work area cleanup, on at least three separate occasions when being observed by the teacher without his knowledge.

ES
01-Core-28

When asked to work in the laboratory with fellow students, the student chooses to cooperate with fellow students in the laboratory by being polite, waiting his turn, being orderly when moving about, and observing the right of his classmates to work without being unnecessarily disturbed, when observed without his knowledge by the teacher or another designated person on at least three occasions.

ES
01-Core-29

When asked to work with the equipment and text materials of the ISCS course, the student chooses to show personal responsibility for returning laboratory equipment no longer needed to the proper storage places during the activity period by returning such equipment and materials to the designated storage places on at least three

occasions when observed by the teacher or another designated observer without his knowledge of being checked.

When asked questions in the textbook, the student chooses to write in his *Record Book* his answers to 90% or more of the questions in his textbook by exhibiting the written responses when the teacher spot checks to determine if he is doing so.

ES
01-Core-30

When working independently in the laboratory, the student chooses to show proper care and use of ICS laboratory materials by using the materials only for their intended purpose or by requesting permission to do other specific experiments with them, when being observed without his knowledge by the teacher or another designated person on three or more occasions.

ES
01-Core-31

Given a partially labeled grid and a data table and asked to put scales on the axes, to plot the data on the grid, and to draw a line of best fit, the student applies the procedure for graphing data which includes numbering the axes so that each interval represents the same change in the variable and so that the range of the data includes at least one-half of the scale, plotting the data on the grid, and drawing a line of best fit by constructing a graph on which the points are plotted to within ± 0.2 major scale units and on which the line of best fit is a smooth curve.

ES
01-Exc 1-1-1

Given an equation for a reaction in which the products contain elements not present in the original reactants and asked if the reaction is possible and to explain his answer, the student applies the rule that in ordinary reactions, elements in the products are not different from those in the reactants by responding negatively and to the effect that the reaction could not occur because there are elements in the products that are different from those in the reactants.

ES
01-Exc 2-1-1

Given a pictorial chemical equation and a list of terms from the ICS particle model and asked to select from the equation those symbols which are examples of the terms in the list, the student classifies those symbols indicating only one kind of atom as representing elements, those symbols made up of more than one kind of atom as compounds, the symbols of the starting substances in a chemical reaction as reactants, and the symbols of the new substances formed in a chemical reaction as products by selecting a symbol or group of symbols from the equation as illustrative of each of the above notions.

ES
01-Exc 2-1-2

Given the equation for a reaction and a list of four purported ways to increase the rate of the reaction and asked to select from the list the method that will not increase the rate of reaction, the student applies the concept that the rate of a reaction may be increased by increasing the temperature of the reactants, by increasing the concentration of one or more of the reactants, or by adding a catalyst by selecting any statement that appears which does not include one of the methods above.

ES
01-Exc 2-1-3

ES
01-Exc 2-1-4

Given that burning is a chemical reaction of a material with oxygen and asked to explain why a specified substance must be heated before it will begin to burn in air, the student applies the concept that energy is often required to break up combinations of atoms so that a chemical change can occur by stating the effect of that concept.

ES
01-Exc 2-1-5

Given a list of terms from the ISCS particle model and their definitions and asked to match the terms with their definitions, the student recalls that an element is a substance made up of only one kind of atom, that a compound is a substance made up of two or more different kinds of atoms, that a product is a new substance produced during a chemical reaction, that a reactant is a starting substance in a chemical reaction, that an ion is a particle with either an excess positive or an excess negative charge, and that a molecule is a particle containing equal numbers of positive and negative charge by matching terms and their definitions as above.

ES
01-Exc 2-1-6

Given the temperatures of two substances before and after they are mixed and four statements about the relationship between the energy needed to separate the reactant atoms and the energy released when those atoms recombine to form the products and asked to select the statement that best describes the relationship between these energies, the student applies the concepts that if the temperature rises, the energy released is greater than the energy required, if the temperature is constant, the energies are equal, and if the temperature decreases, the energy released is less than the energy needed by selecting the statement that agrees with the data supplied and with the concepts.

ES
01-Exc 2-2-1

Given a description of a situation in which a group of people are proposing to a legislator a campaign to eradicate a certain species of animal in an area because it causes problems and asked to describe what information the legislator should have in order to make an informed decision in this matter, the student recalls that in order to determine the feasibility of a campaign to eradicate a species from an area, one should know (1) how much damage this species causes, (2) the cost of the proposed program, (3) the input and output of the species so that an estimate can be made of the possible effects of its eradication on other species, (4) does the species exist elsewhere, and (5) is the species an endangered species by responding with the effect of at least two of those notions.

When asked to explain what is meant by *biochemical oxygen demand*, the student recalls the definition that the biochemical oxygen demand is the need for oxygen by living things by stating the effect of that definition.

ES
02-Core-1

Given a graph of the size of a population of microorganisms over time and a series of graphs showing possible relationships between times and oxygen demand and asked to select the graph that best represents the oxygen demand over a period of time, the student applies the concept that the oxygen demand of a population of microorganisms is directly proportional to the size of the population by selecting the graph with the same slope as the population-versus-time curve.

ES
02-Core-2

Given the claim that the color change of methylene blue in Activity 3-4 was caused by the milk itself and not by the action of the yeast on the milk and asked to describe an activity to determine whether it was the milk or the yeast and milk combination that caused the color change, the student generates a description of an activity which includes holding all the variables constant except one and using a control by describing an activity which includes varying only the quantity of yeast added while holding the other variables constant and using a control sample which contains milk but no yeast.

ES
02-Core-3

Given a series of graphs showing possible relationships between the oxygen demand of microorganisms when an excess amount of food becomes available to the microorganisms and asked to select the graph which best indicates the relationship of time and oxygen demand, the student recalls that when an excess amount of food is made available to an organism, the oxygen demand increases slowly at first but then rises more and more rapidly by selecting the graph that shows a line with a positive, constantly increasing slope.

ES
02-Core-4

Given a description of a situation in which a small population of microorganisms (between one and ten) is placed into a large container of food and the amount of time required for the population to double (doubling time) and asked to predict the size of the population after some integral multiple (n) of the doubling time, the student applies the concept that the size of a population of organisms doubles after each integral multiple of the doubling time for that organism provided unlimited food is present by stating the final population size found by multiplying 2^n times X (the initial population size).

ES
02-Core-5

Given four graphs of population size versus time for a population of microorganisms and asked to select the graph that best shows how the size of the population of microorganisms would change over time if an unlimited amount of food were supplied, the student applies the concept that the size of a population grows slowly at first and then more and more rapidly (exponentially increasing) in the presence of unlimited food by selecting the graph that shows an increase with time and is concave upwards.

ES
02-Core-6

ES
02-Core-7

Given that a lake has been polluted by sewage, that many kinds of fish can no longer live in it, and four statements about the fish and the lake and asked to select the reason that many kinds of fish can no longer live in the lake, the student applies the concept that many of the microorganisms which decompose sewage in a body of water use oxygen from the water by selecting the statement to the effect that there is no longer enough oxygen in the lake for certain kinds of fish.

ES
02-Core-8

When asked to explain a cause of the oxygen death of a lake or stream, the student recalls that the oxygen death of a lake or stream is caused by an increase in water temperature or by microorganisms using up most or all of the dissolved oxygen as they decompose biodegradable material that has been dumped into the stream by stating the effect of one of those causes.

ES
02-Core-9

Given a situation in which a body of water polluted by sewage is to be sprayed to kill off all the decomposers and asked if this is the best solution to the problem of pollution and to explain his answer, the student applies the concept that decomposers are necessary components of an environmental system which involves biodegradable wastes by responding negatively and, in effect, that sewage will be left and that the best solution is to stop the pollution itself.

ES
02-Core-10

Given a diagram and a description of a situation in which many fish live upstream from and just downstream from where sewage is dumped into a stream but fewer and fewer fish are found as one goes downstream until finally there are no more fish and asked to explain why this occurs, the student generates an explanation based on the notion that the microorganisms that are decomposing the sewage are using up the oxygen from the water as it flows downstream and the progressive downstream reduction in the oxygen content causes the changes in the fish population by stating an explanation to that effect.

ES
02-Core-11

When asked to explain why many cities and towns that get their water from nearby streams have had to install more complicated and effective water purification plants to treat their drinking water, the student applies either the fact that as the earth's population increases, increasing amounts of water are used again and again before they reach the sea, and therefore it becomes difficult to remove all the undesirable materials from the water, or the fact that new kinds of pollutants, which the old methods do not remove, are being added to water by stating an explanation that includes one of those ideas.

ES
02-Core-12

Given a situation in which some newly-planted seeds are regularly splashed with detergent water and asked why such seedlings as appear are not as healthy as other seedlings nearby, the student recalls that detergents in water interfere with the germination of seeds and affect the health of seedlings by responding to that effect.

ES
02-Core-13

Given a description of an activity to determine the effect of detergent on the germination of four different kinds of seeds other than radish seeds and a series of statements about the outcome of these activities and asked to select the statement that

represents the best prediction he can make from his activities with radish seeds, the student applies the concept that the results of activities involving one type of organism suggest what might happen to other types of organisms but cannot be used to make exact predictions about other organisms by selecting the statement which includes that notion.

When asked to describe an activity to determine whether the presence of an insecticide in the soil affects the germination of a specific kind of seed, the student generates a description of an activity which includes the ideas of changing only one variable at a time and using a control sample by describing an activity which includes those ideas.

ES
02-Core-14

When asked to define *biodegradable*, the student recalls the definition that biodegradable materials are chemicals which can be decomposed by organisms by responding with the effect of that definition.

ES
02-Core-15

Given a description of a lake into which biodegradable chemicals are being dumped and asked how biodegradable chemicals can cause the rapid decrease of dissolved oxygen, the student applies the notions that biodegradable chemicals serve as a food source for algae and thus allow the algae population to reproduce rapidly and that the excess number of algae and of microorganisms that feed on algae wastes uses up the oxygen in the lake by stating that in effect.

ES
02-Core-16

Given that the biodegradability of a substance is not a guarantee that it will not pollute and a list of four purported reasons for this and asked to select the best explanation of how biodegradable substances may cause pollution, the student applies the concept that biodegradable substances while being broken down into simpler substances may produce an increase in food supply for an organism which then increases its population thereby drastically increasing its intake from and output to the environment by selecting the response which includes that notion.

ES
02-Core-17

Given a situation in which a citizen claims that he is not negatively influencing a nearby pond environment because of the care he takes in using a nonbiodegradable pesticide and asked to agree or disagree with the position and to defend his response, the student applies the concept that nonbiodegradable pesticides do not have just the desired positive affects on the area on which they are used by responding negatively and that nonbiodegradable pesticides are often carried off by such carriers as rainwater which runs off the field, insects which consume nonfatal amounts of the pesticide, and wind-carried dust particles.

ES
02-Core-18

Given a diagram of a food web and asked to state the term used for the entire system and to explain what an arrow means in the diagram, the student recalls that a system of organisms diagramed to show which are input for others is called a *food web* and that the organism at the tail of each arrow is eaten by (is input to) the organism at the head of each arrow by responding to that effect.

ES
02-Core-19

ES
02-Core-20

Given a description of a situation in which a factory dumps a nonbiodegradable chemical into a river, but a few miles downstream the chemical is found to be present only in small quantities and asked to explain why this chemical seems to be disappearing from the river, the student applies the concept that many nonbiodegradable chemicals are absorbed by living plants or animals or settle to the bottom of the river by stating an explanation that includes both alternatives.

ES
02-Core-21

Given a diagram of a four-level food chain in an area where a nonbiodegradable chemical has gotten into the water and asked to predict which organisms would contain the highest concentration of the chemical and which would contain the lowest concentration of the chemical, the student applies the concept that the concentration of a nonbiodegradable chemical increases with the level of the organism in a food web by stating that the organism near the top of the food chain will contain the highest concentration and the organism near the bottom of the food chain will contain the lowest concentration.

ES
02-Core-22

When asked what characteristics an ideal detergent would have, the student generates the concept that an ideal detergent would break down after use into harmless non-nutritive materials or would react with other sewage materials to be removed in settling basins by responding with one of the characteristics above or a suitable alternative.

ES
02-Core-23

Given his response either to Problem Break 4-4 or to Problem Break 4-5, which involves the use of a chemical that man is adding to the biosphere, its effects on an ecosystem, and a brief description of the uses of the chemical, and asked to defend or modify his arguments both for and against banning the use of this chemical, the student generates arguments both for and against banning a chemical, based on the effects of the chemical on the biosphere, on the people who manufacture and use the chemical, and on how a ban might affect large numbers of people who depend on the products of the industries that use this chemical, by stating at least one defense or modification of his position that the chemical should be banned and one defense or modification of his argument that its use should be continued.

ES
02-Core-24

Given the information that a particular reactive substance should be kept cold to retard its reacting and asked to explain the reason, the student applies the concept that increasing the temperature increases the rate of a chemical reaction by stating an explanation that includes the essence of the concept.

ES
02-Core-25

Given the body temperatures of three different animals at two different outside temperatures and asked to indicate for each animal whether it is warm-blooded or cold-blooded, the student classifies those animals whose body temperatures remain relatively constant when the temperature of the surroundings change as warm-blooded and those animals whose body temperatures vary with the temperature of the surroundings as cold-blooded by correctly indicating whether the three animals are cold-blooded or warm-blooded in agreement with the classifications above.

Given the information that a particular animal is cold-blooded, that its activity drops in cold weather and increases in warm weather, and that certain chemical reactions in the animal release energy to it and asked to explain why in terms of what he has learned, the student generates an explanation of why the activity of a cold-blooded animal varies with the temperature of its surroundings by stating an explanation which includes the idea that when the temperature is low the animal is inactive because the chemical reactions in its body occur less rapidly, releasing energy more slowly, whereas in warm weather the animal is more active because the chemical reactions in its body occur more rapidly, releasing energy more quickly.

ES
02-Core-26

When asked to define *thermal death point*, the student recalls the definition that the thermal death point is that temperature at or above which an organism will die by stating the effect of that definition.

ES
02-Core-27

Given a description of a situation in which fish die after being subjected to a major temperature increase and asked to explain why they died, the student applies the concept that for each kind of organism there is a thermal death point, a temperature at or above which that organism dies, by explaining the essence of the concept.

ES
02-Core-28

Given a description of a situation in which two types of fish are kept in the same tank because they have the same preferred temperature range and asked to explain why only one of the types of fish dies when the temperature in the tank accidentally gets too warm, the student applies the concept that all organisms with a similar preferred temperature range do not have the same thermal death point by responding to the effect that the type of fish that died must have had a lower thermal death point than the other.

ES
02-Core-29

Given a description of a situation in which a certain concentration of a nonbiodegradable substance affects one species but not another and asked to explain why one organism is affected, whereas the other one does not seem to be affected, the student generates the concept that different organisms may have different tolerances for nonbiodegradable substances by stating an explanation that involves that notion.

ES
02-Core-30

Given a description of a situation in which an aquatic species is found in different parts of a body of water at different times of the year and a list of four possible reasons for this change and asked to select the best reason why this change occurs, the student applies the concept that most kinds of living things have a preferred temperature range by selecting the response that includes that idea.

ES
02-Core-31

Given that a certain species of fish requires a great deal of oxygen and asked whether this type of fish is more likely to be found in cold water or warm water and to explain why, the student applies the concept that cold water can hold more dissolved oxygen than warm water by predicting that the fish is more likely to be found in cold water and stating the essence of the concept.

ES
02-Core-32

ES
02-Core-33

Given a series of graphs which purport to show possible relationships between the temperature of water and the amount of oxygen gas that will dissolve in water and asked to select the graph that best shows this relationship, the student applies the concept that increasing the temperature of water decreases the amount of dissolved oxygen in the water by selecting the graph which slopes downward to the right (a negative slope).

ES
02-Core-34

Given a description of two aquatic situations which differ only in temperature and asked to predict in which situation fish would survive longer if the outside oxygen supply were cut off and to give two reasons for his answer, the student applies the concepts that living organisms use oxygen faster at higher temperatures and that less oxygen dissolves in warm water than in cold water by stating that the fish will survive longer in the cooler tank and the essence of both concepts.

ES
02-Core-35

Given a description of an experiment in which the oxygen consumption of a cold-blooded organism is measured at various temperatures and four graphs showing the possible relationships between oxygen consumption and temperature and asked to select the graph that shows this relationship best, the student applies the concept that cold-blooded organisms use oxygen faster at higher temperatures by selecting the graph that slopes upward to the right (a positive slope).

ES
02-Core-36

When asked to define *thermal pollution*, the student recalls the definition that thermal pollution is the accumulation of heat in surface waters by stating the effect of that definition.

ES
02-Core-37

Given a list of five statements, four of which are possible effects of thermal pollution and one of which is not, and asked to select the statement which is not a possible effect of thermal pollution, the student recalls that the effects of thermal pollution include increasing the B.O.D. of living organisms, decreasing the amount of dissolved oxygen in the water, killing some fish by raising the water temperature above their thermal death point, and driving some fish away because the water temperature is no longer within their preferred temperature range by selecting the statement which disagrees with one of those.

ES
02-Core-38

Given a situation in which a permit is issued to a certain company to pollute for a short and limited period of time and asked if the brevity of the pollution is a valid reason to allow this short-term pollution and to explain his answer, the student applies the concept that pollution need not last a long time in order to have long-range effects on the environment by responding to the effect that there are limits to the amount of pollutants with which organisms can survive for even short periods.

ES
02-Exc 3-1-1

Given a description of two areas of the country which have equal amounts of precipitation, but whose vegetation is very different and asked to list three factors which might account for this difference in vegetation, the student recalls that many factors, such as altitude, temperature, soil type, amount of runoff, population, amount of

sunlight, and evaporation rate affect the amount of water available for plants and therefore the type of plants that can grow by listing three variables including at least two of those given above.

Given that international or regional disputes are beginning to occur about water rights and asked to explain why these did not occur as often in the past and why some people expect that these disputes are likely to become much more vigorous in the future, the student applies the concept that water use has increased rapidly and is expected to continue to increase rapidly by stating in effect that there has been a rapid rate of increase in the amount of water used and that this has meant that certain areas are running short of water and are attempting to get more water wherever they can.

ES
02-Exc 3-1-2

Given transpiration rate data for trees and grass and the possibility of using both kinds of plants as deterrents to erosion and asked which he would recommend for landscaping a hilly area surrounding a new development with a water table that is slightly low, the student generates the notion that solutions to practical environmental problems are often compromises from among several sets of values by responding to the effect that a compromise be struck between trees for beauty and erosion control and grass for erosion control without the high transpiration rate.

ES
02-Exc 3-1-3

Given a list of terms related to the water cycle and asked to arrange them in the order in which they occur in the cycle, the student applies the concept that the water cycle, in part, involves the following sequence: evaporation, precipitation, runoff, and becoming part of a larger body of water, by arranging the items to reflect that sequence.

ES
02-Exc 3-1-4

When asked to give two different operational definitions that could be used to detect and to measure *plant growth*, the student applies the concept that different operational definitions can be used to detect and measure a quantity as long as each operational definition is related to the variable to be measured by stating two different operational definitions for *plant growth* which involve changes in the plant, such as the distance from the ground to the topmost leaf, the number of leaves, or the maximum spread of leaves from the stem, and a way to measure the change.

ES
02-Exc 4-1-1

Given a description of a variable that might affect the rate of germination and the growth of the plants that germinate and asked to describe an experiment that he could perform to determine whether this variable affects the plants, the student generates a description of an experiment that involves changing only the one variable to be investigated while holding others constant by describing such an experiment.

ES
02-Exc 4-1-2

Given a description of a person who has found one or two ways to keep from contributing to air pollution and asked whether it is true that this person does not contribute to the air pollution problem at all and to explain his answer, the student applies the concept that everyone is directly or indirectly a source of air pollution by responding negatively and with the essence of the concept or with examples to illustrate the concept.

ES
03-Core-1

Given a description of a situation in which a company has installed a filtering system in its smokestack to remove solid particles and asked whether this factory can now definitely be classed as one which is not contributing to air pollution and to explain his answer, the student applies the concept that air pollution can occur in the form of solid particles, liquids, or gases by responding negatively and with the essence of the concept.

ES
03-Core-2

When asked to state an operational definition for *solid-particle air pollution*, based on the sticky-tape method, the student generates an operational definition for *solid-particle air pollution* which describes a procedure involving exposing sticky tape for a certain period of time and then counting the particles in a unit area of the tape by stating such a procedure.

ES
03-Core-3

Given a graph showing the amount of pollution from each of several major sources, including motor vehicles, and a reminder of the relative sizes of each of the sources and asked to explain why motor vehicles are the largest producers of pollution, the student applies the concept that although the pollution output of individual producers is very small the total output of the producers may be of catastrophic proportions by responding to that effect.

ES
03-Core-4

Given a list of five combustion products and asked to indicate which of the products is not a major pollutant, the student recalls that the products of combustion considered to be major pollutants include carbon monoxide, unburned hydrocarbons, nitrogen oxides, sulfur oxides, and solid particulates by selecting the combustion product listed which is not one of those.

ES
03-Core-5

Given a list of four results of air pollution and the option "all of these" and asked to select the option which best describes the effects of air pollution, the student recalls that air pollution can (1) increase some human diseases, (2) damage crops, (3) weaken or kill animals, (4) discolor and damage clothes, automobiles, and buildings, (5) increase the rate of deterioration of steel, rubber, glass, leather, nylon, paper, and even stone, and (6) cause discoloration or peeling of paint by selecting the option "all of these."

ES
03-Core-6

Given the assumption that removing pollutants from factory output costs money but releasing them costs nothing and asked to write a reply to this assumption, the student applies the concept that released pollutants cause costly damage to living organisms, crops, and materials by responding with the essence of the concept and two examples of the damage done.

ES
03-Core-7

ES
03-Core-8

Given a description of a situation in which a person wants to move to the country so that he can escape air pollution and asked whether he will escape air pollution entirely by doing so and to explain his answer, the student applies the concept that no area of the world is free from air pollution by responding negatively and that one will not escape air pollution by leaving a city because air pollution is worldwide.

ES
03-Core-9

Given four graphs of population size versus time and asked to select the graph that best illustrates a severe population explosion, the student classifies the curve whose slope increases most rapidly as the curve showing a population explosion by selecting the graph which is concave upward.

ES
03-Core-10

Given a table showing the number of births and deaths in a population for three consecutive years, the births for the fourth year, and the deaths for the fifth year and asked to supply the number of deaths for the fourth year and the number of births for the fifth year so as to produce a constant population for those two years, the student applies the concept that a population remains constant when the number of deaths equals the number of births by supplying the missing data for both years so that the number of births for each of those two years equals the number of deaths for that year.

ES
03-Core-11

Given a graph of the population size of a type of organism over time and a description of a situation and asked to indicate the first point in time at which the number of births equals the number of deaths, the student applies the concept that when the number of births equals the number of deaths in the population, the population size remains constant by indicating the first period of time at which the curve is parallel to the time axis, to within \pm one-fourth of a week of the accepted time.

ES
03-Core-12

Given four different graphs of population versus time and asked to select the graph which best indicates how populations of plants and animals change with time, the student recalls that population studies of many plants and animals indicate that an S-shaped curve is typical of changing population by selecting the graph showing an S-shaped (sigmoid) population curve.

ES
03-Core-13

When asked to list four variables that could limit the size of a nonhuman population, the student recalls that the variables that could limit the size of a nonhuman population include the presence of disease organisms, the presence of wastes and poisons, the availability of food and necessary gases, the presence of man, and the availability of space by stating four variables, at least three of which express those notions.

ES
03-Core-14

Given that the human population has recently increased at a rapid rate and asked what variables man has learned to control to allow such an increase, the student generates the notion that disease, disease carriers, sanitation, food storage, and food production are variables that man has learned to control which have allowed the present population explosion to occur by listing at least two of the variables above or examples of them.

Given his response either to Problem Break 8-1 or to Problem Break 8-3, both of which involve the use of a chemical which man is adding to the biosphere and its effects on an ecosystem, and a brief description of the use of the chemical and asked to defend or modify his arguments both for and against banning the use of this chemical, the student generates arguments both for and against banning a chemical, based on its effects on the biosphere, on its effects on the people who manufacture and use it, and on how a ban might affect large numbers of people who depend on the products of the industries which use this chemical, by stating at least one defense or modification of his position that the chemical should be banned and one defense or modification of his argument that its use should be continued.

ES
03-Core-15

Given his response to Problem Break 8-2, which involves an industry (a potential polluter) which builds a plant in a financially poor state, thus increasing employment and the state's tax revenue, and asked to defend or modify his argument both for and against bringing in such an industry, to defend or modify the limitations he would place upon such an industry, and to defend or modify his argument for supporting or not supporting such an industry if he were a member of the state legislature, the student generates arguments both for and against permitting such an industry to locate in the state, based on the effects of the industry on employment and the state's tax revenue and on the industry's polluting potential, by stating at least one defense or modification of his argument that the industry should be allowed to locate in the state and one defense or modification of his argument that the industry should not be allowed to locate in the state.

ES
03-Core-16

Given the total world population on a certain date and the birthrate and death rate in individuals per day and asked to calculate how long it will take the world's population to reach a specified size if these rates are maintained, the student generates the procedure for determining the time required for the population to reach a certain size by subtracting the current population size from the specified future size, dividing this total population increase by the difference between the birthrate and the death rate, and stating the time he calculates, using the procedure.

ES
03-Core-17

Given one chart showing current birthrate and death rate and two charts showing conditions for a constant population, one of which shows an increased death rate and the other of which shows a decreased birthrate, and asked which of these situations would a more desirable solution to the population problem and to explain his answer, the student generates an explanation based on the idea that a reduction in the birthrate would create less human misery and suffering than allowing an increase in the death rate by stating that lowering the birthrate would be more desirable and an explanation based on that idea.

ES
03-Core-18

When asked to state the relationship between a temperature inversion and an increase in air pollution at the earth's surface, the student recalls that a temperature inversion increases the concentration of air pollution by preventing the normal vertical mixing of air and trapping the pollutants near the ground by responding to that effect.

ES
03-Exc 6-1-1

ES
03-Exc 6-1-2

When asked to state a major cause of temperature inversions, the student recalls that a major cause of temperature inversions is advancing fronts by responding to that effect.

ES
03-Exc 6-1-3

Given four graphs showing relationships between air temperature and altitude and asked which graph represents the normal relationship between altitude and temperature and which represents a temperature inversion, the student applies the concepts that the temperature decreases as the altitude increases and that in a temperature inversion, the temperature decreases, then increases, and then decreases again as altitude increases by selecting the graphs which illustrate correctly the relationships indicated by the concepts above.

ES
03-Exc 7-1-1

Given a list of variables, two of which directly influence the size of a population, and asked to select all the variables that directly influence the size of the population, the student recalls that the variables which directly influence the size of a population include the birthrate, the death rate, the rate of immigration, the rate of emigration, and the food supply by selecting both variables from the list above which occur in the question.

ES
03-Exc 7-1-2

Given a table listing the conditions of three population experiments analogous to those of Dr. John Emlen's experiments on mice populations and a table listing the possible birthrates and death rates and asked to match the experimental conditions with the experimental results, the student applies the concepts that an open system with a limited food supply results in a higher birthrate than death rate, that a closed system with a limited food supply results in a low birthrate which is equalled by the death rate, and that a closed system with an unlimited food supply results in a high birthrate and a high death rate by matching the experimental conditions to the experimental results, in agreement with those concepts.

ES
03-Exc 7-2-1

Given data about the atmospheric composition and temperature range of two imaginary planets and asked whether they would be suitable for human habitation without special support equipment and to explain his answer, the student applies the concept that if a planet is to be suitable for human habitation, the temperature range on at least part of its surface must be between 0°C and 100°C if there is to be a possibility that liquid water is available and its atmosphere must contain oxygen by responding negatively and with the essence of the concept.

ES
03-Exc 7-3-1

Given the assumption that there is no change in the life span of the individual and three graphs of population size as a function of time, one of which shows population increasing, one decreasing, and one remaining almost constant, and asked to indicate for each graph whether a family in the population averages fewer than two children, exactly two children, or more than two children, the student applies the facts that, assuming there is no change in the life span of the individual, a family with fewer than two children results in a decline in population, two children results in an almost constant population, and a family with more than two children results in an increas-

ing population by indicating the average family size which is in agreement with a particular graph in accordance with the above facts.

Given a graph of how human life expectancy has changed in the United States since 1920, with an extension of the curve to indicate a possible decline in life expectancy beyond the known data, and asked to state reasons that might cause a decline in life expectancy during the next few decades, the student generates an explanation which includes the ideas (1) that increased pollution may cause a decline in life expectancy, (2) that increasingly crowded conditions may facilitate the spread of diseases, or (3) that crowded conditions might cause increased violence (as they do in mice) by stating an explanation including at least one of those ideas.

ES
03-Exc 7-3-2

Given a graph of life expectancy since 1200 A.D. and asked to predict the life expectancy in the year 2100 A.D. and to state why his prediction is likely to be inaccurate, the student applies the concept that predictions based on extrapolations beyond known data are not likely to be accurate because of the effects of unknown variables by predicting a life expectancy and stating the essence of the concept.

ES
03-Exc 7-3-3

Given a description of a situation in which a person who works in a noisy environment notices that after he leaves work he has difficulty hearing for a little while and asked to explain what might be the cause of this, the student generates an explanation based on the idea that a noisy environment may cause a temporary hearing reduction by stating an explanation that includes that idea.

ES
03-Exc 8-1-1

Given an operational definition for *hearing index* and four graphs showing possible relationships between a person's age and *hearing index* and asked to select the graph which best illustrates this relationship, the student applies the facts that hearing loss usually begins in a person about age twenty-five and that the rate of loss increases with age after that by selecting the graph which illustrates those facts.

ES
03-Exc 8-1-2

Well-Being **WB**

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When asked to define *system*, the student recalls the definition that a system is several objects (components) that influence each other by stating the effect of that definition.

WB
01-Core-1

Given a diagram and a set of operations descriptive of a system and asked to name the stimuli and responses and to explain how they function as a negative feedback system, the student applies the concept that a negative feedback system is a set of components which influence each other in such a way that the response of the system to a stimulus is the opposite of the change produced by the stimulus by naming such stimuli and responses in the system and explaining with the effect of the concept.

WB
01-Core-2

Given a graph of the variation of a variable that is controlled by a negative feedback system and asked to read the set point of the detecting mechanism, the student applies the concept that the set point of the detecting mechanism of a negative feedback system is the midpoint between the maximum and minimum fluctuations of the system by reading the set point to within $\pm 0.5^{\circ}\text{C}$ of the midpoint between the maximum and minimum values of the variables.

WB
01-Core-3

Given a description of how the temperature-controlling mechanism of a refrigerator works and a series of graphs showing possible temperature variations in the refrigerator over time and asked to select the graph that best indicates how the temperature would vary inside a closed refrigerator, the student applies the concept that a variable which is controlled by a negative feedback system fluctuates around a set point in a regular manner by selecting the graph that shows this relationship.

WB
01-Core-4

When asked to predict one thing which might happen if a thermostat can no longer detect temperature changes and send messages to the furnace and to explain why it would happen, the student applies the concept that a negative feedback system detects changes in the variable being controlled so that the value of that variable does not become too large or too small by stating in effect either that the room will get very hot because the thermostat does not turn the furnace off, or that it will get cold because the thermostat does not turn the furnace on.

WB
01-Core-5

Given that the number of calories equals the mass (grams) of water times the change in temperature, the mass of water in grams, and the initial and final temperatures of the water in degrees Celsius and asked to calculate the number of calories required to heat the water from one temperature to the other, the student applies the formula to the given data to determine the number of calories required by multiplying the mass of water in grams times the temperature change in $^{\circ}\text{C}$ and reporting the product of the two variables as the number of calories needed.

WB
01-Core-6

When asked to give an operational definition of *calorie*, the student recalls the operational definition that a calorie is the amount of heat required to raise the temperature of one gram of water 1°C by stating the essence of that definition.

WB
01-Core-7

WB
01-Core-8

When asked to state the number of calories that equals one Calorie, the student recalls that 1,000 calories equal 1 Calorie by stating that 1,000 calories equal 1 Calorie.

WB
01-Core-9

Given a list of things that purport to happen to the energy in food inside the body and asked to select the best description of what happens to the energy in food which has been eaten, the student recalls that the energy in consumed food can be used by the body to keep the body temperature constant or for doing work or that it may be stored as fat by selecting the answer that includes all three of those.

WB
01-Core-10

When asked to name two things that a person can do if he wants to lose weight without taking drugs, the student recalls that if a person wants to lose weight, he can either decrease the amount of food energy he takes in or increase the amount of work he does by responding to that effect.

WB
01-Core-11

Given the energy equivalent of a pound of stored fat, the daily food energy input of a particular person, and the amount of energy his body uses each day for doing work and for temperature control and asked to calculate how long it would take that person to gain or to lose five pounds of weight, the student applies the procedure for determining the amount of time it takes a person to gain or to lose a certain amount of weight by subtracting the number of Calories used each day from the food energy input to determine the difference, dividing the product of the number of Calories per pound of stored fat times the number of pounds he wants to lose or gain by that difference, and reporting the time in days accurately to within $\pm 10\%$.

WB
01-Core-12

When asked to explain why most diet plans suggest that the dieter eat a variety of different kinds of food such as leafy vegetables, meats, yellow vegetables, and fruit when trying to reduce his Calorie input to lose weight, the student applies the concept that nutrients such as vitamins, minerals, and proteins are just as important as the number of Calories in food by stating in effect that a variety of food is suggested to ensure that the dieter receives enough of the other necessary nutrients such as vitamins, minerals, and proteins.

WB
01-Core-13

Given ample opportunity to work with materials on a laboratory activity of more than one day's duration and asked to observe the cleanup period at the appropriate time, the student chooses to close the laboratory activity period promptly upon receiving notification of the time by immediately ceasing the laboratory activity, returning materials in usable, clean condition to storage places, and participating in work area cleanup on at least three separate occasions when being observed by the teacher without his knowledge.

WB
01-Core-14

When asked to work in the laboratory with fellow students, the student chooses to cooperate with fellow students in the laboratory by being polite, waiting his turn, being orderly when moving about, and observing the right of his classmates to work without being unnecessarily disturbed; when observed without his knowledge by the teacher or another designated person on at least three occasions.

When asked to work with the equipment and text materials of the ISCS course, the student chooses to show personal responsibility for returning laboratory equipment no longer needed to the proper storage places during the activity period by returning such equipment and materials to the designated storage places on at least three occasions when observed by the teacher or another designated observer without his knowledge of being checked.

WB
01-Core-15

When asked questions in the textbook, the student chooses to write in his *Record Book* his answers to 90% or more of the questions in his textbook by exhibiting the written responses when the teacher spot checks to determine if he is doing so.

WB
01-Core-16

When working independently in the laboratory, the student chooses to show proper care and use of ISCS laboratory materials by using the materials only for their intended purpose or by requesting permission to do other specific experiments with them, when being observed without his knowledge by the teacher or another designated person on three or more occasions.

WB
01-Core-17

Given a list of five units of measurement including the unit *calorie* and asked to choose from them the unit in which heat energy is measured, the student recalls that the calorie is a unit in which heat energy is measured by selecting *calorie*.

WB
01-Exc 1-1-1

Given four possible conclusions for the activity in which water was heated using burning marshmallows and burning peanuts and asked to select the best possible conclusion, the student applies the concept that finding that a variable differs in two objects does not indicate that all objects differ in this variable by selecting the conclusion which expresses that notion.

WB
01-Exc 1-1-2

Given a specified number of calories and asked how many Calories that number represents, the student applies the relationship that 1,000 calories equal 1 Calorie by reporting an answer that is 1/1,000th of the number of calories specified.

WB
01-Exc 1-1-3

Given a list of foods identified as containing mostly carbohydrates, fats, or proteins and asked to select the food he would want most to avoid if he were trying to reduce his Calorie intake, the student applies the concept that gram for gram, fats contain more Calories than carbohydrates or proteins by selecting the food that is mostly fats.

WB
01-Exc 1-2-1

Given a description of the same food prepared in three different ways and asked to select which method of preparation results in the largest number of Calories and to explain his answer, the student applies the concept that the method by which food is prepared affects the number of Calories it contains by selecting the fried form of the food and explaining in effect that of the three methods of preparation, frying introduces Calories through the addition of fats and oils.

WB
01-Exc 1-2-2

WB
01-Exc 1-2-3

Given the statement that a person has a well-balanced diet and asked if *well-balanced diet* means only that his Calorie intake is being counted and to explain his answer, the student applies the concept that other things such as vitamins, minerals, and protein are involved in a well-balanced diet by responding negatively and with that notion.

WB
01-Exc 1-3-1

Given appropriate data and a section of an activity-calorie-body weight chart similar to the one on page 104 and asked to calculate the total number of Calories used by the person during the time represented and to show his work, the student applies the procedure for calculating the total number of Calories used by a person in performing various activities by multiplying the time (in hours) by the number of Calories used per pound of body weight per hour by the body weight in pounds for each activity, then summing the Calories used for each activity to determine the total number of Calories used, and reporting the total number of Calories correctly within $\pm 5\%$.

When asked to explain why a control had to be used when investigating the effect of the cigarette-smoke solution on the germination of corn seeds, the student applies the concept that controls are necessary in most experiments to determine whether the observed effect is associated with the treatment or whether it would occur anyway by responding either to that effect or with an example of another variable which could have affected the results.

WB
02-Core-1

When asked to list three chemicals or types of chemicals in cigarette smoke, the student recalls that the chemicals in cigarette smoke include nicotine, cancer-producing substances, irritants, carbon monoxide, and arsenic by listing three of those five.

WB
02-Core-2

Given three diagrams of epithelial tissue from people's windpipes which show no damage, minor damage, and major damage and the three labels "nonsmoker," "moderate smoker," and "heavy smoker" and asked to match the labels with the diagrams, the student recalls that the amount of damage to the epithelium of a person's windpipe is proportional to the amount he smokes by matching the diagrams with their labels correctly.

WB
02-Core-3

Given a list of five possible effects of smoking on the body and asked to select the one effect that smoking does not have, the student recalls that smoking has the following effects on the body: (1) it causes the epithelium of the windpipe to become thicker and contain more and larger goblet cells, (2) it reduces the number and activity of the cilia in the epithelium of the windpipe, (3) it increases the mucus and the chances of having a cough or other respiratory problems, (4) it causes a loss in the control of cell production in the epithelium, (5) it tends to break down the walls of the air sacs in the lungs, (6) it increases the heartbeat rate, and (7) it increases the breathing rate by selecting the effect which contradicts one of those listed.

WB
02-Core-4

Given a situation in which two variables increase together but are not directly related to each other and asked whether this proves that a change in one variable causes a change in the other and to explain his answer, the student applies the concept that the fact that two variables are associated and increase or decrease together does not prove that one causes the other, as unknown or uncontrolled variables may also be involved, by responding negatively and with the essence of the concept.

WB
02-Core-5

Given four statements about the death rate of people who smoke and asked to select the statement that is not true, the student recalls that the death rate and diseases of the respiratory system are increased by smoking by selecting the statement which disagrees with one of the following: (1) the death rate due to lung cancer increases the more a person smokes, (2) smoking increases the chances of dying from a number of diseases such as bronchitis and emphysema, (3) cancer of the voice box, mouth, and throat increases with increased smoking, (4) the death rate increases the more a smoker inhales, and (5) the death rate decreases slowly for people who stop smoking.

WB
02-Core-6

WB
02-Core-7

When asked to state an operational definition for *physical dependence*, the student recalls the operational definition that physical dependence is indicated by the withdrawal reaction to stopping the use of a drug and the amount of dependence is measured by the extent of the withdrawal reaction by stating the essence of the definition.

WB
02-Core-8

When asked to define *psychological dependence* operationally, the student recalls the operational definition that psychological dependence is indicated by a mental craving for something when there is no physical need for it and is measured by the extent of the craving by stating the effect of that definition.

WB
02-Core-9

Given a description of two persons, one physically dependent on a drug and the other psychologically dependent on a drug, and asked to indicate for each description whether the dependence is psychological or physical and explain the reason for his answer, the student applies the concept that a person physically dependent on a drug would suffer a withdrawal illness when he stopped using the drug and that a person psychologically dependent on a drug has a mental craving for it, but his body does not require the drug for normal functioning, by stating the type of dependence correctly in both cases and the essence of the applicable concept.

WB
02-Core-10

Given a description of a situation in which a pregnant woman is advised not to use a certain drug until after her baby is born and asked to state the reason that pregnant women should not use certain drugs, the student generates an explanation based on the idea that the drug may affect the unborn infant by causing it to become physically dependent on the drug or by effecting its development by stating an explanation that expresses at least one of those ideas.

WB
02-Core-11

Given a description of the physical effects of a drug on a body system and asked to diagram and label a possible negative feedback system that might not work when this drug is taken, the student applies the concept that a negative feedback system contains at least one detecting mechanism, a message component, and a controlling component, all of which interact so that when a stimulus is imposed on the system, the system reacts to counteract the effect of the stimulus, by diagramming and labeling a negative feedback system, in agreement with this concept, which may cause the physical symptoms if the system did not operate correctly.

WB
02-Core-12

When asked to list two different ways of sending messages in the human body, the student recalls that messages may be carried in the human body chemically or electrically by stating both ways.

WB
02-Core-13

When asked to explain the difference between drug use and drug abuse, the student generates an explanation to the effect that drug abuse refers to using drugs unnecessarily or without or beyond medically recommended dosages, whereas drug use refers to using drugs within medically recommended limits to aid one's health or welfare by stating an explanation that includes those ideas.

Given the terms *cell*, *tissue*, *organ*, and *organ system* and asked to arrange them in order of increasing complexity from simplest to most complex, the student recalls that a cell is the simplest unit, a tissue is composed of many cells, an organ is composed of several different types of tissues, and an organ system is made up of several organs by listing the words in the following order: cells, tissue, organ, and organ system.

WB
02-Exc 2-1-1

When asked to explain why it is necessary for most plants and animals to be composed of many different kinds of cells instead of just one kind of cell, the student recalls that there are many different kinds of cells because cells in different parts of the plant or animal must do different things by responding to that effect.

WB
02-Exc 2-1-2

When asked to list three advantages of an interview over a written questionnaire, the student recalls that advantages of an interview include the facts that (1) sometimes people will say more than they will write, (2) movements, looks, or tones of voice may give clues about what a person is really thinking, and (3) in an interview a person can be asked to make a point clearer or to give more information by listing three advantages, two of which express the essence of statements above.

WB
02-Exc 2-2-1

When asked to explain why companies which take surveys of public opinion train their interviewers to ask exactly the same questions in exactly the same tone of voice, the student applies the concept that in any data gathering it is necessary to control all extraneous variables that might affect the results (data) by stating the effect of that concept.

WB
02-Exc 2-2-2

When asked to explain why many surveys use written questionnaires rather than interviews, despite the advantages of an interview, the student recalls that questionnaires are often used because they make it possible to contact a larger number of people more quickly and more cheaply than is possible using personal interviews by responding to that effect or with any other advantage that he can defend.

WB
02-Exc 2-2-3

Given a four-item questionnaire which includes a request for the respondent's name, one ambiguous question, one question with very biased wording, and one multiple-choice question with overlapping or missing categories and asked to improve the construction of the questionnaire, the student applies the concepts of good questionnaire construction that (1) an anonymous questionnaire is more likely to be answered and provides a better measure of a person's feelings than one which is signed, (2) the questions should use clear and simple language so that words and ideas cannot be misunderstood, (3) the questions should never indicate the preferred answer, and (4) multiple-choice questions should provide an unambiguous response for every possible type of respondent by improving a questionnaire so that it is in agreement with at least three of the four concepts.

WB
02-Exc 2-2-4

Given a schematic diagram of the human circulatory system with arrows indicating certain parts and asked to name the parts indicated, the student identifies the major

WB
02-Exc 2-3-1

parts of the human circulatory system by naming correctly the heart, lungs, veins, arteries, and capillaries.

WB
02-Exc 2-3-2

Given a schematic diagram of the human circulatory system with parts identified by letters and asked to indicate the path of blood flow through the body starting with a particular part, the student recalls the general pattern of blood flow through the body by listing the letters that correspond to the following sequence of parts beginning with the part initially indicated: blood flows from the veins to the left auricle of the heart, to the left ventricle, to the pulmonary arteries, to the lungs, to the right auricle, to the right ventricle, to the arteries, to the capillaries of the body, and back to the veins.

WB
02-Exc 2-3-3

When asked to give two reasons why the red blood cells are so important to the functioning of the body, the student recalls that red blood cells carry oxygen from the lungs to the rest of the body cells and carry carbon dioxide from the body cells to the lungs by responding to that effect.

Given a sentence using *depressant* in the context of drugs and asked to define *depressant*, the student recalls the definition that depressants are chemicals used to slow down the rate of functioning of the body by stating the effect of the definition.

WB
03-Core-1

When asked to describe two symptoms experienced by a person who had taken a depressant, the student recalls that a depressant causes slower breathing, slower reaction rates, slurred speech, trouble concentrating, decreased coordination, slower heartbeat, lower blood pressure, and poor emotional control by listing at least two of those symptoms in his response.

WB
03-Core-2

Given a list of effects of drugs and asked to indicate those which are effects of depressants which might cause a physician to prescribe them, the student recalls that depressants are sometimes prescribed by doctors to relieve severe pain due to heart failure, heart attack, and cancer; to reduce the tendency to cough; to prevent epileptic seizures; to reduce restlessness; or to lower high blood pressure, by selecting any two of the three of these effects that occur in the check.

WB
03-Core-3

Given a graph showing the stopping distances of a car as a function of speed ... a graph having two curves, one showing stopping distances for a driver before and one showing stopping distance after the driver has drunk some alcohol, and asked to state which curve indicates the driver after he has been drinking and to explain his answer, the student applies the concept that alcohol dulls the senses and increases reaction time by selecting the curve showing the greater stopping distance and stating the essence of the concept.

WB
03-Core-4

When asked to explain why people sometimes suggest substituting a test for the speed of a person's reactions for the blood-alcohol percentage level test in order to determine whether a driver is under the influence of alcohol, the student applies the concepts that there are differences in the effect of the same amounts of alcohol on individuals and that measurements should be appropriate to the variables they measure by stating an explanation which includes that concept as a reason for testing something which, like reaction time, is more closely related to driving than is blood-alcohol level.

WB
03-Core-5

Given a description of a situation in which one person has drunk some alcohol, another has taken a barbiturate, and a third has taken both and asked to predict which person is likely to be affected most and to explain his answer, the student applies the concept that one drug may increase the effect of another so that their combined effect may be much greater than the effect of either one alone by stating that the person who has taken both drugs is likely to be affected most and the essence of the concept.

WB
03-Core-6

Given a list of useful properties of different drugs and asked to indicate which of the properties listed is a useful property of stimulants, the student recalls that the useful properties of stimulants prescribed by a doctor include reducing the appetites of

WB
03-Core-7

overweight people, relieving severe pain, and reducing drowsiness by selecting any two of the properties from the above list.

WB
03-Core-8

Given a list of purported effects of stimulants on the body and asked to select all of those effects that can be caused by stimulants, the student recalls that the effects of stimulants on the body include increasing heartbeat or breathing rates; producing psychological changes such as nervousness, irritability, tension, and anxiety; making it difficult to sleep; increasing aggressive and unpredictable behavior; reducing the appetite; and causing the body to use up energy reserves, thereby leading to sudden exhaustion or collapse, by selecting at least two of the effects listed above that appear in the check.

WB
03-Core-9

Given that a person feels that the stimulants pep pills or coffee eliminate the need for sleep and let him work much longer and asked whether these chemicals are effective substitutes for sleep or not and to explain his answer, the student recalls the concept that stimulants do not really eliminate fatigue but simply postpone tiredness because they help the body use up its stored energy by responding negatively and with the essence of the concept.

WB
03-Core-10

When asked to explain what is meant when a person is said to be developing a tolerance to a drug, the student recalls that a person is said to be developing a tolerance to a drug if he experiences decreasing effects per unit of the drug taken by stating the effect of that notion.

WB
03-Core-11

Given a list of the four common hallucinogens and the sources of these drugs and asked to match the hallucinogens and their sources, the student recalls that marijuana is derived from the hemp plant, mescaline from the peyote cactus, psilocybin from mushrooms, and LSD from a fungus on rye seed by matching the hallucinogens and their sources correctly.

WB
03-Core-12

Given a description of a situation in which a person has operationally defined a variable which describes a measurement distantly related to the variable to be measured and asked whether this is a good operational definition or not and to explain why, the student applies the concept that the measurement of a variable as defined by an operational definition should be closely related to the definition of the variable purported to be measured by responding negatively and with the essence of the concept.

WB
03-Core-13

When asked to predict whether two people could be expected to experience the same psychological effects if each took the same amount of a hallucinogen and to explain the reason for his answer, the student applies the concept that there are great differences among individuals in the psychological effects of hallucinogens because of differences in sensitivities, body weight, and background by responding negatively and with the essence of the concept.

When asked to list at least four possible undesirable effects of the hallucinogen LSD, the student recalls that common undesirable psychological effects of LSD include hallucinations that may be very frightening and flashbacks from these hallucinogens at a later time and that common undesirable physical effects include dilated pupils, lowered body temperature, increased heartbeat rate, chills, nausea, and possibly long-term damage to chromosomes by stating in his response the essence of at least four of those effects.

WB
03-Core-14

Given that a person claims that a hallucinogen does not have any bad effects because he has often used the drug and has noticed none and asked whether this is proof that the hallucinogen does not have any bad effects and to explain his answer, the student applies the concepts that hallucinogens have different effects on different people and that a drug may produce long-term changes that are not easily detected by responding negatively and with an explanation that includes the above notions.

WB
03-Core-15

When asked to define *placebo*, the student recalls the definition that a placebo is a harmless substance containing no active medicine and that it is used when testing the effects of drugs (medication) on people by stating the effect of the definition.

WB
03-Core-16

When asked to explain why when testing the effectiveness of a new drug, scientists give some people the actual drug and others placebos, the student recalls that scientists use placebos when testing the effectiveness of drugs to separate the effects caused by a person's belief that the drug will produce an effect and the effects caused by the drug itself by responding to that effect.

WB
03-Core-17

When asked to define *double-blind experiment* and explain why such experiments are used, the student recalls the definition that a double-blind experiment is one in which neither the experimenter nor the subject knows whether the actual treatment or a placebo is being used and that this procedure is used to prevent the experimenter from showing bias toward either the treatment group or the placebo group and to check for the mental effect on a subject of simply being part of an experiment by stating the effect of the definition.

WB
03-Core-18

Given a description of an experiment in which the effect of something is being tested on humans and asked to indicate whether this is a double-blind experiment or not and to explain his answer, the student applies the concept that in a double-blind experiment neither the subject nor the experimenter knows whether or not the subject is receiving the treatment by correctly stating whether or not the experiment is a double-blind experiment and the essence of the concept.

WB
03-Core-19

Given two laws and asked to state the reasons given in the text which explain why each of the two laws might have been passed, the student classifies each law as existing either to protect people from other people or to try to keep people from doing things that certain lawmakers or a segment of society do not consider right (moral laws) by stating the effect of the appropriate reason.

WB
03-Core-20

WB
03-Core-21

Given that Chapter 6 states that laws are passed to protect people from other people and also to support the moral standards of the community and asked if a tax law fits into one of the above mentioned categories and to explain his answer, the student generates the concept that laws may also be passed for other reasons than the two stated in the text by responding negatively and, in effect, that the law cited was passed to raise revenue.

WB
03-Exc 5-1-1

Given a five-item list describing illusions, delusions, and hallucinations and asked to indicate whether each of the items is a delusion, an illusion, or a hallucination, the student classifies as an illusion something that seems different from what it really is, as a delusion a feeling or belief that is not really true, and as a hallucination sensing something that is not really there at all by indicating the correct category for each item on the list.

WB
03-Exc 5-2-1

Given that the Digit Symbol Substitution Test (DSST) has been used with new and regular users of marijuana and that the DSST is an operational definition of an entity called *reaction time*, *matching ability*, or *concentration* and asked to explain how the DSST is an operational definition of the entity, the student applies the concept that an operational definition is a statement of how to detect and to measure an entity by stating that the DSST is a way to detect and measure that entity.

WB
03-Exc 5-3-1

Given a description of a loud, noisy party and asked whether the people at the party were more likely to have been drinking alcohol or smoking marijuana and to explain his answer, the student applies the concept that alcohol seems to stimulate aggressive behavior, whereas marijuana tends to stimulate passive and withdrawn behavior by stating that the people were probably drinking alcohol and the essence of the concept.

Why You're You

WYY

When asked the source and the function of sperm, the student recalls that sperm are things produced by the male parts – the testes or anther (stamen) – of animals and plants, and they can fertilize the eggs of the female by responding to that effect.

WYY
01-Core-1

When asked to state the source and function of an egg, the student recalls that eggs are produced by the female parts of plants and animals or the names of the specific parts, pistils and ovaries, and that an egg can combine with a sperm to become a new plant or animal by responding to that effect.

WYY
01-Core-2

When asked to describe what happens to sperm during the mating of animals, the student recalls that during the mating of animals the male deposits sperm directly into the body of the female by responding to that effect.

WYY
01-Core-3

Given access to ether, an etherizer, and a vial containing only live fruit flies and asked to etherize the fruit flies, the student manipulates the fruit flies and the etherizing apparatus by etherizing the fruit flies so that none of the flies are moving around and none have been killed (wings spread).

WYY
01-Core-4

Given a vial containing fruit flies, some of which are dead, two empty vials with caps, an etherizer, and ether and asked to etherize the flies in the vial, to separate the dead flies from the etherized ones, and to label them, the student classifies the fruit flies with folded wings as etherized and those with outstretched wings as dead by separating and labeling the flies correctly as dead or etherized.

WYY
01-Core-5

Given a vial containing fruit flies of both sexes, ether, an etherizer, and two empty vials with caps and asked to etherize the flies, to separate the males from the females, to put them into different vials, and to label the vials, the student classifies the fruit flies as males if their abdomens are blunt and black or as females if their abdomens are pointed and light colored by separating and labeling the male and female fruit flies correctly.

WYY
01-Core-6

When asked to outline the procedure for obtaining virgin female fruit flies from a vial containing all stages of fruit flies, the student recalls the procedure for obtaining virgin female fruit flies as (1) clearing the adults from the vial, (2) waiting more than five and fewer than ten hours for more flies to hatch, (3) etherizing the newly hatched flies, and (4) separating the females from the males by stating such a procedure.

WYY
01-Core-7

When asked to define *pure strain* operationally, the student recalls the definition that a pure strain is one in which all the offspring for several successive generations have the same characteristics by responding to that effect.

WYY
01-Core-8

When asked to list the stages in the life cycle of a fruit fly, the student recalls that the stages in the life cycle of a fruit fly are egg, larva, pupa, and adult by so stating.

WYY
01-Core-9

WYY
01-Core-10

Given a hand lens and a jar containing a culture of fruit flies including eggs, larvae, pupae, and adults and asked to indicate the eggs, larvae, pupae, and adults, the student identifies the tiny white objects on top of the fly food as eggs, the small worm-like creatures crawling through the food as larvae, the light brown cases on the sides of the jar as pupae, and the free flying flies as adults by indicating the correct specimen as exemplary, of each stage.

WYY
01-Core-11

Given a variation of a single feature in each of two pure strains of fruit flies and asked to predict the possible appearance of this feature in the first-generation offspring of a cross between these pure-strain flies, the student applies the concept that one of two variations of a given feature will cover up (mask) the other in the first-generation offspring of a cross between two different pure-strain fruit flies by stating that all the first-generation offspring will show the same variation as one of the parents.

WYY
01-Core-12

When asked to state why the inheritance of only one feature is studied at a time although the organism inherits many features at once, the student applies the concept that the systems approach permits an orderly investigation of factors in complex systems by stating the essence of that concept.

WYY
01-Core-13

Given the variation of a feature shown by each of two pure-strain parent bean plants and asked to predict the variations that will be present in each of the first two generations of offspring of a cross between the parent plants, the student applies the concept that when two bean plants, each a pure strain for a different variation of a feature, are crossed, the first-generation offspring show only one of the variations, but some of the second-generation offspring show one variation and some show the other by predicting that all of the first-generation offspring will be alike in this feature and that some of the second-generation offspring will have one variation and some the other.

WYY
01-Core-14

Given that two pure strains are crossed and that the first-generation offspring are crossed among themselves and asked to predict the ratio of the variations that will appear in the second-generation offspring, the student applies the rule that there is a three-to-one ratio of feature variations in the second-generation offspring of a cross between two pure strains by predicting such a ratio.

WYY
01-Core-15

Given a great many objects that can be classified into two types on the basis of some visible characteristic and asked to estimate the ratio of one type to the other quickly and accurately, the student applies the concept of sampling by drawing a sample of 30 to 80 beans, counting the number of each type of object in the sample, and calculating the ratio of one type to the other in the sample to estimate the ratio in the large population.

WYY
01-Core-16

Given an organism and asked to determine by inspection whether the organism is or is not a pure-strain organism the student applies the concept that appearance is

insufficient evidence on which to determine whether or not an organism is pure strain by stating the essence of the concept.

Given information as to the occurrence of a single variation of a feature in three successive generations for a cross between two organisms and asked whether or not the organisms are pure strain for the feature, the student applies the concept from the ISCS two-bit model that organisms are pure strain for a particular feature variation if the offspring of a cross between two organisms all have the same variation of a feature for at least two offspring generations by responding positively and to the effect that the organisms are pure strain if all the offspring have the same variation as the parents for two or more generations of offspring.

WYY
01-Core-17

Given the different variations of a given feature in each of two pure-strain parent plants and five purported descriptions of the first-generation offspring and asked to predict the appearance of the first-generation offspring, the student applies the concept that the first-generation offspring of a cross between parents that are pure strain for different variations of the same feature all have the variation of the feature shown by one of the parents by selecting the description in agreement with the concept.

WYY
01-Core-18

Given the variations of a feature in two different pure-strain plants and five possible descriptions of the second-generation offspring and asked to select the best description of the second-generation offspring of a cross between these pure strains, the student applies the concept that some of the second-generation offspring of a cross between two different pure strains will look like each strain, but the variation of one strain will occur three times as often as the other by selecting the choice in agreement with the concept.

WYY
01-Core-19

Given the variation of a feature in the second-generation offspring of a cross between two different pure-strain parents and asked to state the variations of the feature exhibited by the parents and the first-generation offspring, the student applies the concept that one of the parents and all of the first-generation offspring of a cross between two different pure strains have the same variation of a feature as three-quarters of the second-generation offspring and the other parent has the same variation as the rest of the second-generation offspring by stating the appearance of the parents and the first-generation offspring on that basis.

WYY
01-Core-20

Given ample opportunity to work with materials on a laboratory activity of more than one day's duration and asked to observe the cleanup period at the appropriate time, the student chooses to close the laboratory activity period promptly upon receiving notification of the time by immediately ceasing the laboratory activity, returning materials in usable, clean condition to storage places, and participating in work area cleanup, on at least three separate occasions when being observed by the teacher without his knowledge.

WYY
01-Core-21

WYY
01-Core-22 When asked to work in the laboratory with fellow students, the student chooses to cooperate with fellow students in the laboratory by being polite, waiting his turn, being orderly when moving about, and observing the right of his classmates to work without being unnecessarily disturbed, when observed without his knowledge by the teacher or another designated person on at least three occasions.

WYY
01-Core-23 When asked to work with the equipment and text materials of the ISCS course, the student chooses to show personal responsibility for returning laboratory equipment no longer needed to the proper storage places during the activity period by returning such equipment and materials to the designated storage places on at least three occasions when observed by the teacher or another designated observer without his knowledge of being checked.

WYY
01-Core-24 When asked questions in the textbook, the student chooses to write in his *Record Book* his answers to 90% or more of the questions in his textbook by exhibiting the written responses when the teacher spot checks to determine if he is doing so.

WYY
01-Core-25 When working independently in the laboratory, the student chooses to show proper care and use of ISCS laboratory materials by using the materials only for their intended purpose or by requesting permission to do other specific experiments with them, when being observed without his knowledge by the teacher or another designated person on three or more occasions.

WYY
01-Exc 1-1-1 When asked to define the word *cross* as it is used in the study of inheritance, the student recalls the genetic definition that cross is the planned mating of two organisms of different strains by stating the essence of the definition.

WYY
01-Exc 1-2-1 Given an operational and a nonoperational definition of two human variations and asked to state which of the definitions is an operational definition and to explain the reasons for his choice, the student applies the concept that an operational definition has two parts, one telling how to determine whether the variation is present or not and the other telling how to measure the amount of the variation present, by selecting the operational definition and by stating the essence of the concept.

WYY
01-Exc 1-2-2 When asked to state the two questions that an operational definition should answer, the student recalls that an operational definition should answer the questions, "How can I tell when I have some?" and "How can I tell how much I have?" by stating the essence of each of those questions.

WYY
01-Exc 1-3-1 Given a description of a situation in which insects develop more slowly or not at all in cool weather and asked to explain why there appear to be few adult insects in the winter, the student applies the concept that cool temperatures slow down or prevent insects from completing their life cycle by stating the essence of the concept.

When asked to determine the total number of bits that all of a person's great-grandparents had for a single feature, the student applies the concepts that the number of ancestors doubles in each preceding generation and that each person has two bits for each feature by responding with the number *sixteen*.

WYY
01-Exc 1-4-1

Given a description of a specific genetic feature in an individual and asked whether it can be determined which ancestor contributed the specific genetic feature and to explain his answer, the student applies the concept that the ancestor who contributes a specific genetic feature is determined by chance by responding negatively and with the essence of the concept.

WYY
01-Exc 1-4-2

Given two whole numbers between 2 and 99 and asked to calculate the rough ratios of these two numbers to one decimal place, the student applies a procedure for calculating a rough ratio that involves dividing the smaller number into the larger number and itself and expressing the ratio in the standard format by stating the rough ratio in the standard format, such as 6.7 to 1, to within an accuracy of ± 0.2 .

WYY
01-Exc 2-1-1

Given four rough ratios and asked to convert them to rounded-off ratios, the student applies the rule that a rough ratio whose fractional part is 0.5 or larger is rounded off to the next highest whole number and a rough ratio whose fractional part is 0.4 or smaller is rounded off to the next lowest whole number by converting the rough ratios to rounded-off ratios correctly in at least three of the four cases.

WYY
01-Exc 2-1-2

Given the frequency of two variations of a feature in the second-generation offspring from the mating of two pure-strain fruit flies and asked to state the occurrence of these variations in the parents and the first-generation offspring, the student applies the concept that one of the original parent fruit flies and all of the first-generation offspring show the feature variation shown by approximately three-quarters of the second-generation offspring and that the other original parent shows the variation shown by one-quarter of the second-generation offspring by responding to that effect.

WYY
02-Core-1

Given the variations of one feature in each of a pair of pure-strain parent fruit flies and the frequency of these variations in the first-generation offspring and asked to predict the proportion of each variation in the second-generation offspring, the student applies the concept that three-quarters of the second-generation offspring of a cross between pure-strain parents with different variations of one feature will show the same variation as one of the original parents and all of the first-generation offspring and that the remaining one-quarter of the second-generation offspring will show the variation of the other original parent by predicting correctly the ratios of the appearance of the variations of that feature in the second-generation offspring.

WYY
02-Core-2

Given four statements about the transmission of features from parent to offspring and asked to select the statement that best describes the relationship of the parents' features to the features of the offspring, the student classifies as the pattern by which features of the parents are passed to the offspring the statement that the offspring generally show some features in common with each of their parents by selecting that statement.

WYY
02-Core-3

When asked to name the science which deals with the study of patterns of inheritance, the student recalls that the science which deals with the study of patterns of inheritance is called *genetics* by so stating.

WYY
02-Core-4

When asked to state the assumptions of the one-bit model of inheritance, the student recalls that the assumptions of the one-bit model of inheritance are that each individual has just one bit of information for each feature and that it is a matter of chance whether an offspring receives its bit from one parent or the other by stating the effect of these assumptions.

WYY
02-Core-5

When asked to give a reason why the one-bit model is not a satisfactory model of inheritance for most features, the student recalls that the one-bit model is not a satisfactory model for inheritance either because it doesn't explain the inheritance of the feature variations in the second-generation offspring of certain crosses (without making wild assumptions) or because it doesn't allow prediction of the ratios of the variations in the second-generation offspring of certain crosses by stating the essence of one of those.

WYY
02-Core-6

WYY
02-Core-7

Given a phenomenon for which there are two models and five possible reasons that one model might be rejected and another model accepted and asked to select the best reason for rejecting one model and accepting another, the student classifies one model as better than another if it agrees more closely with experimental evidence by selecting the response that expresses that idea.

WYY
02-Core-8

When asked to state the assumptions of the two-bit model of inheritance, the student recalls as assumptions of the two-bit model of inheritance that (1) every individual has two bits of information for each feature, (2) one bit for each feature is passed from each parent to each of the offspring, (3) the bit for one variation can mask the other bit, and (4) chance determines which of the two bits is passed from a parent to an individual offspring by stating the effect of at least three of the assumptions.

WYY
02-Core-9

Given that the inheritance of a feature follows the two-bit model, the variations of a feature shown by two different parent plants, and the variation which masks the other and asked to use the two-bit model to predict the appearance of the first- and second-generation offspring of a cross between two pure-strain parents for different variations of a feature, the student applies the concept that if the inheritance of a feature follows the two-bit model, all the first-generation offspring of a cross between two different pure strains show the masking of the same variation and there is a three-to-one ratio of masking to masked variations of a feature among the second-generation offspring of this cross by predicting results to that effect.

WYY
02-Core-10

When asked to state why a plant that is pure strain for the masked (recessive) variation of a feature is used in a test cross with an unknown plant, the student recalls that a known plant that is pure strain for the masked variation of a feature is used for a test cross with an unknown plant so that the bits from the known plant do not mask the bits from the unknown plant by responding to that effect.

WYY
02-Core-11

Given experimental data that cannot be explained by the two-bit model of inheritance and asked whether it is possible to explain these data in terms of the two-bit model and to explain his answer, the student applies the concept that a model can explain only experimental data that agree with the predictions made by the model by responding negatively and, in effect, that the data disagree with predictions based on the two-bit model.

WYY
02-Core-12

Given a description of a situation in which new experimental evidence is not explained by the two-bit model and five possible courses of action and asked to select the best course of action, the student recalls that when a model cannot explain new experimental data, the preferred course of action is to make an attempt to modify the model so that it explains both the new and the old data by selecting the answer that expresses that idea.

WYY
02-Core-13

Given which variation of a feature is masking and a description of the offspring from a test cross between an unknown plant that shows the masking (dominant) variation and a plant that is pure strain for this variation and asked to state what bits are

carried by the unknown and the reason for his answer, the student applies the concept that a plant that is pure strain for the masking (dominant) variation of a feature is not used for a test cross with an unknown because such a cross produces the same offspring no matter what the bits from the unknown are by stating, in effect, that he cannot identify the bits for that feature of the unknown and the notion of the concept.

Given which variation of a feature masks the other, the variation shown by an unknown plant, the variation shown by a pure-strain test plant, and information that half of the offspring of a cross between these two resemble the unknown plant and half resemble the known plant and asked to state whether or not the unknown plant is pure strain, the student applies the concept that if half the offspring of a cross show the same variation as the unknown plant and the other half show the same variation as the pure-strain known plant, the unknown plant is not pure strain for the feature by responding negatively and with the effect of the concept.

WYY
02-Core-14

Given which variation of a feature masks the other, that the masking variation is shown by an unknown plant, that the masked variation is shown by a pure-strain known plant, and that all the offspring of the test cross have the same variation as the unknown plant and asked to predict whether or not the unknown is pure strain and to state the basis for his response, the student applies the concept that according to the two-bit model if all the offspring of a cross show the same variation as the unknown parent plant, the unknown plant is pure strain for the feature by responding positively and with the effect of the concept.

WYY
02-Core-15

Given the variation of a feature shown by two different pure-strain parents and the variation of the feature shown by the first-generation offspring of a cross between these two pure strains and asked to explain why only one variation of the feature is present in the first-generation offspring, the student applies the concept that the first-generation offspring of a cross between two organisms that are pure strain for different variations of a feature show that variation of the feature which masks the other variation by stating the essence of the concept.

WYY
02-Core-16

When asked to define the term *recessive bit* as used in the two-bit model, the student recalls the definition that a recessive bit is a bit of genetic information for a feature that can be masked by a dominant bit for that feature by responding to that effect.

WYY
02-Core-17

When asked to define the term *dominant bit* as it is used in the two-bit model, the student recalls the definition that a dominant bit refers to a bit of genetic information for a feature that will mask recessive bits for that feature by responding to that effect.

WYY
02-Core-18

Given the letters used to represent the bits for variations in a hypothetical study of some variation of a feature and asked whether the variation is dominant or recessive, the student classifies the feature variation as dominant or recessive on the basis of

WYY
02-Core-19

whether the bit for the variation is represented by a capital letter or a lowercase letter by so indicating.

WYY
02-Core-20

Given the dominance or recessiveness of a variation of a feature and asked to devise a symbol to represent a bit for the variation, the student applies the convention that a bit for a dominant variation is represented by a capital letter and a bit for a recessive variation is represented by a lowercase letter by writing symbols in agreement with the convention.

WYY
02-Core-21

Given the information that two individuals involved in a cross are pure strain, one for the dominant variation of a feature and the other for the recessive variation, a two-generation inheritance chart showing the cross, and the first-generation offspring who exhibit only one variation and asked to state which variation is dominant, which is recessive, and the basis for his answers, the student applies the concept that the variation of a feature which is dominant masks the recessive variation by selecting such variations and by stating the effect of the concept.

WYY
02-Core-22

Given a three-generation family inheritance chart in which some individuals show the dominant variation and some show the recessive variation of a simple dominant-recessive feature and information as to the dominant variation and asked to state for each individual a possible set of the genetic bits it carries, the student generates a possible set of genetic bits for each individual shown on a three-generation family inheritance chart in agreement with the following rules:

- (a) individuals showing the recessive variation have two recessive bits,
- (b) individuals showing the dominant variation may have either two dominant bits or one dominant and one recessive bit,
- (c) the offspring of a mating with an individual who has two recessive bits, must have at least one recessive bit,
- (d) each parent of an individual showing the recessive variation must have at least one recessive bit,
- (e) a parent probably (but not necessarily) has two dominant bits if the dominant variation is shown by all the several offspring of a mating with an individual having two recessive bits, and
- (f) a capital letter must be used to represent a dominant variation and a lowercase letter to represent a recessive variation

by stating a possible genotype for at least sixteen of the nineteen individuals shown in the chart.

WYY
02-Core-23

Given that one parent shows the dominant variation of a feature and the other shows the recessive variation and asked to state from this knowledge alone the variation of this feature that their first offspring will have and to explain the reason for his answer, the student applies the concept that predictions of the feature variations of a particular offspring cannot be made with certainty but rather only in terms of probability by stating the essence of the concept.

Given a description of the inheritance pattern of a simple dominant-recessive feature for three generations and asked to construct an inheritance chart for the feature, using squares and circles and shading and nonshading, and to write near each square or circle the person's name and a possible pair of bits which that person may have, the student applies the following conventions used in inheritance charts: each generation is in a single horizontal row, the generations are separated vertically with the oldest at the top, circles are used to represent females and squares are used for males, shading is used to distinguish individuals showing the dominant variation from individuals showing the recessive variation, crosses (marriages) are indicated by a straight horizontal line joining the symbols of the partners, and the offspring of a cross are indicated by vertical lines originating from the cross line and terminating at the offspring, by constructing such a chart from the data.

WYY
02-Core-24

Given the feature variation of and the bits carried by each of two parents for one feature and which bit is dominant and asked to state the ratio of feature variations in the offspring of this cross by completing and using a Punnett square, the student applies the procedure for determining the ratio of feature variations in the offspring of a cross, using a Punnett square in which each vertical column represents a bit inherited from one parent and each horizontal row a bit from the other parent, combining the row and column bits to produce the table entries, counting the table entries that represent the same feature variations, and taking the ratio of these variations by constructing a chart and stating a ratio in agreement with the data provided.

WYY
02-Exc 4-1-1

Given a specified number of features inherited by an offspring and asked the total number of bits the offspring receives for these features according to the two-bit model, the student applies the assumption of the two-bit model that an offspring inherits one bit for each feature from each parent for a total of twice as many bits as features by stating a number which is twice the number of features.

WYY
03-Core-1

Given the bit symbols for the possible variations of five simple dominant-recessive features and the genetic bits of an individual and asked to describe the features of the individual as predicted by the two-bit model, the student applies the concept from the two-bit model that an individual will show the dominant variation of a simple dominant-recessive feature unless both genetic bits for this feature are for the recessive variation, in which case he will show the recessive variation, and the convention that dominant variations are represented by capital letters and recessive variations are represented by lowercase letters by predicting the individual's appearance correctly.

WYY
03-Core-2

Given that data from breeding experiments disagree with predictions based on the two-bit model of inheritance and asked to state how the value of the data could be established and the effects this would have on the model, the student applies the concepts that experiments which produce unusual results should be repeated and that if similar results are obtained in sufficient instances such results would cause the modification of existing models or a new model to be devised which would explain both the new and the old data by stating the effects of those concepts.

WYY
03-Core-3

When asked to state two reasons why Mendel was successful in understanding patterns of inheritance, whereas others were unsuccessful, the student recalls that the reasons Mendel was successful in understanding the patterns of inheritance were that (1) he studied only one feature at a time (systems approach), (2) he applied mathematics to his study, and (3) he devised a model to account for what he saw by stating the essence of two of those reasons.

WYY
03-Exc 6-1-1

When asked to explain why Mendel's use of the systems approach, mathematics, and a model helped him understand patterns of inheritance, the student generates the notion that (1) the systems approach is helpful because it allows one to examine a single feature at a time, (2) mathematics is helpful because it facilitates making accurate comparisons of data, and (3) a model is helpful for understanding patterns because a model provides a basis for explaining what may be happening and a basis on which to make predictions by stating the effect of at least two of those notions.

WYY
03-Exc 6-1-2

Given which variations of two features are dominant and that two individuals are each pure strain for a dominant variation of one of the features and the recessive variation of the other and asked to predict the appearance of the first-generation offspring of this cross, the student applies the concept that when two individuals that are pure strain for different variations of the same two features are crossed, the first-generation offspring show only the dominant variations of the two features

WYY
03-Exc 6-2-1

by predicting that the first-generation offspring would have the dominant variation of both features.

WYY
03-Exc 6-2-2

Given directions to refer to Excursion 6-2, which variations of two features are the dominant variations, and that two individuals are each pure strain for a dominant variation of one of the features and a recessive variation of the other and asked to predict the ratio of variations that will appear in the second-generation offspring of this cross, the student applies the concept from the two-bit model that when two individuals that are pure strain for different variations of the same two features are crossed, the feature variations that appear in the second-generation offspring are in the ratio of 9 (dominant, dominant) to 3 (dominant, recessive) to 3 (recessive, dominant) to 1 (recessive, recessive) by predicting the ratio correctly.

WYY
03-Exc 7-1-1

Given that a variation of a feature does not entirely mask another variation but results in a blending of the two variations in an individual which has a bit for each variation and asked to predict the appearance of four offspring from each of two crosses, one between parents each of which shows the blend of the two variations and one between parents one of which shows the blend of the two variations and the other of which shows one of the variations, the student applies the concepts that (1) in cases of incomplete masking, an individual which exhibits a blend of two variations has bits for each of the variations, and the bits are given to the offspring as any other bits are given, (2) when unlike bits appear in the offspring, the appearance is that of the blended variation, and (3) some offspring will have the same variation as the pure-strain parents and others will have a blend of the two variations by predicting that both of the variations and the blend will be shown by different offspring in the first cross and that one of the variations and the blend will be shown by different offspring in the second cross.

WYY
03-Exc 7-2-1

Given the information that one variation of a feature is dominant in males, that the other variation is dominant in females, and a three-generation inheritance chart for this feature and asked to predict the bits carried by each individual shown, the student applies the rules of the modified two-bit model of inheritance, that (1) an individual showing the recessive variation for his sex has two bits for this variation, (2) an individual showing the dominant variation for his sex has either two bits for this variation or one bit for each variation, and (3) if an offspring has two identical bits, each parent must have at least one of these same bits by predicting the possible bits that could be carried by each individual in agreement with those rules.

WYY
03-Exc 7-3-1

Given a description of a situation in which a husband blames his wife for the fact that all their children are girls and asked to state whether the husband's reasoning is logical or not and to explain his answer, the student applies the concept that the genetic information passed from the father to the offspring determines the sex of the offspring by stating that his reasoning is not logical and the notion of the concept.

WYY
03-Exc 7-4-1

Given directions to refer to Excursion 7-4, that the bit for a feature is carried on the X chromosome; that the Y chromosome carries no information for this feature, and the dominant and recessive variations of this feature and asked to predict the

appearance of and the bits carried by the first- and second-generation offspring of a cross between a female that is pure strain for the recessive variation and a male carrying a dominant bit, the student applies the following concepts of the two-bit model of inheritance as it is modified to explain sex-linked inheritance: (1) males have an X chromosome and a Y chromosome, whereas females have two X chromosomes, (2) bits that carry genetic information are located on chromosomes, and (3) either the dominant or the recessive bit is expressed in males if the bit is located on the X chromosome and the Y chromosome carries no information for this feature by predicting that (1) the first-generation male offspring will have a recessive bit and will show the recessive variation, (2) the first-generation female offspring will have one bit for each variation and will show the dominant variation, (3) half of the second-generation male offspring will have a recessive bit and will show the recessive variation, whereas the rest will have a dominant bit and will show the dominant variation, and (4) half of the second-generation female offspring will have two recessive bits and will show the recessive variation, whereas the rest will have one bit for each variation and will show the dominant variation.

Given a situation in which genetically identical living things appear different and asked to explain the cause of these differences, the student applies the concept that environmental factors can cause differences in the appearance of genetically identical individuals by stating the essence of the concept or by listing specific environmental factors of the situation presented.

WYY
03-Exc 7-5-1

Given a description of a situation in which two groups of the same species of animal are released in a closed environment in which there are predators and in which the predominant background color is similar to the color of one group but very different from the color of the other and asked whether there are more of one kind than the other after a period of time and to explain his answer, the student applies the concept that animals with protective coloration have an advantage over more visible animals in surviving predators in the environment by responding affirmatively and with the effect of the concept.

WYY
03-Exc 7-6-1

Given a situation in which an environmental factor changes the appearance of an individual and asked whether the offspring of this individual will have the same appearance and to explain his answer, the student applies the concept that features developed because of environmental factors are not transmitted to offspring through bits of genetic information by responding negatively and with the essence of the concept.

WYY
03-Exc 7-7-1

Investigating Variation

IV

Given an operational and a nonoperational definition of two human variations and asked to state which of the definitions is an operational definition and to explain the reasons for his choice, the student applies the concept that an operational definition has two parts, one telling how to determine whether the variation is present or not and the other telling how to measure the amount of the variation present, by selecting the operational definition and by stating the essence of the concept.

IV
01-Core-1

When asked to state the two questions that an operational definition should answer, the student recalls that an operational definition should answer the questions, "How can I tell when I have some?" and "How can I tell how much I have?" by stating the essence of those questions.

IV
01-Core-2

Given a statement which stereotypes a group of people and asked if the statement could be true and to state the reason for his answer, the student applies the concept that human beings grouped on the basis of one variable still show great variation in other traits by responding negatively and, in effect, that the statement cannot possibly be true because of human variation.

IV
01-Core-3

When asked to explain why scientists look for patterns in the changes they see, the student generates a reason for the pattern-seeking nature of scientific investigation by stating, in effect, that it allows scientists to predict what changes may occur or may even be an aid in developing an explanation for why they occur.

IV
01-Core-4

Given a human characteristic that shows variation and asked to give an operational definition for that characteristic, the student generates an operational definition for the characteristic that includes methods of determining whether the characteristic is present and of measuring how much is present by stating such a definition.

IV
01-Core-5

Given a description of a human variation and several possible ways to measure this variation and asked to select the best of these ways, the student applies the concept that the best way to measure a human variation is to use an objective testing method in a standard way by selecting the method of measurement that uses this technique.

IV
01-Core-6

When asked to explain why it is important to use a measuring device, such as a ruler or a test, when attempting to compare several things, rather than to rely on just the senses, the student applies the concept that because human senses can be fooled by the appearance of things, a measuring device should be used so that comparisons are made on the basis of an objective standard or quantity by stating the essence of the concept.

IV
01-Core-7

Given a description of a situation involving catching a dropping meterstick in which one student seems to have a much faster reaction time than the rest of the class and the observation that this student appears to watch the release point, whereas the other students watch the catch point, and asked to describe an activity that he could perform to test whether a person's reaction time, as measured by the dropping

IV
01-Core-8

meterstick, depends on whether he watches the release point or the drop point, the student generates an activity to test this hypothesis, including the notion of measuring the reaction time of several students by a standardized testing procedure which includes measuring the reaction times of each student both when he watches the release point and when he watches the catch point, by designing such an activity.

IV
01-Core-9

When asked to describe what is meant by a feature that shows continuous variation, the student recalls that a feature which shows continuous variation is one which varies through all the different values between the extreme variations by responding to that effect.

IV
01-Core-10

When asked to define *either-or* features, the student recalls that either-or features have only two possible variations by responding to that effect.

IV
01-Core-11

Given a description of five variables and asked to identify each as a continuous variable or an either-or variable, the student applies the rule that a variable is considered to be an either-or variable if it can have one of only two possible values and it is considered to be a continuous variable if it can have any value in a range of values by indicating the types of four of the variables correctly.

IV
01-Core-12

Given eighteen measurements and a table for grouping these data, which has a column indicating the maximum and minimum values to be included in each group, a tally column, and a total column, and asked to complete the table, using the data supplied, the student applies the procedure for completing a table of grouped data, which includes entering a mark in the tally column in the appropriate data group for each datum, counting the marks for each group to get a group total, and entering each group total in the space provided for that data group in the total column by completing the table so that not more than two of the totals are more than two units in error.

IV
01-Core-13

When asked to state why scientists usually arrange their data in charts, tables, or graphs, the student recalls that scientists usually arrange their data in charts, tables, or graphs because these arrangements present the data in an ordered rather than a random form, they make the data easier to analyze, and they make it easier to see the relationships between the variables by stating two of those three notions.

IV
01-Core-14

Given a description of an either-or variable and asked to construct an appropriate table for collecting and analyzing measurements of this variable, the student applies the rule that measurements of an either-or variable are most easily collected and analyzed using a table with two data rows (or columns), with each row (or column) labeled with the feature variation which applies to it by constructing and labeling such a table.

Given the data for and a description of a continuous variable and asked to construct an appropriate table for analyzing measurements of that variable, the student applies the rules that measurements of a continuous variable are most easily collected and analyzed using a table with more than two rows, in which each row is labeled with the range of measurements that fall into that data group, such that each datum falls into one and only one data group, by constructing and labeling a table of that type.

IV
01-Core-15

Given a description of two either-or variables and asked to construct an appropriate table for collecting measurements of and analyzing the relationship between these variables, the student applies the rule that a contingency table is the most appropriate table for collecting measurements of and analyzing the relationship between either-or variables by constructing and labeling a table of this type.

IV
01-Core-16

Given descriptions of a continuous and an either-or variable and asked to construct an appropriate table for collecting measurements involving these variables, the student applies the rule that these measurements can best be organized for analysis by means of a two-way table in which one dimension, either the columns or the rows, represents the possible values of one variable and the other dimension, either columns or rows, represents the possible values of the other variable and in which two of the rows or columns are labeled with the possible values of the either-or variable and more than two of the columns or rows are labeled with the ranges of the continuous variable that fall into that data group by constructing and labeling a table of that type appropriate to the variables given.

IV
01-Core-17

Given ample opportunity to work with materials on a laboratory activity of more than one day's duration and asked to observe the cleanup period at the appropriate time, the student chooses to close the laboratory activity period promptly upon receiving notification of the time by immediately ceasing the laboratory activity, returning materials in usable, clean condition to storage places, and participating in work area cleanup, on at least three separate occasions when being observed by the teacher without his knowledge.

IV
01-Core-18

When asked to work in the laboratory with fellow students, the student chooses to cooperate with fellow students in the laboratory by being polite, waiting his turn, being orderly when moving about, and observing the right of his classmates to work without being unnecessarily disturbed, when observed without his knowledge by the teacher or another designated person on at least three occasions.

IV
01-Core-19

When asked to work with the equipment and text materials of the ISCS course, the student chooses to show personal responsibility for returning laboratory equipment no longer needed to the proper storage places during the activity period by returning such equipment and materials to the designated storage places on at least three occasions when observed by the teacher or another designated observer without his knowledge of being checked.

IV
01-Core-20

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- IV
01-Core-21
- When asked questions in the textbook, the student chooses to write in his *Record Book* his answers to 90% or more of the questions in his textbook by exhibiting the written responses when the teacher spot checks to determine if he is doing so.
-
- IV
01-Core-22
- When working independently in the laboratory, the student chooses to show proper care and use of ISCS laboratory materials by using the materials only for their intended purpose or by requesting permission to do other specific experiments with them, when being observed without his knowledge by the teacher or another designated person on three or more occasions.
-
- IV
01-Exc 1-1-1
- Given several metric measurements in mm, cm, and m for each of two familiar objects and asked to select for each object the measurement that would be closest to its size, the student applies the relationships that a meter is slightly longer than a yard, a centimeter is about half an inch long, and a millimeter is about 1/25th of an inch long by selecting the appropriate measurements.
-
- IV
01-Exc 1-1-2
- Given a metric scale with three points, A, B, and C, indicated by arrows and asked to state the distance between two of those points in millimeters and the distance between two other points in centimeters, the student applies the concepts that the number of small scale divisions between two points is the distance between those points in mm and that ten mm make up one cm by stating the distances correctly to within ± 1 mm (0.1 cm).
-
- IV
01-Exc 1-1-3
- Given a situation in which two students have measured an object with the same measuring device and find that their measurements disagree in the last reported figure and asked to state the most likely reason why this difference occurred, the student applies the concept that when the last digit of a measurement is estimated, the last digit will vary by stating that probably the last digit had to be estimated and the essence of the concept.
-
- IV
01-Exc 2-1-1
- Given four measurements between 1.0 and 9.9 cm and asked to calculate the average of these measurements to one decimal place, the student applies the rule that an average of a set of numbers is found by adding together all the numbers and dividing their sum by the number of numbers by calculating the average to within ± 0.1 cm.
-
- IV
01-Exc 2-1-2
- Given five numbers between 100.0 and 999.9 reported to the nearest tenth and asked to round off these numbers to the nearest whole number, the student applies the rules that if the digit to be dropped is five or greater, the digit is dropped and one is added to the digit to the left of it and if the digit to be dropped is less than five, the digit is dropped and the digit to the left of it remains the same by converting the decimal numbers to whole numbers correctly.
-

Given a contingency table showing experimental data and two statements about the relationship between pairs of variables, one of which relates the two experimental variables and the other of which relates one of the experimental variables and an extraneous variable, and asked to state whether the data provide evidence for judging the correctness of these statements and to explain his answer, the student applies the concept that experimental data can be used to evaluate statements only when the statements relate to the investigated variables by stating that the data can be used to judge the correctness of the one statement which refers directly to the measured variables and cannot be used to judge the correctness of the other statement and the effect of the concept.

Given two qualitative values for four variables and asked to indicate whether each of the variables is a continuous or an either-or variable, the student classifies a variable as an either-or variable if only two values of the variable are possible and as a continuous variable if many different values are possible by indicating the types of variables correctly.

IV
02-Core-1

Given a sentence using the term *range* to describe data and asked to state an operational definition for the term *range*, the student recalls the operational definition that the range is the difference between the largest measurement and the smallest measurement by stating the effect of the definition.

IV
02-Core-2

Given a set of ten measurements and asked to find its range, the student applies the definition that the range of a set of values is the difference between the largest value and the smallest value by reporting the range correctly.

IV
02-Core-3

When asked to define operationally the *mean* of a set of measurements, the student recalls the operational definition that the mean of a set of numbers is the sum of all the numbers divided by the number of numbers by stating the effect of that definition.

IV
02-Core-4

Given a set of eight measurements and asked to find its mean, the student applies the definition that the mean of a set of measurements is the quotient of the sum of the measurements divided by the number of measurements by reporting the mean correctly to the nearest whole number.

IV
02-Core-5

When asked to define the *mode* of a set of measurements, the student recalls the definition that the mode of a set of measurements is that measurement which occurs most often by stating the effect of that definition.

IV
02-Core-6

Given a set of twelve measurements and asked to identify its mode, the student applies the concept that the mode is the measurement that occurs most often in the data set by reporting the mode correctly.

IV
02-Core-7

Given a grid and a table of data grouped in mutually exclusive but continuous groups of the same size and asked to construct a histogram of the data on the grid which was provided, the student applies the procedure for constructing a histogram, which includes (1) labeling and numbering the horizontal axis so that each data group is of equal range, (2) labeling and numbering the vertical axis so that each scale division represents the same number of individuals, and (3) constructing in each of the columns a vertical bar representing a data group whose height, as measured by the vertical scale, corresponds to the number of individuals in that data group by constructing the appropriate histogram.

IV
02-Core-8

IV
02-Core-9

When asked to explain why data are often arranged in a histogram or in another kind of graph, the student recalls that data are often graphed because graphing makes patterns in the data easier to see by responding to that effect.

IV
02-Core-10

Given ungrouped data and a blank sample table for grouping data in fifths and asked to construct a similar table and group the data in fifths, the student applies the procedure for grouping in fifths, which includes (1) dividing the range of the data by five and raising the quotient to the next whole number to determine the number of units (N) in a fifth, (2) finding the lower limit of the bottom fifth by lowering the lowest measurement to the preceding whole number, (3) finding the lower limits of each of the fifths by successively adding N to the lower limit of the bottom fifth, (4) finding the upper limit of each of the fifths by adding N - 1 to the lower limits of each of the fifths, (5) writing the upper and lower limits of each fifth in the appropriate column of the table, and (6) counting the total number of measurements that fall into each fifth, by completing the table in agreement with that procedure.

IV
02-Core-11

Given that scientists often repeat experiments even after they have drawn conclusions from them and asked to explain why experiments are frequently repeated many times, the student recalls that experiments are frequently repeated many times to check the results for accuracy or because it is easier to see a pattern in the data when there are more data by stating one of those notions in his answer.

IV
02-Core-12

When asked to explain why he was asked to make three separate measurements of each student's peripheral angle of vision rather than just one measurement, the student recalls that the effect of errors unique to individual measurements are reduced when several measurements are made and averaged by responding to that effect.

IV
02-Core-13

Given data and asked to determine whether a specified value is above or below the mean and how far above or below the mean that particular value is, the student applies the procedure for comparing a value to the mean, which includes calculating the mean for the data, comparing the value with the mean, and subtracting the mean from the specified value to determine the difference, by stating that the specified value is above or below the mean and how far it is above or below the mean.

IV
02-Core-14

Given a set of data and its mean and asked why it is possible that no piece of datum is equal to the mean, the student applies the concept that the mean is a calculated value based on a set of measurements and may not correspond to any actual measured value by stating the essence of the concept.

IV
02-Core-15

Given the statement that the best example of an average (normal) person is someone whose characteristics are not exactly average and asked to explain this statement, the student applies the concept that a particular person's traits are usually not average but tend to fluctuate around the mean of the population by stating an explanation that embodies that notion.

Given a single measurement of some relatively unknown variable and asked whether it can be determined if the value is high or low for that variable and to give the reason for his answer, the student applies the concept that a single measurement of a feature cannot be interpreted unless at least the mean or the range of possible values of the variable is known by answering negatively and with the essence of the concept.

IV
02-Core-16

Given a situation in which people who are tested for touch sensitivity and their ability to locate objects by hearing are told to keep their eyes closed and asked whether it is necessary for them to keep their eyes closed and to explain his answer, the student applies the concept that since people often use two or more senses to detect a stimulus and then cannot tell which sense detected the stimulus, a particular sense can best be tested when it is impossible for the subject to use another sense by responding affirmatively and with the essence of the concept.

IV
02-Core-17

Given the true value of a quantity and ten estimates of its size and asked to calculate the mean error of these estimates, the student applies the procedure for calculating the mean error by subtracting the true value from the estimates to find the errors, adding the absolute values of these errors, dividing this sum by the number of estimates, and reporting the mean error correctly within $\pm 1\%$.

IV
02-Core-18

When asked to explain why the mean error of a set of measurements is determined, the student generates the idea that the mean error provides a good measure of the extent of the variation within the data by stating the effect of that idea.

IV
02-Core-19

Given the actual value of a quantity and ten estimates of the value of that quantity, and asked to calculate the mode error of the estimates, the student generates the procedure for finding the mode error by subtracting the actual value from the estimates to find the errors and reporting the mode error as the absolute error which occurs most frequently.

IV
02-Core-20

When asked to explain why many researchers are concerned with patterns and similarities rather than with individual differences, the student recalls that many problems concern groups of people and that the best way to judge what will be best for the greatest number of people is to determine the characteristics of the group by responding to that effect.

IV
02-Core-21

Given the mean of the measurements of a characteristic for a group of individuals and asked if he can state the specific value of that characteristic for a particular individual in the group and to give the reason for his answer, the student applies the concept that the mean can be used only to describe the characteristics of an entire group by responding negatively and to the effect that it is impossible to predict the characteristics of a particular individual from the mean for the group.

IV
02-Core-22

IV
02-Exc 3-1-1

Given a histogram and a series of labeled points in each of three class intervals and asked which points should be used to convert the histogram into a line graph and to justify the selection, the student applies the fact that the midpoint of the top of the bar of each interval is used to produce a line graph from a histogram by selecting the midpoints and naming them as such.

IV
02-Exc 4-1-1

Given a protractor and diagrams of two angles of less than 180° with arcs between the arms to indicate the angles to be measured and asked to measure the size of the indicated angles, the student manipulates the protractor to measure an angle by placing the protractor so that its reference point is at the vertex of the angle, the side of the baseline with the 0° marking lies along one arm of the angle, and the other arm of the angle cuts the arc of the protractor at the point to be read by reporting the size of each angle correctly to within $\pm 2^\circ$.

IV
02-Exc 4-1-2

Given a protractor and asked to construct angles of two different sizes, each less than 180° , the student manipulates the protractor to construct an angle by (1) drawing a straight line, (2) placing the protractor so that its straight edge lies along the line and its reference point is at some marked point on the line, (3) marking the angle to be constructed with a dot along the arc of the protractor, and (4) drawing a line joining the marked point and the dot by constructing each angle correctly to within $\pm 2^\circ$.

IV
02-Exc 4-2-1

Given a description of two animals, one a carnivore and the other a herbivore, their living area, food, method of eating, and enemies, and asked to state for each of these two animals whether it would be advantageous for it to have its eyes in the front of its head or in the sides of its head and to explain his answer, the student applies the concepts that animals with eyes in the fronts of their heads have better depth perception than those with eyes in the sides and that animals with eyes in the sides of their heads have a wider range of vision than those with eyes in the fronts by stating, in effect, that it would be advantageous for the carnivore to have eyes in the front of its head because it would then have greater ability to judge distances when attacking its prey and that it would be advantageous for the herbivore to have eyes in the sides of its head because it would then have a wider range of vision to spot approaching enemies.

IV
02-Exc 4-3-1

Given diagrams of sample fingerprints and asked to explain why a certain person's fingerprints do not look exactly like the samples shown for the various fingerprint types, the student applies the concept that no two people have exactly the same fingerprints by stating, in effect, that the sample fingerprints are representative of various typical patterns and no one's fingerprints will look exactly like any one of them.

IV
02-Exc 5-1-1

When asked to explain why the characteristics of a group are measured by using samples from the group rather than by measuring the characteristics of the entire group, the student generates an explanation that sampling is used because measuring

the characteristics of the entire population is usually too time consuming and expensive by responding to that effect.

Given four graphs of frequency distributions and asked to select the graph of a normal curve, the student identifies the smooth, bell-shaped, symmetrical curve as a normal curve by selecting the correct graph.

IV
02-Exc 5-1-2

Given four graphs of four different frequency distributions and asked to select the graph that best represents the curve most likely to be obtained from measuring and plotting a continuously varying human trait in a random sample of the population, the student applies the concepts that the ideal random sample has the same distribution of characteristics as the total population and that most continuously varying human traits in the total population produce a normal curve when graphed by selecting the graph of a normal curve.

IV
02-Exc 5-1-3

When asked to define *random sample*, the student recalls that a random sample is a sample of the population which is chosen in such a way that each person in the population has the same chance to be included in the sample by stating the effect of the definition.

IV
02-Exc 5-1-4

When asked to explain why it is desirable to use a random sample when measuring the characteristics of a population, the student recalls that a random sample is desirable because the characteristics of the sample will more likely represent the characteristics of the entire population, not just a small, unusual group, by responding to that effect.

IV
02-Exc 5-1-5

Given descriptions of a population to be studied and the sampling procedure to be used and asked whether the procedure will produce a random sample and to explain his answer, the student applies the concept that a sample is random only if each member of the population has an equal chance of being selected by responding negatively and with the essence of the concept.

IV
02-Exc 5-1-6

In Orbit

10

Given a sheet of white paper, a 150-watt light bulb representing the sun, and an ISCS spectroscope and asked whether the spectrum when viewed with the left eye is different from the spectrum when viewed with the right eye, the student manipulates the spectroscope safely to view the spectrum of the light reflected by a sheet of white paper by so-observing the spectrum.

10
01-Core-1

Given a bulb and socket and an ISCS spectroscope and asked to use the spectroscope to observe the spectrum of the light given off by the bulb and to state the color of certain areas of the spectrum he observes, the student manipulates an ISCS spectroscope to obtain a spectrum by using the spectroscope and stating the color of that area of the spectrum asked for.

10
01-Core-2

When asked to define the term *spectroscope*, the student recalls that a spectroscope is a device which spreads light into its component colors as the light passes through it by stating the essence of that definition.

10
01-Core-3

When asked to describe what a diffraction grating does to sunlight, the student recalls that a diffraction grating causes sunlight to spread out into a color spectrum by responding to that effect.

10
01-Core-4

When asked to define the term *spectrum*, the student recalls that a spectrum is a band of colors which is formed when light is broken up by a spectroscope, a prism, droplets of water, or another such diffraction mechanism by stating the essence of that definition.

10
01-Core-5

Given three light sources and four descriptions of spectra and asked to match the light sources with the spectral types — a continuous spectrum, a line spectrum, or both types of spectra — which they form, the student recalls that light from the sun or an incandescent light forms a continuous spectrum, that light from heated chemical elements forms a line spectrum, and that light from fluorescent lamps forms both types of spectra by matching the type of spectrum formed with the light source.

10
01-Core-6

Given a diagram of the line spectra of several different elements and the spectrum of an unknown mixture that contains two of the elements whose spectra are given and asked to predict which elements are present in the unknown mixture, the student applies the concept that the lines in the spectrum can be used to predict the presence of definite elements in an unknown substance by naming the two elements whose known spectra make up the spectrum of the unknown mixture.

10
01-Core-7

Given a description of a situation in which a new type of burner fuel is to be used for observing the spectra of an unknown mixture of salts and asked to describe the steps to follow to determine which salts are in the unknown solution, the student applies the concept that a control sample established data for the sample which is not subjected to the experimental variable by stating a procedure that includes viewing the spectrum of the flame of the new burner fuel itself as a step in his procedure.

10
01-Core-8

IO
01-Core-9 When asked to explain why the spectrum of the alcohol flame was observed before the various chemicals were put into the flame, the student applies the concept that a control is needed to establish observations about samples not affected by the experimental variable from which variations can be observed or measured by stating, in effect, that a control is needed so that one can be sure that some of the lines observed are the result of the heated crystals and are not produced by the alcohol flame.

IO
01-Core-10 Given a description of a situation in which the heating effect of a light bulb is to be changed by increasing the wattage of the bulb and asked to suggest ways in which the heating effect could be changed other than by purchasing larger bulbs, the student applies the concept that the heating effect of a radiant energy source may be changed by (1) changing the distance between the source and the absorbing object, (2) changing the absorbing surface, and (3) changing the absorbing time by stating solutions that use two of those methods.

IO
01-Core-11 When asked to state the four variables that determine the amount by which the temperature of an object increases when it is placed in direct sunlight, the student recalls that the temperature increase of an object placed in direct sunlight depends on (1) how large the object is (volume versus surface area), (2) how well it absorbs heat, (3) how quickly it conducts heat, and (4) how long it is heated by stating at least three of those four variables or factors which determine them.

IO
01-Core-12 Given a description of two similar objects, one having a light surface and the other having a dark surface, and asked to predict which object will be hotter when in direct sunlight and to explain the reason for his choice, the student applies the concept that darker surfaces absorb radiant energy more readily than light surfaces by predicting, in effect, that the object with a dark surface will be hotter because the dark surface is a better absorber of radiant energy.

IO
01-Core-13 When asked to state why the copper vane on the sun-energy measurer was blackened, the student recalls that blackening a surface increases the amount of light energy it will absorb and convert to heat by responding to that effect.

IO
01-Core-14 Given a diagram of a sun-energy measurer and the fact that when the measurer was used to determine the effects of bulbs of different wattages on temperature change, the variables time and distance were held constant, and asked to state why time and distance were held constant when investigating the effects of the wattage of the light bulb on the temperature change of the sun-energy measurer, the student applies the concept that only one experimental variable is changed at a time so that the effect of this variable is not confused with the effects of other variables by responding with the essence of the concept.

IO
01-Core-15 Given a graph of the total temperature change of a sun-energy measurer over time which shows a temperature change that increases at first, but stabilizes at a constant level and asked to predict what the total temperature change will have been a certain

number of minutes later provided that no other variables change, the student applies the rule of graphic interpretation, that a trend shown by the slope of a line on a graph can be extrapolated beyond the graphed line if all conditions remain constant, by stating the same total temperature change as that last shown on the graph, correctly within $\pm 0.2^{\circ}\text{C}$.

Given nine sets of time, temperature, and temperature-change readings from a sun-energy measurer as it heats up and a labeled grid and asked to plot a graph of the temperature change and time on the labeled grid, the student applies the procedure of graph construction for plotting data and drawing the best-fit line by constructing the graph so that the points are accurate to within ± 1 scale division and the best-fit line is a smooth, regular curve.

10
01-Core-16

Given a description of a lighting device with standard electrical wiring which carries the warning that bulbs of wattage higher than a certain wattage should not be used in the device and asked to explain why this warning appears and to predict what will happen if a bulb of higher wattage is used, the student applies the concept that a light bulb of higher wattage produces a greater heating effect by responding with the idea that a bulb of higher wattage would generate more heat which might damage the device or surrounding materials.

10
01-Core-17

Given the maximum temperature change of a sun-energy measurer when placed in direct sunlight and a graph of the maximum temperature change of the same measurer as a function of its distance from a light bulb and asked at what distance from the light bulb the sun-energy measurer receives the same amount of energy as it does when it is placed in direct sunlight, the student applies the concept that the sun-energy measurer receives the same amount of energy from two sources when the maximum temperature changes produced by the two sources are equal by stating the distance within ± 0.5 cm.

10
01-Core-18

Given a description of a device that uses a light bulb of specified wattage as a source of radiant energy and asked to select which of several wattages would produce nearly the same heating effect in a similar device at twice the distance, the student applies the concept that in order for the heating effect of a light source to remain constant, changes in the wattage of the source must increase at a rate greater than twice the rate of the increase in distance from the source by selecting the wattage which is more than twice as high as the wattage of the bulb in the smaller device.

10
01-Core-19

Given four graphs of temperature change versus time and asked to select the graph that best illustrates the temperature change of a sun-energy measurer when it is placed in direct sunlight, the student applies the fact that when a sun-energy measurer is placed in direct light, its temperature rises rapidly at first, but then the rate of increase slows down gradually until it reaches some maximum temperature, by selecting the curve whose shape shows that pattern.

10
01-Core-20

IO
01-Core-21

Given the wattages of four different light bulbs and four temperature change versus time graphs, each of which shows the effects of one of the light bulbs on a sun-energy measurer, and asked to match each graph with the wattage of the appropriate light bulb, the student applies the concept that when energy sources of different wattage are placed at the same distance from an object, the temperature change of the object will vary with the wattage of the energy source by matching the graphs with the bulb wattages so that the final temperatures shown vary with the wattages of the bulb.

IO
01-Core-22

Given a graph of the temperature in $^{\circ}\text{C}$ of a sun-energy measurer versus time and asked to state the total temperature change of the sun-energy measurer, the student applies the concept that the total temperature change is the arithmetic difference between the final temperature (after the graph flattens out) and its starting temperature (at the zero point on the time axis) by stating the total temperature rise correctly within $\pm 0.5^{\circ}\text{C}$.

IO
01-Core-23

Given four graphs and asked to select the graph that best shows how the temperature change of a black object varies with its distance from a light source, the student applies the concept that the temperature change produced in an object decreases as its distance from a radiant energy source increases by selecting a graph which slopes downward from left to right.

IO
01-Core-24

Given ample opportunity to work with materials on a laboratory activity of more than one day's duration and asked to observe the cleanup period at the appropriate time, the student chooses to close the laboratory activity period promptly upon receiving notification of the time by immediately ceasing the laboratory activity, returning materials in usable, clean condition to storage places, and participating in work area cleanup, on at least three separate occasions when being observed by the teacher or another designated observer without his knowledge.

IO
01-Core-25

When asked to work in the laboratory with fellow students, the student chooses to cooperate with fellow students in the laboratory by being polite, waiting his turn, being orderly when moving about, and observing the right of his classmates to work without being unnecessarily disturbed, when observed without his knowledge by the teacher or another designated person on at least three occasions.

IO
01-Core-26

When asked to work with the equipment and text materials of the ISC'S course, the student chooses to show personal responsibility for returning laboratory equipment no longer needed to the proper storage places during the activity period by returning such equipment and materials to the designated storage places on at least three occasions when observed by the teacher or another designated observer without his knowledge of being checked.

When asked questions in the textbook, the student chooses to write in his *Record Book* his answers to 90% or more of the questions in his textbook by exhibiting the written responses when the teacher spot checks to determine if he is doing so.

IO
01-Core-27

When working independently in the laboratory, the student chooses to show proper care and use of ISCS laboratory materials by using the materials only for their intended purpose or by requesting permission to do other specific experiments with them, when being observed without his knowledge by the teacher or another designated person on three or more occasions.

IO
01-Core-28

Given a diagram of the bright-line spectrum of an element and asked to predict the location of the dark Fraunhofer lines that would appear in the dark-line spectrum of this element, the student applies the concept that the dark lines in an absorption spectrum of an element are in the same position as the bright lines in the bright-line spectrum for that element by drawing lines in the same positions.

IO
01-Exc 1-1-1

Given a description of a self-contained device that is producing energy but presently has no input of energy and asked (1) to describe, using the ideas of energy, what is happening to keep the device working, (2) to state if the device can continue to work forever, and (3) to explain his answer, the student generates the explanation for the operation of a self-contained device, including that it uses stored energy to do work and it can continue to operate until some or all of the stored energy is transferred from one place to another or changed from one form to another, at which time the device will stop, by responding negatively to the notion of ceaseless operation and with an explanation to that effect.

IO
01-Exc 2-1-1

When asked how to calculate the amount of work done on an object, the student recalls that the amount of work done may be calculated by multiplying the force applied to the object by the distance the object is moved by responding to that effect.

IO
01-Exc 2-1-2

When asked to define the term *conservation of energy*, the student recalls that the term *conservation of energy* means that energy may be changed from one form to another but cannot be created or destroyed by responding to that effect.

IO
01-Exc 2-1-3

When asked to list three different forms of energy, the student recalls that energy exists in the forms of light, heat, chemical, electrical, gravitational, nuclear, sound, kinetic (motion), and potential by listing any three forms of energy included in or implied by the above list.

IO
01-Exc 2-1-4

When asked to describe two situations in which a distance is better measured indirectly, using a device such as a range finder, rather than measured directly, using a device such as a ruler, the student generates descriptions of two situations each of which involves one of the following conditions: (1) direct measuring devices are not suitable to the intervening distance, (2) making a direct measurement is too difficult or time-consuming, and (3) making a direct measurement may disturb the object whose distance is to be measured, by describing two situations each of which involves one of those conditions.

10
02-Core-1

When asked to state the principle on which a range finder is based, the student recalls that a range finder is based on the principle that the distance from an observer to an object can be determined from the angle formed when the observer looks at the object from two different positions by stating that principle in his own words.

10
02-Core-2

When asked why calibrated rather than uncalibrated measuring devices are used, the student recalls that calibrated measuring devices enable investigators to report their findings in the form of numbers which can be easily analyzed or compared with the findings of other investigators by responding to the effect of at least one of those reasons.

10
02-Core-3

Given an ISCS range finder that has been accurately calibrated and asked to measure the distance between two points that are less than fifteen meters apart, the student manipulates the range finder to measure the distance by standing at one point and lining up the sighting line and the sighting bar with the other point and reading the scale of distances by reporting the measurement as found with the range finder accurately within $\pm 20\%$.

10
02-Core-4

Given diagrams of two ISCS range finders which have equal baselines but different angles between the sighting bar and the parallel sighting line and asked to select the range finder which is being used to measure the greater distance and to explain his choice, the student applies the relationship that as the distance measured by a range finder becomes larger, the angle between the sighting bar and the parallel sighting line decreases by selecting the range finder with the smaller angle between the sighting bar and the parallel sighting line and stating, in effect, that the smaller size of the angle was the basis for his choice.

10
02-Core-5

Given sketches of two ISCS range finders that have baselines of different lengths and asked to state which range finder can measure a large distance more accurately and to explain the reason for his choice, the student applies the concept that the distance which a range finder can measure accurately is limited by the length of its baseline by selecting the range finder with the longer baseline and stating, in effect, either that the range finder with the longer baseline can measure longer distances more accurately or that a longer baseline will result in a greater variation in sighting angles to objects at different large distances.

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02-Core-6

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02-Core-7 When asked to state the two variables which determine the greatest distance that can be measured by a range finder, the student recalls that the variables which determine the greatest distance a range finder can measure accurately are the length of the baseline and the smallest measurable angle formed by the sighting bar and the parallel sighting line by stating the essence of those variables.

10
02-Core-8 Given a light bulb to represent the sun and the instructions for Activities 3-7 and 3-8 and asked to use the range finder to measure the distance to a bulb on the other side of the room but to carry out the procedure as if the bulb were the sun itself, the student manipulates the range finder in accordance with the safety notes about the dangers of looking at the sun directly by sighting the shadow of the bolts rather than lining up the bolts while directly sighting the bulb.

10
02-Core-9 When asked to state why a range finder of the type constructed in class cannot be used to measure the distance from the earth to a star, the student applies the concept that the ISCS range finder cannot be used to measure the distance from the earth to a star because any possible baseline on such a range finder is too short by stating the essence of that concept.

10
02-Core-10 Given a diagram of the Earth-sun-Venus model and asked to list four assumptions that are made when drawing this model, the student recalls that the assumptions made in drawing the Earth-sun-Venus model are that (1) the sun is the center of the solar system, (2) Earth and Venus are planets revolving around the sun, (3) Venus and Earth move in the same plane, (4) both Venus and Earth move in roughly circular orbits, and (5) Venus is closer to the sun than Earth is by stating the essence of four of the five assumptions.

10
02-Core-11 Given a diagram of the Earth-sun-Venus model showing the positions of Earth and Venus at one time, the position of Venus a few months later, and four alternative positions for the Earth at that same later time and asked to locate the approximate position of Earth at the later time, the student applies the fact that the angular speed of Venus is greater than that of Earth by selecting a position for Earth which shows that it has moved through a smaller angle than Venus.

10
02-Core-12 Given a series of six diagrams of two planets and the sun, each of which shows the lines of sight from the planet whose orbit is greater, and asked to select the diagram which shows the greatest sighting angle, the student applies the concept that the greatest sighting angle is determined by the line of sight to the sun from the planet which has the larger orbit and the line of sight from that same planet which just touches, but does not cut, the orbit of the planet of smaller orbit by selecting the diagram which shows those lines of sight.

10
02-Core-13 Given a compass, a ruler, and a diagram of an Earth-sun-Planet system in which the planet has a smaller orbit than Earth's and asked to draw the largest possible angle between the Earth-sun line and the Earth-Planet line, the student applies the concept that the largest angle between the Earth-sun line and the Earth-Planet line

occurs for a planet with a smaller orbit than Earth's when the Earth-Planet line just touches the orbit of the planet by drawing that angle.

Given a drawing compass and a diagram showing the sun, the orbit of an outer planet and the sighting line to an interior planet, which produces the maximum sighting angle and asked to draw a circle to represent the orbit of the interior planet, the student applies the procedure of using the largest sighting angle from the outer planet to the interior planet to diagram an interior planet's orbit with its center at the sun and just touching, but not cutting, the sighting line from the outer planet by constructing a circle whose center is at the center of the sun and which just touches the sighting line to represent the planet's orbit.

10
02-Core-14

Given a protractor, a drawing compass, and a metric ruler and told the maximum angle between the sun, a specified planet, and a planet which has a smaller orbit than the planet specified and asked to construct a scale model of the orbit of the planet with the smaller orbit, using a specified orbital radius for the larger orbit, the student applies the procedure of using the maximum sighting angle between the sun and the planet with the smaller orbit as observed from the specified planet to construct a scale model of the orbit of the planet with the smaller orbit by drawing a circle to represent the larger orbit and by constructing an angle equal to the maximum sighting angle with its vertex on the circle and one arm passing through the center of that circle and drawing a second, smaller circle which has the same center as the original circle and just touches the second arm of the maximum sighting angle.

10
02-Core-15

Given a scale diagram which shows the orbits of two planets and the position of the sun and the actual minimum distance between the two planets and asked to calculate the actual radius of the outer planet's orbit, the student applies the rules of linear scaling, which include (1) measuring the scaled distances which represent the known and unknown distances, (2) finding the ratio of unknown to known scaled distances, and (3) multiplying this ratio by the actual known distance to calculate the distance from the sun to the planet, by reporting an answer within $\pm 15\%$ of the correct distance.

10
02-Core-16

Given a diagram of the earth-moon system and asked to state two assumptions about the earth-moon system that are used when calculating the moon's diameter, the student recalls that the assumptions used when calculating the moon's diameter are that (1) the moon's orbit is circular, (2) the earth is at the center of the moon's orbit, (3) the earth turns at a constant speed, (4) either the moon is 240,000 miles from the earth or the moon's orbit is 1,500,000 miles around, and (5) all the motion observed, when the moon is viewed for short periods, is due to the earth's turning by responding with the notion of two of the five assumptions.

10
02-Exc 3-1-1

When asked to describe the method by which radar measures the distance to an object, the student recalls that radar measures the distance to an object by measuring the amount of time it takes for a radio signal of known speed to reach the object, bounce off the object, and return to the antenna by stating the effect of those ideas.

10
02-Exc 4-1-1

IO
02-Exc 4-2-1

Given a protractor and diagrams of two angles of less than 180° with arcs between the arms to indicate the angles to be measured and asked to measure the size of the indicated angles, the student manipulates the protractor to measure an angle by placing the protractor so that its reference point is at the vertex of the angle and the side of the baseline with the 0° marking lies along one of the arms of the angle and reading the size of the angle from the protractor scale by reporting the size of each angle correctly to within $\pm 2^\circ$.

IO
02-Exc 4-2-2

Given a protractor and asked to construct angles of certain sizes, the student manipulates the protractor to construct the specified angles by constructing angles within $\pm 2^\circ$ of the specified sizes.

IO
02-Exc 4-3-1

Given a scale drawing, its scale, and a ruler and asked to determine actual distances from the scale drawing, the student applies the procedures for determining an actual distance from a scale drawing, which include measuring the distance on the drawing in the units of the drawing and multiplying the numerical value obtained by the distance each scale unit represents, by reporting the distance to an accuracy of $\pm 5\%$ of the correct value.

IO
02-Exc 4-4-1

Given a scale diagram on which the actual distance between two points is specified and asked to determine the scale of the diagram, the student applies the procedure for determining the scale of a scale diagram, which involves (1) measuring the scale distance which corresponds to the actual specified distance, (2) stating the ratio of scale distance to actual distance, and (3) simplifying the ratio, by reporting the scale as a ratio of one of the scale units to the number of units of actual distance it represents with an accuracy of $\pm 5\%$.

Given a sighting scope and a bright light source one centimeter square and asked to use the sighting scope at a specified distance from the source to obtain an image of fixed size on the frosted acetate screen, the student manipulates the sighting scope to obtain an image of the specified size on the acetate screen by placing the pinhole end of the scope at a specified distance from the source, pointing it toward the object, and adjusting the length of the scope until the image on the screen is of the size specified by reporting the length of the adjusted sighting scope within ± 5 cm.

10
03-Core-1

Given a statement to the effect that it would be impossible to measure the size of the sun because no one could get close enough to measure it without being burned and asked whether he would agree with this statement or not and to explain his answer, the student applies the concept that indirect methods of measurement can be used to measure objects that are impossible to measure directly by stating that he disagrees with the statement and the essence of the concept.

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03-Core-2

Given a brightly illuminated object, a meterstick, a sighting scope, and the mathematical relationship by which the distance across an object can be calculated and asked to use the sighting scope and the meterstick to measure the distance across the object, the student applies the procedure for determining the distance across an object, using a sighting-scope, which involves focusing the image of the object on the screen, measuring the distance from the object to the pinhole, the distance from the pinhole to the screen, and the width of the image, by calculating the distance across the object within $\pm 10\%$, using the relationship

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03-Core-3

$$\text{distance across object} = \frac{\text{distance from object to pinhole}}{\text{distance from pinhole to screen}} \times \text{distance across image}$$

Given a situation in which a person on another planet wishes to use a sighting scope to calculate the distance across the sun and both the equation for calculating the distance across the sun from the planet specified and the distance from the pinhole to the screen of his sighting scope in centimeters and asked to calculate the distance across the sun, the student applies the procedure for calculating the distance across the sun, using the formula

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03-Core-4

$$\text{distance across sun} = \frac{\text{distance from sun to planet} \times \text{distance across image}}{\text{distance from pinhole to screen in cm}}$$

by calculating the distance across the sun within $\pm 10\%$ of the correct answer.

Given the number of hours in a planet's day and asked to determine the number of degrees that the sun would appear to move in one hour across the sky of that planet, the student applies the rule that the number of degrees which the sun appears to move each hour equals 360° divided by the number of hours in the planet's day by calculating the number of degrees per hour that the sun would appear to move.

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03-Core-5

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03-Core-6

When asked to state why it is hard to prove that the earth turns and that the sun does not move around the earth, the student recalls that it is difficult to prove whether it is that the earth rotates or that the sun revolves around the earth because either motion would produce the same apparent motion of the sun across the sky each day by responding to that effect.

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03-Core-7

Given the amount of time that it takes for a planet to make one complete rotation when the sun's path is directly over the equator and asked to state both the number of degrees that the planet turns from sunrise until the sun is most nearly overhead and the number of degrees it turns from sunrise to sunset, the student applies the concept that when the sun's path is directly over the equator, any planet rotates about one-quarter of a rotation (90°) between sunrise and noon and about one-half of a rotation (180°) between sunrise and sunset by stating those amounts of angular rotation.

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03-Core-8

When asked to state why the year has an extra day once every four years and what purpose it serves, the student recalls that February has an extra day once every four years because the earth's period is not exactly 365 days long but is closer to $365\frac{1}{4}$ days; therefore, an extra day is added each four years to keep the calendar in step with the seasons or to keep Easter at a specific time, by responding to that effect.

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03-Core-9

Given a scale diagram of a sun-planet system with the orbit of the sun around the planet showing the angle that the sun appears to move each hour and the scale of the diagram and asked to determine how many miles per hour the sun would have to travel to make one trip around the planet each day, the student applies the procedure for determining from a scale diagram the speed at which the sun would have to travel to make one complete trip around the planet each day, which includes measuring the length of the chord between the intersections of the arms of the angle through which the sun appears to move each hour and multiplying this distance in millimeters by the distance represented by each millimeter to determine the speed of the sun, by reporting the speed of the sun in miles per hour within $\pm 10\%$.

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03-Core-10

Given a compass, a protractor, a ruler, the distance between the sun and a planet, and the number of degrees that the sun appears to move across the sky each hour and asked to calculate the sun's speed in miles per hour if it appeared to make one complete circle around the planet each day, the student applies the concept that measurements can be determined from scale diagrams by calculating the speed of the sun in the following way: drawing a circle whose radius is proportional to the sun-planet distance, constructing an angle with its vertex at the center of the circle and whose size equals the angle through which the sun appears to move each hour, measuring the length of the chord between intersections of the circle and the arms of the angle, and multiplying this chord length by the scale factor, and by reporting the speed of the sun in miles per hour within an accuracy of $\pm 10\%$.

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03-Core-11

When asked to explain why it is unlikely that the sun travels around the earth each day, the student recalls that it is unlikely that the sun travels around the earth each

day because the speed at which the sun would have to travel to do so would be much greater than the speed of any known planet or satellite by responding to that effect.

When asked to state why the earth is divided into time zones, the student generates an explanation which includes the notion that time zones were created for convenience so that at a given clock time, the sun is in the same relative east-west position in each zone by stating an explanation that includes that notion.

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03-Core-12

Given that a device heats a surface by means of a light bulb of specified wattage and asked to state the wattage of the bulb that would be required to produce the same heating effect in a similar device in which the bulb is twice as far away from the surface, the student applies the concept that the intensity of heat from a source varies with the square of the distance from the source by stating that the necessary wattage will be four times that of the wattage of the bulb at half the distance.

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03-Core-13

Given the distance from a sun-energy measurer to a light bulb and the wattage of the bulb and asked to state the wattage of the bulb that would have the same heating effect at a distance that is eight or sixteen times greater than the given distance and to show his work, the student applies either the doubling method, which involves drawing a table of distances and wattages, writing the known wattage and the distance in the table as the initial column entries, finding the remaining table entries by multiplying the previous distance by two and the previous wattage by four until the last entry in the distance column equals the required distance, and reporting that entry in the wattage column which corresponds to this distance as the required wattage, or the squaring method, which involves using the rule that the intensity of radiant energy varies inversely as the square of the distance from the source, finding the ratio of the new distance to the original distance, squaring this ratio, and multiplying the squared ratio by the power of the original source to find the required wattage, by calculating the wattage correctly within $\pm 10\%$, using one of those methods, and showing his work.

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03-Core-14

Given diagrams of the spectra of two stars each of which shows some absorption lines, the spectral line of the elements that correspond to these absorption lines, the distance of these stars from the earth, and the amount of temperature change in a sun-energy measurer caused by each star and asked to compare the composition and wattage of these two stars, the student applies the concept that the composition of a star is shown by the appearance of absorption lines in its spectrum which correspond to the spectra of various elements and the concept that the relative powers of two stars vary directly with the heating effect that they produce on a sun-energy measurer and inversely with the square of their distance from the earth by stating a description which involves those two concepts.

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03-Core-15

When asked to define the term *transit* as it applies to the movement of planets, the student recalls the definition that a transit is the apparent passing of a planet across the face of another heavenly body, such as the sun, by responding to that effect.

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03-Core-16

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- IO**
03-Exc 5-1-1 Given the focal length of the object lens and of the eyepiece lens of a telescope and asked to calculate the power of the telescope that uses these lenses, the student applies the mathematical relationship that the power of a telescope equals the object lens's focal length divided by the eyepiece's focal length by calculating the power of the telescope within $\pm 5\%$.
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- IO**
03-Exc 5-1-2 Given a diagram of a lens, a distant object, the image formed, and several light rays and asked to indicate the line which represents the focal length of the lens, the student applies the concept that the focal length of a lens is the distance between the lens and the focal point (focus) of the lens by selecting the proper line on the diagram.
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- IO**
03-Exc 5-1-3 Given a convex lens, a 15-cm square piece of cardboard with a white surface, a meterstick, and masking tape and asked to measure the focal length of the lens, the student applies the procedure for measuring the focal length of a lens, which includes focusing an image of a distant object on a piece of cardboard and then measuring the distance between the lens and the cardboard, by reporting the focal length of the lens within $\pm 10\%$.
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- IO**
03-Exc 5-1-4 Given the focal lengths of two lenses to be used in constructing a telescope and a diagram showing a human eye, a distant object, and two positions between the eye and the object and asked to draw the positions of the two lenses used to make the telescope to view the distant object and to indicate their focal length and how far apart the lenses are, the student applies the concept that the lens with the shorter focal length is placed near the eye and that the lens with the longer focal length is placed farther from the eye and that for maximum magnification the lenses are separated by a distance that is approximately equal to the sum of their focal distances by indicating their relative positions and stating that their spacing is the sum of their focal lengths.
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- IO**
03-Exc 6-1-1 When asked to explain why people invented calendars, the student recalls that calendars were invented so that people could tell the time of year more accurately and could describe and predict when important events had or were going to happen by responding with the effect of those ideas.
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- IO**
03-Exc 6-1-2 When asked to explain why so many different calendars were devised and rejected, the student recalls that the early calendars were not accurate enough so that the seasons began in the same calendar month each year and, therefore, had to be frequently adjusted by responding to that effect.
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- IO**
03-Exc 6-1-3 Given an example of a double date in history books and asked to explain why two dates are given for a particular event, the student recalls that the date an event occurred is sometimes reported according to the calendar used at the time of the event and sometimes according to today's calendar and so dates from each of the calendars are given in different texts by responding to that effect.
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Given five purported reasons why Galileo decided to accept Copernicus's model of the solar system and reject Ptolemy's model and asked to select the best reason for accepting the one model and rejecting the other, the student applies the concept that one model is considered to be better than another if it agrees with experimental observations more accurately by selecting the option that expresses that idea.

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03-Exc 6-2-1

Given sketches of three possible Venus-earth-sun models and asked which one represents Ptolemy's model and which one represents Copernicus's model, the student identifies the earth-centered system with Venus traveling around a deferent as Ptolemy's model and the sun-centered system with the earth and Venus in circular orbits around the sun as the Copernican system by selecting the correct models.

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03-Exc 6-2-2

Given that work is one of the variables involved in calculating power and asked to name another variable involved in calculating power, the student recalls that time is a variable involved in calculating power by naming time as the other variable.

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03-Exc 7-1-1

Given a situation in which the term *power* is used in its scientific sense as defined in Excursion 7-1 and asked what is meant by the term *power*, the student recalls that power is the rate at which work can be done or the rate at which energy can be transferred by responding with one of those notions.

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03-Exc 7-1-2

Given a situation in which the word *powerful* is used to describe a device and asked whether it is scientifically correct (as defined in Excursion 7-1) to use the word *powerful* in this way and to explain his answer, the student applies the concept that power is a measure of the rate at which work can be done by responding affirmatively and, in effect, that if a device performs more work (force multiplied by distance) in the same amount of time or less than another, it could scientifically be called a more powerful device.

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03-Exc 7-1-3

Given the distance from a sun-energy measurer to a power source, the power of the source, and the temperature change of the sun-energy measurer and asked to use the method of squares to find the power of a source which would produce that same heating effect at a distance that is an odd integral-multiple of the original distance, the student applies the rule that the intensity of radiant energy varies inversely as the square of the distance from the source by finding the ratio of the new distance to the original distance, squaring this ratio, multiplying the squared ratio by the power of the original source, and reporting the power of the new source correctly within $\pm 10\%$.

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03-Exc 7-2-1

Given three numbers and asked to square each of them, the student applies the concept that a number is squared by multiplying it by itself by reporting the squares of at least two of the three numbers correctly.

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03-Exc 7-2-2



What's Up?

WU

Given a plastic water rocket with its pump and funnel, a meterstick, water, and a beaker and asked to launch the water rocket in the presence of an observer, the student manipulates the water rocket and air pump, filling the rocket with water to the designated level, attaching the air pump to the rocket, pointing the rocket upward, pumping a maximum of twenty strokes of air into the rocket, bracing his hands, and pulling back on the trigger release slide, by launching the rocket approximately straight up over an open area.

WU
01-Core-1

Given a quadrant and a conversion table and asked to use the quadrant to measure a specified height difference in meters, the student manipulates the quadrant to measure the specified height by stationing himself at the 7.6-meter mark, crouching down so that the bottom of the quadrant is one meter off the floor, measuring the angle to the nearest 5°, using the conversion table, and reporting the specified height that corresponds to the nearest five-degree angle.

WU
01-Core-2

When asked to explain why indirect methods rather than direct methods were used to determine the height of the rocket flight, the student generates the explanation that indirect methods were used to measure the height of the rocket's flight because they did not affect the variable being measured, were the only methods possible in the situation, were done more rapidly, involved either less equipment or more available equipment, were easier to use, and produced more accurate results than direct measurement would have by stating the essence of at least two of those reasons or examples of them.

WU
01-Core-3

Given the angular height to which a rocket traveled and an angle-height conversion table and asked to find the highest point to which the rocket rose, the student applies the procedure of reading an angle-height conversion table by stating the distance that corresponds to the given angular measurement in an angle-height conversion table.

WU
01-Core-4

When asked to state the reason for having more than one observer to measure the rocket flights, the student applies the concept that several measurements are made of the same thing in order to reduce the effects of random errors in individual measurements by stating the notion of that concept.

WU
01-Core-5

When asked to define operationally *performance* for a water rocket, based on the use of the quadrant, the student recalls that *performance* for a water rocket is operationally defined as the maximum height to which the rocket rises when it is launched by responding to that effect.

WU
01-Core-6

When asked to explain why only one variable is changed at a time when investigating the effects of varying amounts of air and water on the performance of a rocket, the student applies the concept that in an experiment, only one variable is changed at a time so that the effects of changes in the experimental variable can be identified as related to that variable alone and cannot be confused with effects produced by changes in other variables by stating the effect of that concept.

WU
01-Core-7

WU
01-Core-8 Given a description of a variable and asked to design a procedure to test the effect of that variable on the performance of a rocket, the student generates a procedure that includes a way of systematically changing the variable to be investigated while holding the other variables constant so as to investigate the effect of the variable on a rocket's performance by stating such a procedure.

WU
01-Core-9 When asked to state two variables which affect the performance of a water rocket, the student recalls that the two variables which affect the performance of a water rocket are the amount of water it contains and the number of strokes of air forced into it by stating both of those variables.

WU
01-Core-10 Given a diagram of a rocket ready to launch and the apparatus required to launch the rocket and asked to name a system, two subsystems, and four components, the student applies the concepts that a system is a group of objects that influence each other, a subsystem is a group of two or more objects that directly influence each other within the system, and a component is an individual part of the system by naming a system, two subsystems, and four components in agreement with those concepts.

WU
01-Core-11 Given a diagram of a closed system that contains a gas under pressure and asked to draw arrows to represent the force (pressure) exerted by the gas, the student applies the concept that a confined gas under pressure exerts an equal force in all directions by drawing arrows of approximately equal length that point radially outward in all directions against the inside of the container.

WU
01-Core-12 Given a diagram of an object from which gas is escaping and asked to show the direction of the unbalanced force acting on the object, the student applies the concept that the reaction force on an object acts in the direction opposite to the direction in which the gas is escaping by drawing an arrow in that direction.

WU
01-Core-13 Given a situation in which an unbalanced force is acting on a toy and asked how he would measure the unbalanced force, the student applies the concept that an unbalanced force can be measured by measuring the extent to which it changes the shape or motion (speed, direction, or both) of an object, just as a single force can be measured, by responding to the effect that the unbalanced force can be measured by a force measurer whose blade is hooked to the side of the toy opposite to the toy's direction of motion and observing how much the blade of the force measurer is deflected as the toy moves.

WU
01-Core-14 When asked to describe a way that could be used to measure the initial thrust of a water rocket, the student generates a method to measure the thrust of a water rocket, which involves the idea of connecting a force-measuring device to the rocket and then releasing the rocket from its launcher, by stating such a method.

Given that in an activity thin plastic rulers were substituted for the metal blades on the force measurers and asked what must be true of the rulers if the results of the activity using the modified device are to be compared, whether or not everyone would have had to use the same units to calibrate the scale cards, and to explain his answer, the student applies the concept that measuring devices must be calibrated against a common standard if the values of measurement are to be easily compared, by stating in effect that the rulers and units must be identical because comparisons of measurements depend upon getting similar results when making identical measurement.

WU
01-Core-15

Given the hint that he could use different sized jets and asked to design an experiment to investigate the effect of changing only the speed, not the rate, at which water leaves a jet on the resultant unbalanced force, the student generates a description of a plan to determine the effect on the unbalanced force of changing just the speed at which water leaves the jet, which includes the ideas of (1) changing the size of the jet, (2) adjusting the rate of flow so that a standard volume of water flows from the jet in a certain amount of time, (3) measuring the speed of flow, and (4) measuring the unbalanced force, using a force measurer, by responding to that effect.

WU
01-Core-16

When asked to state whether a rocket will have a greater unbalanced force when it is in the atmosphere or in the vacuum of outer space and to explain his answer, the student applies the concept that the thrust of a jet is less when it discharges into a fluid by stating that the thrust (unbalanced force) is greater in the vacuum of outer space and, in effect, that this is so because there the rocket exhaust has nothing to push against.

WU
01-Core-17

When asked to state two reasons that experiments are performed on simplified systems rather than on larger, more complex systems, the student recalls that the reasons that simplified rather than more complex systems are studied are (1) to decrease the expense and time of investigation, (2) to have a more manageable and more easily observable system, and (3) to control variables more easily by stating the effect of two of the reasons.

WU
01-Core-18

Given ample opportunity to work with materials on a laboratory activity of more than one day's duration and asked to observe the cleanup period at the appropriate time, the student chooses to close the laboratory activity period promptly upon receiving notification of the time by immediately ceasing the laboratory activity, returning materials in usable, clean condition to storage places, and participating in work area cleanup on at least three separate occasions when being observed by the teacher or another designated person without his knowledge.

WU
01-Core-19

When asked to work in the laboratory with fellow students, the student chooses to cooperate with fellow students in the laboratory by being polite, waiting his turn, being orderly when moving about, and observing the right of his classmates to work without being unnecessarily disturbed, when observed without his knowledge by the teacher or another designated person on at least three occasions.

WU
01-Core-20

WU
01-Core-21

When asked to work with the equipment and text materials of the ISC'S course, the student chooses to show personal responsibility for returning laboratory equipment no longer needed to the proper storage places during the activity period by returning such equipment and materials to the designated storage places on at least three occasions when observed by the teacher or another designated observer without his knowledge of being checked.

WU
01-Core-22

When asked questions in the textbook, the student chooses to write in his *Record Book* his answers to 90% or more of the questions in his textbook by exhibiting the written responses when the teacher spot checks to determine if he is doing so.

WU
01-Core-23

When working independently in the laboratory, the student chooses to show proper care and use of ISC'S laboratory materials by using the materials only for their intended purpose or by requesting permission to do other specific experiments with them, when being observed without his knowledge by the teacher or another designated person on three or more occasions.

WU
01-Exc 2-1-1

When asked to define *force* operationally, the student recalls the operational definition that a force is that which can change an object's shape, speed, or direction and can be measured by measuring the extent to which it changes the shape or motion (speed, direction, or both) of the altered object by responding with the essence of the operational definition.

WU
01-Exc 2-1-2

When asked to define *unbalanced force* operationally, the student recalls the operational definition that an unbalanced force acting on an object causes a change in the motion or shape of the object and that the size of the change is a measure of the size of the force by stating the effect of that definition.

Given the weight of an empty rocket casing and the weight and thrust of five small rocket engines and asked to select the smallest rocket engine that will allow the rocket to lift off and to explain the reason for his choice, the student applies the concept that the thrust of a rocket must be greater than its total weight for it to lift off by selecting the smallest engine that provides sufficient thrust and stating the essence of the concept.

WU
02-Core-1

Given a diagram showing two identical rockets which have traveled the same amount of time but different distances and asked to state which rocket has had the larger unbalanced force acting on it and to explain his answer, the student applies the concept that the distance a movable object will travel in a given amount of time varies directly with the size of the unbalanced force applied to it by selecting the higher rocket and stating the essence of the concept.

WU
02-Core-2

Given a four-part diagram, each of which shows a pattern of water drops whose spacing increases, decreases, or remains the same and the direction of motion of the cart that left this track, and asked to state whether the speed of the cart increased, decreased, or remained constant as it made each of the tracks, the student classifies the speed of a water-clock cart as increasing if the drops become farther apart, as decreasing if the drops become closer together, or as constant if the drops are equally spaced by stating whether the speed increases, decreases, or remains the same correctly for at least three of the four cases.

WU
02-Core-3

Given three speed-time interval graphs showing increasing, decreasing, and constant speeds and a series of water-clock cart-drop records in which an arrow shows the direction of motion of the cart and asked to match each water-clock cart drop record with the appropriate graph, the student classifies a water-clock cart drop record as corresponding to the graph that slopes upward to the right if the drop separation increases in the direction of motion, as corresponding to the graph that slopes downward to the right if the drop separation decreases in the direction of motion, or as corresponding to the graph with the horizontal line if the drop separation is constant by so matching the graphs and drop records.

WU
02-Core-4

Given a description of a situation in which the same force is applied to two similar objects of different masses and asked to select the object whose speed will increase faster and to explain his answer, the student applies the concept that an object's speed varies inversely with its mass when equal forces are applied by selecting the object with less mass and stating the effect of the concept.

WU
02-Core-5

Given a labeled grid and data for five trials in which a cart, traveling during a fixed time interval, is acted on by a constant force but carries a different mass in each trial and asked to graph the data, the student applies the procedures for graphing, which include plotting the points to within 0.2 scale divisions and drawing a best-fit line, by constructing such a graph of the speed change of carts with different masses acted on by a constant force.

WU
02-Core-6

WU
02-Core-7

Given an illustration of a water cart and four graphs showing relationships between the mass put on a cart and the change in the speed of the cart and asked to select the graph that best shows the relationship between the mass on the cart and the cart's change in speed when the force is constant, the student applies the concept that if the force applied to an object is held constant while the mass of the object is varied, the object's rate of speed varies inversely with the variations in mass, by selecting the graph that shows that relationship.

WU
02-Core-8

Given four graphs showing different relationships between unbalanced forces and the rates at which speed changes and asked to select the graph that would be obtained if the data were plotted after different forces were applied to the same water-clock cart, the student applies the concept that the speed of an object varies directly with the size of the unbalanced force applied to it by selecting a graph that illustrates the concept.

WU
02-Core-9

Given a situation in which the same unbalanced force acts on two identical objects for different lengths of time and asked to predict which object will speed up more and to explain his answer, the student applies the concept that the amount of change in the speed of a mass depends on the size of the unbalanced force applied to it and the amount of time the force is applied by selecting the object which is in contact with the force longer and stating the essence of the concept.

WU
02-Core-10

Given an illustration and a description of a situation in which the range of a projectile whose firing position is fixed has to be increased and asked to state how the increase could be achieved and to explain why that method would work, the student applies the concept that the greater the unbalanced horizontal force acting on an object when it is launched, the greater its range will be, by describing an increase in the force to produce the desired change in range and explaining, in effect, the concept.

WU
02-Core-11

When asked to explain the purpose of the ball that fell straight down in the activity which investigated the effect of the amount of horizontal force on a ball and the time the ball took to fall, the student applies the concept that a control, a sample not subjected to the experimental variable, is used in an experiment as a standard with which changes are compared by stating, in effect, that this ball served as an experimental control or standard with which the other fall times were compared.

WU
02-Core-12

Given a situation in which one object is projected horizontally at high but less than orbiting speed at the same time as another object of different weight is dropped from the same height and asked to state which, if either, object will hit the ground first and to explain his choice, the student applies the concept that the time of fall of an object is independent of its weight and horizontal speed by stating that both objects will hit the ground at the same time and the essence of the concept.

Given the distance an object falls in one second on the surface of a particular planet and a sketch like Figure 4-5 showing the horizontal surface which curves downward and a distance equal to the distance of fall and asked to determine the orbiting speed of a satellite at the surface of the planet, the student applies the rule that the orbiting speed (distance per unit of time) is numerically equal to the surface distance an object falls in one second when it is dropped near the surface by stating the orbiting speed in agreement with the rule.

WU
02-Core-13

Given four graphs purporting to show the relationship between the period of a satellite and its distance from the earth's surface and asked to select the graph which correctly shows that relationship, the student identifies the graph which shows the period of a satellite increasing as the radius of its orbit increases as the graph which shows the correct relationship by selecting such a graph.

WU
02-Core-14

Given four graphs each of which purports to show the relationship between the minimum orbiting speed of a satellite and its height above the earth's surface and asked to select the graph that best shows this relationship, the student identifies the graph showing the minimum orbiting speed of a satellite decreasing with the satellite's increased height above the earth's surface by selecting such a graph.

WU
02-Core-15

When asked to list two forces that slow down a rocket leaving the earth, the student recalls that friction with the atmosphere and the force of gravity slow down rockets leaving the earth by naming those two.

WU
02-Core-16

Given four graphs each of which relates the weight of an object to its distance from the earth's surface and asked to select the graph which shows the correct relationship, the student identifies the graph with a negative slope that is concave upwards as the graph showing the relationship between the weight of an object and its distance from the earth's surface by selecting such a graph.

WU
02-Core-17

When asked to state at what distance from the earth the force of gravity reaches zero and to explain his answer the student recalls that although the force of the earth's gravity decreases with increasing distance from the earth, it never reaches zero, by stating that there is no distance from the earth at which gravity reaches zero and the essence of the idea.

WU
02-Core-18

When asked to define the term *period* of a satellite, the student recalls the definition that the period of a satellite is the amount of time required for the satellite to make one complete orbit by responding with the essence of that definition.

WU
02-Core-19

Given that a satellite of specified diameter is orbiting the earth, its apogee, its perigee, its period, and a list of all trial measurements and asked to select the measurement which best represents the period of the satellite, the student classifies the time required for a revolving body to complete one revolution as its period by selecting that time from the list.

WU
02-Core-20

WU
02-Core-21

Given three diagrams of the possible paths of hypothetical satellites and four statements comparing the speed of a satellite with the speed necessary for a circular orbit and asked to match the statement that best describes the speed of the satellite with each of the paths diagramed, the student classifies the speed of a satellite as less than that necessary for a circular orbit if its path returns it to the earth's surface, as equal to the speed necessary for a circular orbit if its path is a circular orbit, as slightly greater than that necessary for a circular orbit if its path is an elliptical orbit, and as much greater than that necessary for a circular orbit if its path leads away from the earth indicating the escape of the satellite by matching the appropriate statements and diagrams correctly in at least two of the three cases.

WU
02-Core-22

Given a series of possible rocket paths from a planet to one of the planet's moons and back to the planet and asked to select the path that represents a free-return path, the student identifies the figure-8 path as the free-return path of a rocket from a planet to the moon and back to the planet by selecting the appropriate diagram.

WU
02-Core-23

When asked whether a rocket traveling from the earth to the moon must slow down, speed up, or maintain the same speed in order to achieve a lunar orbit and to explain his answer, the student recalls that a rocket from the earth must slow down so that it can be captured by the moon's gravity if it is to achieve a lunar orbit by responding that the rocket must slow down and with the essence of the concept.

WU
02-Core-24

When asked to state why a spacecraft has a heat shield, the student recalls that the purpose of a spacecraft's heat shield is to protect the spacecraft from the heat generated by friction with the atmosphere upon reentry by stating, in essence, the purpose of the heat shield.

WU
02-Core-25

Given that a spacecraft is slowed down by retro-rockets and parachutes and asked to name another variable which slows down a spacecraft returning to earth and to state how it acts to slow the craft, the student recalls that a spacecraft returning to the earth is slowed down by the atmosphere because of the friction which occurs, when the spacecraft pushes the atmosphere out of its path by responding to that effect.

WU
02-Exc 3-1-1

Given an illustration and a description of a device that recoils when matter is ejected from it and asked to explain why recoiling occurs, the student generates an explanation for the recoil of the object when matter is expelled from it, using the ideas that the explosion produces equal forces in all directions, one of which is on the matter which is accelerated rapidly and ejected from the object and another of which is on the launching mechanism itself and causes the mechanism to recoil in the opposite direction, by responding to that effect.

WU
02-Exc 3-1-2

Given a diagram and a description of a situation in which the mass of matter per second forced out of an opening in a container decreases when a substance of different density is used, but the flow rate remains the same, and asked to predict whether the unbalanced force on the force measurer will be greater, the same, or less and to explain his answer, the student applies the concept that the unbalanced

force produced by matter being forced from a container varies with the mass of the matter forced from the container per unit of time by stating that the unbalanced force on the force measurer would be less than the specified number of units because of the reduction in the mass of the matter leaving the container each second.

Given the amount of mass ejected from a rocket each second and the speed at which it is ejected and asked to calculate the thrust (force) of the rocket, the student applies the formula that the thrust of a rocket equals the mass thrown out per second multiplied by the speed at which the mass is ejected by calculating the thrust (force) of the rocket correctly.

WU
02-Exc 3-2-1

When asked to state two ways to increase the thrust (force) of a rocket, the student recalls that the thrust of a rocket can be increased by either increasing the mass of the exhaust gases thrown out of the rocket or increasing the speed at which the mass is thrown out by responding to that effect.

WU
02-Exc 3-2-2

When asked to state why rockets are built so that they burn their fuel in stages, the student recalls that rockets are built to burn their fuel in stages so that as the rocket fuel from one stage is used, the empty tanks making up that stage can be discarded, thus decreasing the mass of the rocket and making the transportation of the useless mass unnecessary, by stating the effect of that idea.

WU
02-Exc 3-2-3

Given an example of an erroneous idea that persisted for many years but has been changed as a result of experimentation and several possible reasons that such an erroneous idea could persist so long and asked to select the most likely reason for the idea's continuance, the student applies the concept that erroneous ideas tend to persist when they are not tested experimentally by selecting the response which expresses that notion.

WU
02-Exc 4-1-1

Given a list of variables that purport to affect the period of a pendulum and asked to select the variable or variables that do affect the period of a pendulum, the student identifies the length of the pendulum as the only variable that affects the period of a simple pendulum by selecting that variable.

WU
02-Exc 4-1-2

When asked why a scientist tries to develop models that use mathematics rather than models that describe things in words alone, the student generates an explanation which includes the idea that a quantitative model is more useful than a qualitative model because it can be used to make accurate predictions which can be used to test the model by stating an explanation which includes the effect of that idea.

WU
02-Exc 4-2-1

Given data about a planet's period of rotation, period of revolution, size, and strength of gravitational field and a series of possible periods of rotation for a communications satellite and asked to select that period of the satellite which would allow the satellite to stay above one point on the planet's surface, the student applies the concept that a satellite's period of revolution must equal the planet's

WU
02-Exc 4-3-1

period of rotation in order for the satellite to remain above the same spot on the planet's surface by selecting the period for the satellite that equals the period of rotation of the planet.

WU
02-Exc 4-3-2

Given the period of a space vehicle and a grid with two curves plotted on it, one showing height above the surface versus speed and the other showing height above the surface versus period, and asked to find the vehicle's height above the surface and its orbiting speed, the student applies the procedure for reading values from graphs involving three variables by reporting on the basis of the period curve, the height that corresponds to the specified period within ± 500 km and then moving vertically from this point until he intersects the speed curve and reporting the speed that corresponds to that height within ± 0.2 km per sec.

WU
02-Exc 4-4-1

Given four temperature-time graphs for the heating of a solid that changes to a liquid and then to a gas and asked to select the graph that best shows the temperature of a substance as it is heated at a constant rate, the student applies the concept that it takes heat without temperature change to convert a substance from a solid to a liquid and a liquid to a gas by selecting the graph with two constant temperature sections.

WU
02-Exc 4-4-2

When asked to explain why a spacecraft does not burn up from the heat generated during its reentry, the student recalls that a spacecraft does not burn up during reentry because the heat shield melts and boils, absorbing and taking away much of the heat caused by friction and thus protects the rest of the spacecraft by responding to that effect.

Given an illustration of the lunar surface in which several physical features are pointed out and asked to find the mare among those features, the student identifies a mare as a broad, flat area on the lunar surface by selecting the mare.

WU
03-Core-1

Given an illustration of the lunar surface showing several arrows, one of which points to a ray from a crater, and asked to select the arrow which points to a ray, the student identifies a ray as a streak across the surface of the moon that seems to originate in a crater by selecting the arrow indicating the ray.

WU
7 03-Core-2

When asked to explain why scientists are particularly interested in the origin of the moon's surface, the student recalls that scientists are particularly interested in the origin of the moon's surface because they believe such information may help to explain the age and origin of the earth by responding to that effect.

WU
03-Core-3

Given three illustrations of volcanic craters, meteor craters, and craters formed by an underground atomic blast and asked to name the probable cause of each of the craters, the student classifies (1) the craters whose floors are above the surrounding area as caused by volcanic activity, (2) the circular craters with raised rims, steep walls, and floors below the surrounding area as caused by meteor impact, and (3) the circular craters with sloping walls extending below the surrounding surface as caused by an underground atomic blast by naming the correct cause for at least two of the three craters.

WU
03-Core-4

When asked to list the two variables that affect the size of craters formed by the impact of falling objects, the student recalls that the two variables that affect the size of impact craters are the mass of the falling object and its speed when it hits by stating the essence of both of those variables.

WU
03-Core-5

Given a situation in which two objects of different mass are dropped from the same height and asked to state which object was traveling faster when it hit the earth and to explain his answer, the student applies the concept that all objects dropped from the same height fall at the same speed (ignoring the effects of air friction) by stating that both were traveling at the same speed and the essence of the concept.

WU
03-Core-6

Given four graphs purporting to show the relationship between balls of different masses but the same diameter and the size of the crater formed by the balls and asked to select the graph that best represents the relationship, the student classifies the graph showing an increase in crater size with an increase in mass as the one best representing the relationship between the mass of a ball and the crater size by selecting such a graph.

WU
03-Core-7

When asked why only one variable, such as the mass or the vertical height of an object, was changed at a time when balls were dropped into sand to form craters, the student applies the concept that only one variable is changed at a time so that the effects of changes in the variable can be traced and will not be confused with the effects of changes in other variables by stating the essence of the concept.

WU
03-Core-8

WU
03-Core-9 When asked to describe a plan that he could use to investigate the effect of the diameter of a falling body on the size of the crater formed, including the variables he would hold constant and those he would vary, the student generates a description of a plan to investigate the effect of the diameter of a falling body on the size of the crater, which includes the idea of holding the mass of a ball and the distance of fall constant while systematically varying the size of the ball, by stating such a procedure.

WU
03-Core-10 Given a diagram of a tray with a sand model of a portion of the lunar landscape and two light sources, one above the model and one at the side, and asked to select the position of the light source that would provide the greater surface detail if a picture is taken and to explain his answer, the student applies the concept that more detail of a rough surface is seen when the light source is positioned at the side rather than overhead because the shadows reveal the surface irregularities by selecting the light source at the side and stating the essence of the concept.

WU
03-Core-11 When asked why features on the moon's surface get worn down by erosion although there is no rain or wind on the moon, the student recalls that erosion on the moon's surface is the result of bombardment by particles (meteors) from space by stating the effect of that idea.

WU
03-Core-12 Given a diagram showing two overlapping craters and asked to identify the crater which was formed first and to explain his choice, the student applies the concept that when crater rims intersect, the rim of the younger crater will tend to be complete and the rim of the older will be interrupted by the younger, by selecting the crater with the incomplete rim and stating the essence of the concept.

WU
03-Core-13 When asked to explain why the model of the moon's surface was changed from sand to rottenstone on top of bentonite, the student applies the concept that models are modified when they no longer agree with observations by stating, in effect, that the model was changed because the old sand model could not explain the light-colored rays on the surface of the moon.

WU
03-Core-14 When asked to predict how the color of the rock would change as the moon's surface near a crater from which rays emanate was drilled, the student applies the concept that the light-colored material of the rays may come from beneath the surface by predicting either that the rock will be lighter or that the sequence will be light-dark-light beneath the moon's surface.

WU
03-Core-15 Given four conclusions that might be drawn from Activity 5-12, the darkening of light-sensitive paper by sunlight, and asked to select the best conclusion, the student applies the concept that the fact that a model may act in the same way as a real object does not mean that the two are the same by selecting the response to the effect that since sunlight causes some substances to darken, sunlight is a possible cause of the darkening of the moon's surface.

When asked whether a small force exerted upon a movable object on the moon will displace the object a greater or smaller distance than it would on the earth and to give two reasons for the difference, the student applies the concepts that a small force can move an object a greater distance on the moon's surface than on the earth's surface because on the moon's surface the force of gravity is less and there is no air friction by responding that it would travel a greater distance and with the essence of both of the concepts.

WU
03-Core-16

Given diagrams of two craters, one of which has a central peak formed by the impact of a meteor, and asked whether the meteor that produced that crater was traveling more slowly or more rapidly than the meteor which caused the other crater and to give evidence for his answer, the student recalls the model that a meteor must be traveling very rapidly to form a crater with a central peak because the heat produced by the impact must be great enough to melt both the meteor and the moon's surface so that they become liquids by responding that the meteor which formed the crater with the central peak was traveling more rapidly and with the essence of the model.

WU
03-Core-17

When asked to state three ways in which the size of the central peak in a crater could be increased, using the water drop-bentonite model of the moon's surface, the student recalls that larger central crater peaks are formed (1) when the depth of the loose material is increased, (2) when the size of the drops of water are increased, or (3) when the height from which the water is dropped is increased by stating the effect of at least two of those three methods.

WU
03-Core-18

Given a diagram of a lunar cinder cone whose crater bottom is above the surface of the moon and asked to state what is most likely to have caused this cinder cone, the student recalls that lunar cinder cones whose crater bottoms are above the moon's surface may be of volcanic origin by responding that it's of volcanic origin.

WU
03-Core-19

When asked to state a possible cause for the dome-shaped mountains on the moon's surface, the student recalls that the dome-shaped mountains are thought to have been caused by underground flows of molten rock, or magma, by responding to that effect.

WU
03-Core-20

Given diagrams of a meteor crater with a central peak, a meteor crater without a central peak, a cinder cone volcanic crater, and a dome-shaped mountain and a list of five probable causes of these lunar features and asked to match the lunar features with their most probable causes, the student identifies the meteor crater with a central peak as having been caused by a fast-moving meteor, the meteor crater without a central peak as having been caused by a slow-moving meteor, the cinder cone crater as having been caused by a volcanic eruption, and the dome-shaped mountain as having been caused by an underground magma flow by matching the diagrams with their probable causes.

WU
03-Core-21

WU
03-Core-22

Given a diagram and a description of a situation in which a scientist has discovered that there are differences between the cones that appear to be of volcanic origin on the earth and those on the moon and asked if the differences provide sufficient evidence to throw out the model that volcanic action is responsible for the lunar cones and to explain his answer, the student applies the concept that a model may not be directly interchangeable from one system to another because of the effects of other variables but the essential features of the basic model may still be pertinent by responding negatively and, in effect, that this one difference is not sufficient to discard the model because other variables may be influencing the formation of the cone.

WU
03-Core-23

Given a diagram of a cone of volcanic origin and asked to state the cause of the formation of this cone and the evidence supporting his answer, the student applies the concept that (1) the cone has steeply sloping sides (cinder cone), (2) the floor of the center crater is above the level of the surrounding surface, (3) the crater is surrounded by rock debris, or (4) the crater is surrounded by a lava flow with a rippled surface is evidence that a lunar cone is of volcanic origin by stating that the cone is of volcanic origin and the two pieces of evidence shown in the diagram.

WU
03-Core-24

When asked to state three things that cause a change in the moon's features over a period of time, the student recalls that the moon's surface may be changed over time by (1) meteor impacts, (2) covering with dust, (3) gravity, (4) sunlight, (5) volcanic action, and (6) the settling and cracking of the crust by responding to the effect of three of the above.

WU
03-Core-25

Given a diagram of the lunar surface with arrows pointing to overlapping craters and features covered by light material (rays) and three pairs of features and asked to determine for each pair which feature is probably the older of the two features and to explain his answer, the student applies the following rules for predicting the relative ages of surface features on the moon: (1) circumscribing craters are older than smaller craters on their floors, (2) in a pair of overlapping craters, the one with the incomplete rim is the older, and (3) craters covered by light material from another crater (rays) are older than the crater that produced the rays by predicting the relative ages in agreement with the rules and stating the supporting evidence.

WU
03-Core-26

Given the model of the earth-moon-sun system used for Activity 7-2 and asked to determine what fraction of the earth's surface could be seen by an observer on the surface of the moon in twelve hours and in six hours when the earth is full, the student applies the ISC'S model of the moon-earth-sun system to determine empirically the amount of the earth's surface that would be seen by a lunar observer in specified time periods by stating that the entire surface can be seen in twelve hours and three-fourths of the surface can be seen in six hours.

Given a diagram of a sun-earth-moon model showing three positions of the moon and five diagrams showing various phases of the moon and asked to select the diagrams of the moon which best show how the moon would appear to an observer on the earth when the moon is in each of the indicated positions, the student applies the sun-earth-moon model, in which the moon is orbiting around the earth and the sun is the center of the earth's orbit, by matching the diagram of the full moon with the position in which the earth is between the moon and the sun, the three-quarter moon with the position in which the sun-earth-moon angle is approximately 135° , the half moon with the position in which the sun-earth-moon angle is about 90° , the one-quarter moon with the position in which the sun-earth-moon angle is about 45° , and the new moon with the position in which the moon is between the sun and the earth.

WU
03-Core-27

Given a diagram of a sun-earth-moon model with three positions of the moon indicated and five diagrams showing various phases of the earth and asked to match the diagram of the earth that best shows how the earth would appear to an observer on the moon with the appropriate position of the moon, the student applies the sun-earth-moon model in which the sun is the center of the earth's orbit and the moon is orbiting around the earth by matching the diagram of the full earth with the position of the moon between the earth and the sun, the three-quarter earth with the sun-earth-moon angle of approximately 45° , the half earth with the sun-earth-moon angle of approximately 90° , the one-quarter earth with the sun-earth-moon angle of approximately 135° , and the new earth with the earth between the moon and the sun.

WU
03-Core-28

Given a description of a situation in which the earth appears to be directly overhead to an astronaut on the moon's surface and three positions of the earth at a specified later time and asked to select the answer that best indicates where the astronaut would have to look to see the earth if he were in the same spot seven days later, the student applies the concept that the same side of the moon always faces the earth by selecting the response to the effect that the astronaut would still have to look directly overhead.

WU
03-Core-29

Given a diagram which shows the moon directly between the earth and the sun and asked to explain why the moon's surface is dimly lighted when viewed from the earth instead of being completely dark, the student recalls that the new moon is dimly lighted by light that is reflected from the earth by responding to that effect.

WU
03-Core-30

When asked to explain why only one side of the moon is ever visible from the earth although the moon revolves around the earth, the student recalls that the moon makes one complete rotation on its axis in the same amount of time as it makes one complete revolution around the earth so that the same side of the moon always faces the earth by responding to that effect.

WU
03-Core-31

When asked to state the moon's period in days, the student recalls that the moon's period is $29\frac{1}{2}$ days by so stating.

WU
03-Core-32

WU
03-Core-33

When asked to state the earth's period, the student recalls that the earth has a period of $365\frac{1}{4}$ days by so stating.

WU
03-Exc 5-1-1

When asked whether an object's weight on the moon's surface would be more, less, or about the same as its weight on the earth's surface and if more or less, how much more or less, the student recalls that the weight of an object at the moon's surface is $\frac{1}{6}$ its weight at the earth's surface by responding that the weight of the object would be less on the moon's surface and that it would be $\frac{1}{6}$ its weight on earth.

WU
03-Exc 5-1-2

Given the weight of an object on the earth's surface and asked to calculate the weight of the same object on the moon's surface, the student applies the fact that an object weighs $\frac{1}{6}$ as much on the moon as on the earth's surface by multiplying its weight on the earth by the fraction $\frac{1}{6}$.

WU
03-Exc 7-1-1

When asked whether the surface features of the far side of the moon differ from the surface features of the side visible from the earth and if so, to describe the differences, the student recalls that there are no important differences between the surface features of the near and far sides of the moon by responding to that effect.

97

Winds and Weather

WW

Given three diagrams showing three different distributions of air particles in a convection box containing a tray of water identified as either hot or cold and asked to select the diagram that best shows how the air particles would be distributed if the tray were filled with water of the temperature specified and to explain his choice, the student applies the concepts that air above water tends to assume the temperature of the water below it and that air particles over the water are farther apart when the air is warm than when it is cool by selecting the diagram which shows the particles closer together above the water identified as cold or the particles farther apart above the water identified as hot and stating the essence of the concepts.

WW
01-Core-1

Given diagrams showing three identical open-ended containers, each containing a different number of dots, and the information that these dots represent air particles and asked to select the container which holds the warmest air and to explain his answer in terms of the particle model, the student applies the concepts that in a heated substance, the particles move faster and that the more frequent collisions which result tend to force the particles farther apart by selecting the container with the greatest particle separation as the one having the warmest air and stating the essence of the concept.

WW
01-Core-2

Given a description of a situation in which water is poured on a hot surface and four possible explanations for this action, the student applies the concept that the temperatures of some substances change more than those of other substances when the same amount of radiant energy strikes them by selecting the option that indicates that the wet surface would have a lower temperature.

WW
01-Core-3

Given that a light-colored surface and a dark-colored surface were both exposed to sunlight and their temperatures measured at various times and a grid showing two graphs (lines) with different rates of temperature increase and asked to select the graph (line) which represents the temperature of the light-colored surface and to explain his choice, the student applies the concept that dark-colored surfaces absorb radiant heat energy more readily than do light-colored surfaces by selecting the graph (line) showing the slower rate of increase in temperature and stating the essence of the concept.

WW
01-Core-4

Given a description of an experiment in which the temperatures of a wet surface and a dry surface composed of the same material were measured at various times while they were exposed to sunlight and a temperature-time grid showing two graphs (lines) which indicate different rates of temperature increase and asked to indicate which graph (line) represents the temperature of the wet surface and to explain his answer, the student applies the concept that radiant energy heats wet surfaces of a material more slowly than dry surfaces of the same material by selecting the graph (line) which shows the smaller rate of increase in temperature and stating the essence of the concept.

WW
01-Core-5

WW
01-Core-6 Given four unordered events involving sun-warmed surfaces and the air above the surfaces and asked to arrange the events in order, the student applies the concept that solar radiation causes differential heating of the earth's surface, which in turn causes differential heating of the air above the surface, resulting in up-and-down motion of the air, by arranging the events in the order implied by the sequence.

WW
01-Core-7 Given a description of four different surfaces and asked to predict the surface above which the warmest air on a sunny day would be found, the student applies the concepts that a dark-colored surface warms up more than a light-colored surface, that a dry surface warms up more than a moist or wet surface, and that the air above a warm surface is warmer than the air above a cool surface by predicting that the air will be warmest above a dry, dark-colored surface.

WW
01-Core-8 Given a description of a situation in which an object is observed gliding through the air for about ten minutes without seeming to exert energy to maintain its altitude and at the end of the ten minutes it is farther above the ground than at the outset of the observation and asked to state how it is possible for an object to stay airborne and even gain altitude without visibly exerting energy, the student generates an explanation which includes the idea that an object in a column of rising air resulting from uneven heating of the earth's surface will be supported or lifted by that rising air by stating an explanation which includes that notion.

WW
01-Core-9 Given the claim that the sun heats the air above dark-colored surfaces and that this warmer air makes the surface hotter and the claim that the reverse is true and asked to describe an experiment he could perform to determine whether it is the air which causes the surface to heat or the surface which causes the air to heat, the student generates a description of a plan that includes measuring both the air and surface temperatures to determine which heats first by describing such an experiment.

WW
01-Core-10 Given an ISCS weather instrument set up indoors and asked to read the weather instrument to determine the wind speed, the wind direction, the temperature, and the amount of precipitation and to record these readings, the student applies the procedure for reading the weather instrument, which includes reading the wind speed as shown by the position of the wind speed indicator, reading the wind direction as shown by the pointer on the wind direction indicator, reading the temperature on the thermometer, and reading the amount of precipitation as shown by the level of the water in the rain gauge by recording the wind speed within ± 3 mph, the direction of the wind correct to the nearest lettered compass bearing, the temperature correct to the nearest whole degree, and the amount of rainfall within ± 0.2 inch.

WW
01-Core-11 Given five variables involved in weather watching and asked to select the variable that can be controlled, the student applies the concept that separate weather measurements are variables which cannot be controlled by selecting the entry "time of day you take the readings" as the only listed variable which can be controlled.

When asked to state why he should make his weather-watch measurements at the same time each day, the student generates an explanation which includes the ideas that weather measurements change with the time of day as well as with the kind of weather and that unless measurements are made at the same time each day, they are not comparable by stating an explanation that includes those notions.

WW
01-Core-12

Given a diagram of an ISCS weather instrument, showing the position of the wind-speed indicator, the position of the wind-direction indicator, and water in the rain gauge and asked to state the wind speed, the wind direction, and the amount of precipitation, the student applies the procedure for reading the weather instrument, which includes reading the wind speed as shown by the position of the wind speed indicator; reading the wind direction as shown by the pointer on the wind direction indicator, and reading the amount of precipitation as shown by the level of the water in the rain gauge by stating the wind speed within ± 3 mph, the wind direction to the nearest lettered compass bearing, and the amount of rainfall within ± 0.2 inch.

WW
01-Core-13

Given diagrams of three cloud types - cirrus, stratus, and cumulus - and asked to identify the cloud type shown in each diagram, the student identifies (1) the fluffy-topped, flat-bottomed clouds as cumulus, (2) the heavy, thick, layered clouds as stratus clouds, and (3) the thin, wispy clouds as cirrus clouds by naming correctly the type of cloud shown in each diagram.

WW
01-Core-14

When asked to draw the symbols used to indicate the amount of cloud cover for two different degrees of coverage, the student recalls that (1) an unshaded circle indicates no cloud cover, (2) a circle one-fourth shaded indicates a 25% cloud cover, (3) a circle half shaded indicates a 50% cloud cover, (4) a circle three-fourths shaded indicates a 75% cloud cover, and (5) a fully shaded circle indicates total cloud cover by drawing the symbols for the two amounts of overcast.

WW
01-Core-15

Given a diagram showing a partially cloudy sky and asked to draw the cloud-cover symbol which indicates the amount of cloud cover present, the student applies the procedure for indicating the amount of cloud cover present, which includes estimating to the nearest 25% that fraction of the sky covered by clouds and symbolizing this fraction by using a completely darkened circle if coverage is 100%, a circle three-quarters darkened if coverage is 75%, a circle half darkened if coverage is 50%, a circle one-quarter darkened if coverage is 25%, and an undarkened circle if coverage is 0%, by drawing the symbol that correctly indicates the fraction of the sky covered in the diagram.

WW
01-Core-16

Given three words and their symbols and asked to state why scientists use symbols, the student generates an explanation for scientists' use of symbols by stating an explanation which includes the notion that symbols are used as a time-saving device or as a shorthand method of communication.

WW
01-Core-17

WW
01-Core-18

Given data concerning the depth of a snowfall and asked how many inches of rainfall is its equivalent, the student applies the concept that in terms of the amount of precipitation, a particular depth of snow is approximately equivalent to one-tenth that depth of rain by stating the equivalent amount of rainfall as one-tenth the number of inches of snowfall.

WW
01-Core-19

Given ample opportunity to work with materials on a laboratory activity of more than one day's duration and asked to observe the cleanup period at the appropriate time, the student chooses to close the laboratory activity period promptly upon receiving notification of the time by immediately ceasing the laboratory activity, returning materials in usable, clean condition to storage places, and participating in work area cleanup, on at least three separate occasions when being observed by the teacher or another designated observer without his knowledge.

WW
01-Core-20

When asked to work in the laboratory with fellow students, the student chooses to cooperate with fellow students in the laboratory by being polite, waiting his turn, being orderly when moving about, and observing the right of his classmates to work without being unnecessarily disturbed, when observed without his knowledge by the teacher or another designated person on at least three occasions.

WW
01-Core-21

When asked to work with the equipment and text materials of the ISCS course, the student chooses to show personal responsibility for returning laboratory equipment no longer needed to the proper storage places during the activity period by returning such equipment and materials to the designated storage places on at least three occasions when observed by the teacher or another designated observer without his knowledge of being checked.

WW
01-Core-22

When asked questions in the textbook, the student chooses to write in his *Record Book* his answers to 90% or more of the questions in his textbook by exhibiting the written responses when the teacher spot checks to determine if he is doing so.

WW
01-Core-23

When working independently in the laboratory, the student chooses to show proper care and use of ISCS laboratory materials by using the materials only for their intended purpose or by requesting permission to do other specific experiments with them, when being observed without his knowledge by the teacher or another designated person on three or more occasions.

WW
01-Exc 1-1-1

Given a diagram and a description of a situation in which a hot-air balloon is beginning to descend prematurely and four devices which would affect the air in the balloon and asked to select the device which the balloonist should choose in his predicament, the student applies the concept that a balloon inflated with heated air will rise through cooler air by selecting the device that will produce heat so as to keep the balloon aloft.

When asked to state whether a balloon filled with hot air will have a greater lifting force when the surrounding air is hot or when it is cold and to explain his answer, the student applies the concepts that warm air is less dense than cold air and that hot air enclosed in a balloon exerts a lifting force because it is less dense than the surrounding air by stating in effect that the lifting force will be greater when the surrounding air is cold than when it is warm and the notion that it is the difference in the mass (density) of the air in the balloon and the surrounding air that supplies the lifting force.

WW
01-Exc 1-1-2

When asked to describe a plan which could be used to measure the relationship between the lifting force of a hot-air balloon and the temperature of the air inside the balloon, the student generates a description of a plan which includes measuring the effect of changes in temperature on a lifting force while holding the other variables constant by stating a description of an experiment which includes that notion.

WW
01-Exc 1-1-3

Given a diagram showing the cardinal points of the compass and arrows to indicate the direction of the wind and five possible wind directions and asked to select the name of the wind direction, the student applies the rule that a wind is named by the direction from which it is blowing by selecting the response which best indicates that direction.

WW
01-Exc 2-1-1

Given that during the measuring of wind direction, the pointer on the wind instrument fluctuates through several contiguous compass points and five choices of what to do in such a case and asked to select the proper procedure, the student applies the rule that in reading wind direction, an average (midrange) reading is used by selecting the average (midrange) reading.

WW
01-Exc 2-1-2

Given four observations made in various wind speeds and asked to arrange them in order of increasing wind speed, the student applies the concept that wind speeds can be judged visually by the effects the wind has on common objects by arranging the observations in order of increasing wind speed.

WW
01-Exc 2-1-3

When asked to define the prefix *alto* when it is associated with a cloud type, the student recalls the definition that the prefix *alto* means "of medium height" when it is added to the name of a type of cloud by responding with that definition.

WW
01-Exc 2-2-1

Given three photographs of the sky, each showing one of the following types of clouds: cirrus, cirrocumulus, cirrostratus, altocumulus, altostratus, stratus, stratocumulus, nimbostratus, cumulus, and cumulonimbus, and asked to name the three types of clouds, the student identifies the clouds as (1) cirrus if they are high, thin and wispy, (2) cirrocumulus if they are high, thin, white, and patchy, (3) cirrostratus if they are high, thin sheets of white or bluish clouds with a slight fibrous look, (4) altocumulus if they are middle level rows or waves of fairly large, flattened globules, (5) altostratus if they form a middle layer of thin, gray or bluish uniform veils having a slightly striated structure, (6) stratus if they form a uniform, amorphous, gray, low-lying layer resembling fog, (7) stratocumulus if they are relatively low, soft, gray clouds in the form of ridges or large globules, (8) nimbostratus if they

WW
01-Exc 2-2-2

are relatively low, amorphous, dark gray clouds with ragged bases, (9) cumulus if they are relatively low, dense, puffy clouds with flat, gray bases and dome-shaped tops, and (10) cumulonimbus if they are very tall, billowing clouds with dark bases and anvil-shaped tops by correctly naming at least two of the three cloud types.

WW

01-Exc 2-3-1

Given a conversion table for converting Celsius and Fahrenheit temperature readings and one temperature stated in degrees Celsius and another stated in degrees Fahrenheit and asked to convert the Celsius reading to Fahrenheit and the Fahrenheit reading to Celsius, the student applies the procedure for converting temperatures from one scale to another, which includes locating the given temperature in that column of the table which corresponds to its temperature scale and reading the corresponding number in the opposite column, by stating the two converted temperatures correctly.

WW

01-Exc 2-3-2

Given two wind speeds in miles per hour and the information that there are 1.6 kilometers in one mile and asked to convert the speeds from miles per hour to kilometers per hour, the student applies the procedure for converting from miles per hour to kilometers per hour, which includes multiplying the speed in miles per hour by 1.6, by stating the two speeds in kph correctly within $\pm 5\%$.

WW

01-Exc 2-3-3

Given that there are 2.54 cm in an inch and that a specified number of inches of rain fell during a period of time and asked to state how many centimeters of rain fell, the student applies the procedure for converting a measurement in inches to centimeters, which includes multiplying the measurement in inches by 2.54, by stating the amount of rainfall in centimeters correctly within $\pm 5\%$.

101

Given a diagram showing two cubes of air at different heights above a warm surface and two at different heights above a cool surface and asked to select the hottest and the coolest cubes, the student applies the concepts that the temperature above the earth's surface varies with the heat absorbed by the surface and that air gets cooler as it rises by selecting the cube closest to the hot surface as the hottest and the cube farthest from the cool surface as the coolest.

WW
02-Core-1

Given four graphs which purport to show ways in which temperature varies with altitude above the earth's surface and asked to select the graph that best shows the usual relationship, the student applies the concept that air temperature usually varies inversely with altitude by selecting the graph showing that relationship.

WW
02-Core-2

When asked what causes air pressure on an object at the earth's surface, the student recalls that air pressure on an object is the result of the total weight of the column of air above that object by stating the essence of that notion.

WW
02-Core-3

When asked to explain what is being measured when air pressure is measured by the height of a column of mercury, the student recalls that air pressure results from the weight of a column of air extending out to the limit of the earth's atmosphere by responding to that effect.

WW
02-Core-4

Given four graphs which purport to show relationships between air pressure and altitude above the earth's surface and asked to select the graph that best shows the usual relationship, the student applies the concept that air pressure usually varies inversely with altitude by selecting the graph that slopes downward to the right.

WW
02-Core-5

Given four statements about air pressure at high altitudes and asked to select the statement which explains why the air pressure is lower at higher altitudes, the student applies the concepts that at higher altitudes there are fewer air particles present and there is less air pushing down from above by selecting the statements which reflect the two concepts.

WW
02-Core-6

Given a diagram of a baby-food jar barometer and a description of a situation in which the barometer is moved from one altitude to another and asked to state whether the pointer will move up or down and to explain his answer, the student applies the concept that air pressure varies inversely with altitude by stating that the pointer will move down if the altitude increases or up if the altitude decreases and the essence of the concept.

WW
02-Core-7

Given three diagrams of the ICS baby-food jar barometer with a rubber cover, one in which the rubber covering bulges out, one in which it is flat, and one in which it is dishd in, and statements of three possible relationships between the inside and outside pressures for each and the option "none of these" and asked to match the relationship between the inside and outside pressures with the appropriate diagram, the student identifies the jar in which the top bulges outward as having an inside pressure

WW
02-Core-8

which is greater than the outside pressure, the jar with the flat top as having inside and outside pressures which are equal, and the jar with the top dished in as having an inside pressure which is less than the outside pressure by matching the appropriate statements of inside and outside pressures with the diagrams.

WW
02-Core-9

Given a diagram of a tin can that was damaged because the pressure difference between the inside and outside was too great and asked to state whether the pressure was greater inside or outside the can and to explain his answer, the student generates a decision and an explanation based on the idea that a greater pressure inside the can would tend to force the can apart, whereas a greater pressure outside would cause the can to collapse by stating the area of the greater pressure correctly and an explanation based on the idea.

WW
02-Core-10

Given a diagram of a baby-food jar barometer and asked to state why it is a good idea to attach a straw to the rubber covering on the top of the barometer, the student generates an explanation for the straw used in the baby-food jar barometer, which includes the notion of amplifying the motion of the material covered, by stating an explanation that includes that notion.

WW
02-Core-11

Given a diagram of a baby-food jar barometer and a description of a situation in which a student puts this barometer outside and takes a reading one day and then finds the same reading the next day when the temperature is very different and asked to state whether the air pressure increased, decreased, or stayed the same from the first day to the next and to explain his answer, the student applies the concepts that the volume of a gas varies directly with temperature and inversely with pressure and that a variation in temperature and pressure in the same direction have opposite (cancelling) effects by stating the direction of change of the air pressure and, in effect, that the pressure has increased if the temperature has increased or that the pressure has decreased if the temperature has decreased and so the readings remain the same because of the cancelling effects of temperature and pressure.

WW
02-Core-12

Given that a person believes that water collects on the outside of a cold glass of water because water at low temperatures can pass through the glass and asked to devise an experiment to show that such moisture does not come from inside the glass, the student generates a description of a plan to show that the moisture does not come from inside the glass, which may include the idea of (1) using an empty cold glass, (2) using a number of different types of containers holding cold water, (3) using a different cold liquid, such as oil, or (4) carefully weighing the glass before and after water collects on the sides, by describing a plan which includes an idea similar to one of those.

WW
02-Core-13

When asked to define the term *dew point*, the student recalls either the definition that the dew point is the temperature at which the moisture in the air begins to condense to form tiny droplets or the definition that the dew point is the temperature at which the air is saturated with water vapor; that is, it can no longer hold all its moisture, by stating the essence of one of those definitions.

When asked to define the term *relative humidity*, the student recalls the definition that relative humidity is the ratio between the amount of water vapor in the air at a particular temperature and the greatest amount of water vapor that the air can hold at that temperature and is expressed as a percentage by stating the essence of that definition.

WW
02-Core-14

Given a sling psychrometer and the use of Table 4-2, which gives the relative humidity in terms of the dry-bulb temperature and the difference between the wet- and dry-bulb temperatures, and asked to measure the relative humidity, the student manipulates the psychrometer according to the procedure which involves wetting its wick, swinging it around for about 15 seconds, reading the wet- and dry-bulb temperatures, finding the difference between them, and consulting the table to determine the relative humidity by stating the relative humidity as determined by using that procedure.

WW
02-Core-15

Given the temperature, the amount of water vapor in the air, and the maximum amount of water vapor which the air could hold at that temperature and asked to calculate the relative humidity, the student applies the procedure for calculating the relative humidity, which includes dividing the actual water vapor content by the maximum amount of water vapor which the air could hold at that temperature and multiplying the result by 100 to determine the relative humidity, by stating the relative humidity within $\pm 10\%$.

WW
02-Core-16

Given four graphs, each of which shows a relationship between the temperature and the greatest amount of water vapor that the air can hold, and asked to select the graph that best shows this relationship, the student applies the concept that warm air can hold more water vapor than colder air by selecting the graph which indicates an increase in the amount of water vapor that the air can hold as the temperature increases.

WW
02-Core-17

Given four graphs each showing a different relationship between relative humidity and temperature and asked to select the graph that best shows how the relative humidity would change with temperature if the actual amount of water vapor in the air remained the same, the student applies the concepts that the maximum amount of water vapor which the air can hold varies with temperature and that the relative humidity is defined by the percentage ratio of the actual water-vapor content of the air to the maximum amount of water vapor the air can hold at that temperature by selecting the graph which shows decreasing relative humidity with increasing temperature.

WW
02-Core-18

Given the difference between the wet-bulb and dry-bulb thermometer readings on two successive days and asked to state on which day the relative humidity was higher and to explain his answer, the student applies the concept that both the dry-bulb temperature reading and the difference between the wet-bulb and dry-bulb readings are needed to determine the relative humidity by stating, in effect, that it is impossible to determine the day on which the relative humidity was higher and the essence of the concept.

WW
02-Core-19

WW
02-Core-20

Given four graphs purporting to show relationships between the relative humidity and the difference between the wet-bulb and dry-bulb temperature readings of a sling psychrometer and asked to select the graph that best shows this relationship in a situation in which the dry-bulb reading is constant, the student applies the concept that greater temperature differences between the wet-bulb and dry-bulb thermometers indicate lower relative humidities by selecting the graph which curves downward to the right (negative slope).

WW
02-Core-21

Given a sling psychrometer and the use of Table 4-3, which gives the dew point in terms of the dry-bulb temperature reading and the difference between the wet- and dry-bulb readings, and asked to measure the dew point, the student manipulates the psychrometer according to the procedure of wetting the wick, swinging the psychrometer around for about 15 seconds, reading the wet- and dry-bulb temperatures, finding the difference between them, and consulting the table to determine the dew point by stating the dew point as determined by using that procedure.

WW
02-Core-22

When asked why there must be solid particles in the air in order for clouds to form, the student recalls that there must be solid particles in the air in order for clouds to form because these solid particles provide the surfaces necessary for vapor to condense upon in order to form droplets by responding with that notion.

WW
02-Exc 3-1-1

Given six purported pressure readings, some of which use incorrect units, and asked to select all readings that could be measures of pressure, the student applies the concept that a pressure is a force per unit of area by selecting at least two of the three readings, and no others, using units that represent a force per unit of area.

WW
02-Exc 3-1-2

Given the force exerted by an object and the surface area over which this force is distributed and asked to calculate the pressure which this object exerts, the student applies the procedure for calculating pressure, which includes dividing the force by the area over which the force is distributed, by stating the pressure correctly within $\pm 10\%$ and the appropriate units.

WW
02-Exc 3-1-3

Given data concerning two different weights each spread out over an area of a different size and asked which weight is exerting the greater pressure, the student applies the concept that pressure is a measure of the concentration of a force by selecting the weight which exerts the greater force per unit of area.

WW
02-Exc 3-2-1

Given diagrams of two mercury barometers, the information that a certain atmospheric pressure will support a column of mercury of a particular height in a barometer tube of a specific height, and five heights of the mercury column in another tube of the same diameter but different height under the same conditions and asked to select the height of the mercury column in the second tube, the student applies the concept that the height of a mercury column in a barometer tube is determined only by the atmospheric pressure, provided that the tube is longer than the mercury column, by selecting the height which is the same as the height of the mercury column in the first barometer.

Given diagrams of two mercury barometers of the same height but with different diameters, the information that the atmospheric pressure today will support a column of mercury of a particular height in a barometer tube of one diameter, and five purported heights for the mercury in the other barometer and asked to select the height of the mercury column in the other barometer, the student applies the concept that the height of a mercury column in a barometer tube is determined only by the atmospheric pressure, provided that the tube is longer than the mercury column, by selecting the height which is the same as the height of the mercury in the other barometer.

WW
02-Exc 3-2-2

Given that one millibar of pressure is equal to 0.0145 pounds per square inch of pressure and that an air pressure of 1016 millibars is necessary to support a column of mercury 30 inches high and asked to calculate the air pressure in pounds per square inch that is required to support a mercury column of a specified height, the student applies the procedure for calculating the air pressure required, which involves multiplying the pressure equivalence of one millibar by the number of millibars required to support a column 30 inches high and then multiplying the result by the height of the actual mercury column divided by 30, by stating the air pressure required within $\pm 10\%$.

WW
02-Exc 3-2-3

Given a diagram of the scale and the pointer of an aneroid barometer and asked to read the barometric pressure, the student applies the procedure for reading an aneroid barometer, which includes reading the scale value opposite the pointer, by stating the barometric pressure within ± 0.01 units.

WW
02-Exc 3-2-4

Given that two wet-bulb thermometers are moistened, one with water and the other with alcohol, and then are waved around rapidly and asked to predict which thermometer will register the lower temperature and to explain his answer, the student applies the concept that evaporation is a cooling process and the fact that alcohol evaporates more rapidly than water by stating that the thermometer moistened with alcohol will register the lower temperature and the essence of the reasons.

WW
02-Exc 4-1-1

Given that one dry-bulb thermometer is waved around rapidly while another is held stationary and asked to state which will register the lower temperature and to explain his answer, the student applies the concept that waving a thermometer affects its temperature reading only if there is liquid evaporating from around the bulb by responding, in effect, that there will be no difference in the temperature readings of the two thermometers and with the essence of the concept.

WW
02-Exc 4-1-2

Given a description of a situation concerning two wet-bulb thermometers with wet wicks, one of which has been waved around rapidly for 15 seconds and the other of which has been held stationary, and asked to predict which thermometer will give the lower temperature reading and to explain his answer, the student applies the concepts that evaporation is a cooling process and that the rate of evaporation increases if air moves over the wet surface by stating that the thermometer which was waved around would give the lower temperature reading and the essence of the concepts.

WW
02-Exc 4-1-3

Given that one student was successful in getting a mist to form in the reduced-pressure apparatus, whereas another student, who did the same activity several days later, was unable to get a mist to form until he cooled the flask and asked to explain why one student could get a mist to form at room temperature but the other had to cool his flask, the student applies the concepts that relative humidity affects cloud formation and that relative humidity varies inversely with temperature provided that the same amount of water vapor is in the air by stating the effect of the concepts.

WW
03-Core-1

Given a diagram and a description of a situation in which a strong light bulb is placed above a water surface and a dirt surface and asked whether after five minutes the air over the water surface or over the dirt surface will be warmer and to explain his answer, the student applies the concept that the surfaces of many solid materials radiate more energy than water when the same amounts of radiant energy are available to both and as a result the air above the solid material is warmed more than the air above the water surface by responding to the effect that the air will be warmer above the dirt and with the essence of the concept.

WW
03-Core-2

Given a diagram of an observation box containing a piece of ice on a wooden block and asked to draw arrows to indicate the direction of air movement in the box, the student applies the concepts that the air tends to take on the temperature of its surroundings and that cooler air is heavier (denser) than warmer air and tends to push warmer air upward by drawing arrows to show that the air above the piece of ice moves downward, spreads outward over the floor of the box, and then rises near the outer walls to its original position.

WW
03-Core-3

Given a diagram of a land area having an exposed expanse of land next to a large body of water and four arrows indicating possible wind directions and asked to select the arrow that best indicates the wind direction of the air above the boundary between the two different kinds of surfaces on a hot, sunny day, the student applies the facts that during a hot, sunny day the air above a land surface warms up more rapidly than the air above a water surface and that the warmer air over the land is pushed upward by the cooler air moving in from over the water surface by selecting the arrow which indicates a wind moving from the direction of the water towards the land.

WW
03-Core-4

Given five purported reasons that on a hot day there is usually a cool breeze blowing in over the land from a large body of water and asked to select the statement that explains why the cool breeze blows from the direction of the body of water, the student applies the concepts that the sun causes a differential heating of bodies of water and land surfaces and that the denser cool air flows under less dense warm air, causing the warm air to rise, by selecting the statement to the effect that during the day the cooler air over the water moves in over the land causing the warm air over the land to rise.

WW
03-Core-5

Given a table of wind speed symbols, a compass direction, a diagram of a wind speed symbol, a temperature reading, and a barometer reading and asked to indicate the

WW
03-Core-6

wind direction, the wind speed, the temperature, and the barometric pressure, the student identifies the wind direction as from the tail to the head of the symbol, the wind speed as within the range of that symbol on the chart whose tail is the same, the temperature as the integer (whole) number, and the barometric pressure as the number having two decimal places by stating the wind direction to the nearest 45° compass reading (N, NW, W, etc.) and the wind speed, temperature, and barometric pressure correctly.

WW
03-Core-7

Given a simplified weather map which has vertical and horizontal grid scales for locating points and on which the symbols for wind direction, wind speed, temperature, and air pressure appear at ten locations and asked to use the horizontal and vertical scales to locate the weather stations reporting the highest and lowest air pressure readings, the student applies the convention that on a weather map the air pressure readings are represented by the numbers with two decimal places by stating the coordinates of the station with the lowest number having two decimal places as the location at which the air pressure is lowest and the coordinates of the station with the highest number as the location at which the air pressure is highest.

WW
03-Core-8

Given a simplified weather map which has vertical and horizontal grid scales for locating points and on which the symbols for wind direction, wind speed, air pressure, and temperature appear at ten locations and asked to use the horizontal and vertical scales to locate the weather stations reporting the highest and the lowest wind speeds, the student applies the convention that on a weather map the wind speed is indicated by the number and length of the angular barbs on the weather symbol by stating the coordinates of the symbol with the most numerous and longest barbs as the location at which the wind speed is highest and the coordinates of the symbol with the fewest and shortest barbs as the location at which the wind speed is lowest.

WW
03-Core-9

Given a simplified weather map with vertical and horizontal grid scales for locating points and on which the symbols for wind direction, wind speed, temperature, and air pressure appear at ten locations and asked to use the horizontal and vertical scales to locate the weather stations reporting the highest and lowest temperatures, the student applies the convention that the integers (whole numbers) on the weather map represent the temperatures reported by stating the coordinates of the station beside which the highest integer appears as the location at which the temperature is highest and the coordinates of the station beside which the lowest integer appears as the location at which the temperature is lowest.

WW
03-Core-10

Given a sentence using the term *isobar* and asked to define *isobar*, the student recalls the definition that an isobar is a line drawn on a weather map to connect areas of equal pressure by responding with the effect of the definition.

WW
03-Core-11

Given a simplified weather map which uses standard wind direction, wind speed, temperature, and air pressure symbols and which shows the weather readings in the vicinity of a low pressure system and asked to draw in two isobars, the student applies the procedure for drawing isobars, which includes drawing smoothly curved

lines that pass through those weather stations reporting the same barometric readings and that pass between stations reporting higher or lower pressure readings, by drawing two such isobars.

Given an outline map of a state in the middle of which appears a low pressure area and asked to use arrows to show the general pattern of winds around the low pressure area, the student applies the concept that in the Northern Hemisphere air moves in a counterclockwise direction around a low pressure area by drawing arrows on his map which indicate a counterclockwise flow of air around the low pressure area.

WW
03-Core-12

Given a simplified weather map which uses standard wind direction, wind speed, temperature, and air pressure symbols and which shows the cold and warm regions in the vicinity of a low pressure system and asked to shade in the areas on the weather map where heavy cloud cover would probably be found, the student applies the concept that heavy cloud cover is usually located near the boundaries between cold and warm air masses and near the center of low pressure areas by shading on the weather map the areas which correspond both to boundaries between cold and warm air masses and to the center of the low pressure region.

WW
03-Core-13

Given a diagram of a mountain range showing the direction of the prevailing winds and having the windward and leeward sides of the mountain lettered and asked to select the side which would have more rainfall and to explain his answer, the student applies the concept that when air is forced upward by a mountain range, it cools, which often causes condensation and precipitation on the windward side of the mountains, by selecting the windward side as having more rainfall and stating as his reason the essence of the concept.

WW
03-Core-14

When asked to list three major causes of the uplifting of air, the student recalls that the four causes of the uplifting of air are (1) warmed surfaces which heat the air, (2) sharp differences in air temperature (fronts), (3) low barometric pressure, and (4) the influence of geographic features such as mountains or seacoasts by stating the effect of three of the above.

WW
03-Core-15

Given the standard symbols for cold, warm, and stationary fronts and asked to state the meaning of each symbol, the student classifies the line having only pointed bumps as representing a cold front, the line having only rounded bumps as representing a warm front, and the line having both rounded and pointed bumps as representing a stationary front by naming each symbol correctly.

WW
03-Core-16

Given an outline map of the United States showing a low pressure area near the center, four arrows indicating directions in which the low pressure area purports to move, and an option, "all of the directions indicated are equally likely" and asked to select the arrow which points in the direction in which the low pressure area is most likely to move, the student applies the concept that weather phenomena have a general motion over the United States from west to east by selecting the arrow that points eastward.

WW
03-Core-17

WW
03-Core-18

Given an outline map of the United States showing a low pressure area to the west of a particular labeled city, the path of the low pressure area, and five weather changes and asked to select the changes most likely to occur as the low pressure area approaches, the student applies the concepts that as a low pressure area approaches (1) the barometric pressure will drop, (2) the sky will tend to cloud over, (3) the wind will tend to blow from either the southeast or the southwest, and (4) the temperature will either remain constant or rise by selecting at least two of the three changes which appear in the check and are in agreement with those.

WW
03-Core-19

Given an outline map of the United States which shows a cold front approaching a particular labeled city and five weather changes and asked to select those changes which are most likely to occur as the cold front approaches and passes through, the student applies the concepts that (1) as a cold front approaches, the sky will cloud over, primarily with cumulus and cumulonimbus clouds, (2) as a cold front passes through, the temperature will drop, (3) as a cold front passes through, the wind will shift until it is blowing from the north, and (4) the barometric pressure will tend to drop as the cold front approaches and then rise as the cold front passes through by selecting at least two of the three changes which are included in the check and are in agreement with those.

WW
03-Core-20

Given an outline map of the United States showing a warm front approaching a particular labeled city and five weather changes and asked to select those changes most likely to occur in the city as the warm front approaches and passes through, the student applies the concepts that (1) the sky will cloud over with cirrus, then cumulus, then stratus clouds as the warm front approaches, (2) the barometric pressure will tend to fall as the warm front approaches and then passes through, (3) the temperature will increase as the warm front moves through, and (4) the wind before the approaching warm front will generally be from the south by selecting at least two of the three changes which are included in the check and are in agreement with those.

WW
03-Core-21

Given six cross-sectional diagrams of cold and warm air masses and asked to select the diagram which best represents a warm front and that which best represents a cold front, the student identifies the diagram with a straight demarkation line between the cold and warm air masses and in which the warm air is above the cold as representing a warm front and the diagram with a curved interface which bulges upward between the cold and warm air masses and in which the warm air is above the cold as representing the cold front by selecting those diagrams as representing warm and cold fronts respectively.

WW
03-Exc 5-1-1

Given the air temperature at the earth's surface and the information that the air temperature decreases at an average rate of about 1.0°C per 100 m and asked to calculate the air temperature at a specified altitude in meters, the student applies the procedure for calculating the air temperature at a specified altitude, which involves dividing the altitude expressed in meters by 100 m and subtracting this result from the air temperature at the earth's surface, by stating the air temperature within $\pm 0.2^{\circ}\text{C}$.

Given the dew point at the earth's surface and the information that the dew point of air decreases at an average rate of 1.0°C per 550 m and asked to calculate the dew point at a specified altitude in meters, the student applies the procedure for calculating the dew point at a specified altitude, which involves dividing the altitude by 550 and subtracting the result from the dew point at the earth's surface, by stating the dew point within $\pm 0.2^{\circ}\text{C}$.

WW
03-Exc 5-1-2

Given the equation for determining the height of cloud bottoms in meters, the air temperature and the dew point at the earth's surface, and other related measurements and asked to calculate the height at which clouds first form on the day on which the measurements were taken, the student applies the procedure for calculating the height of cloud bottoms, which involves subtracting the dew point from the air temperature as recorded by the dry-bulb thermometer and multiplying the difference by 122, by stating the height of the cloud bottoms within $\pm 1\%$.

WW
03-Exc 5-1-3

Given four statements, each about a measurement needed to determine the speed of clouds with a nephoscope, and two additional statements, one including all four measurements and one including only three, and asked to select the statement that best describes the measurements required, the student recalls that in order to determine the speed of clouds, the height of a cloud, the radius of the nephoscope circle, the height of the viewer's eye above the nephoscope, and the time necessary for the cloud to travel from the center to the edge of the nephoscope circle must be measured by selecting the statement that includes all of the ~~four~~ measurements.

WW
03-Exc 5-2-1

Given the equations $D = H \times d/h$ and $S = D/t$ and the measurements obtained for d , h , H , and t and asked to calculate the speed of the clouds by using these measurements, the student applies the stated formulas to determine the speed of the clouds by stating the speed of the clouds in the proper units within $\pm 5\%$.

WW
03-Exc 5-2-2

Given a diagram and a description of a situation in which many small particles are moving through an area of high static charge and a list of five possible results and asked what will happen to the particles, the student recalls the notion that an electric field tends to make small particles clump together by selecting the option to that effect.

WW
03-Exc 7-1-1

Given that some experiments in rain-making have included dropping tiny crystals of dry ice into clouds and the fact that dry ice is about -73°C and asked to explain how this might cause it to rain, the student generates an explanation based on the notion that because the dry ice is very cold, it would cause the formation of ice crystals in the cloud, and other water droplets would freeze onto these crystals and cause them to grow so that they would eventually fall as precipitation by stating the effect of such an explanation.

WW
03-Exc 7-1-2

When asked to explain why individual cumulus clouds usually do not last very long and tend to fade away quickly, the student recalls that cumulus clouds usually don't

WW
03-Exc 7-2-1

last very long and tend to disappear quickly because the dry air surrounding such clouds causes the cloud droplets to evaporate and become invisible water vapor by responding to that effect.

WW
03-Exc 7-2-2

Given a cross-sectional diagram of a hailstone and asked to explain why a hailstone usually consists of a series of layers of ice in concentric shells, the student recalls that a hailstone usually consists of a series of layers of ice in concentric shells because ice is added only when the hailstone is moving up and down in the cloud and each layer of ice represents either an upward or a downward motion by responding to that effect.

WW
03-Exc 7-3-1

Given Table 2 on page 165 and a table of weather data for four consecutive days, which includes time of measurements, temperature, wind direction, wind speed, cloud type, amount of cloud cover, amount of precipitation, barometric pressure, relative humidity, and dew point, and asked to state the changes which will occur in the next 24 hours in temperature, humidity, cloud cover, cloud type, precipitation, and wind, the student generates a weather forecast based on the supplied data and the relationships presented in Table 2 by stating correctly at least four of six changes in the weather that are in agreement with the patterns evident in the supplied data and the relationships in Table 2.

Crusty Problems

CP

When asked to state the theory that Alfred Wegener proposed about the continents, the student recalls that Wegener proposed that all continents were once joined together in a super landmass which broke apart into separate continents by responding to that effect.

CP
01-Core-1

When asked to cite evidence to support the theory of continental drift, the student recalls the following as evidence which supports the theory of continental drift: (1) the jigsaw puzzle fit of the continents, (2) the location of glacial drift and grooves of the same age in Southern Hemisphere continents and India, (3) the location of similar fossils of the same age in continents separated by oceans, (4) the magnetic lines (anomalies) that form long, ridge-like mirror images parallel to the midocean ridges, and (5) the identical rock sequences on different continents by responding with the notion of at least two of the five.

CP
01-Core-2

Given earthquake data from the "Preliminary Determination of Epicenters" table and a world map marked with lines of longitude and latitude with the resulting boxes numbered and asked to indicate the site of four earthquakes, the student applies the procedure of locating places on the earth, using the latitude-longitude coordinate system, by indicating the position of at least three of the four earthquakes.

CP
01-Core-3

Given two diagrams, one showing plates colliding and one showing plates separating, and for each diagram five statements, two describing the location of the boundary and three describing the depth of an earthquake at the boundary, and asked to select for each boundary the probable description of its location and the depth of the earthquake associated with it, the student applies the concepts that boundaries between plates which are moving apart tend to be in midocean basins and to produce shallow earthquakes, whereas boundaries between colliding plates tend to be near the edges of continents and produce deep earthquakes, by selecting the correct statements to describe the plates shown.

CP
01-Core-4

Given a diagram of a geologic environment and asked if there is any evidence of geologic change in the diagram and, if so, to name the processes which caused the change, the student generates inferences based on observation by inferring that change has occurred and naming processes such as erosion, uplift, faulting, and deposition.

CP
01-Core-5

Given a diagram and a description of an unexplained observation in earth science and asked to state two questions that must be answered in resolving the problem, the student generates two questions that are inquiry-oriented and which indicate systematic investigation by listing the two questions.

CP
01-Core-6

Given ample opportunity to work with materials on a laboratory activity of more than one day's duration and asked to observe the cleanup period at the appropriate time, the student chooses to close the laboratory activity period promptly upon receiving notification of the time by immediately ceasing the laboratory activity.

CP
01-Core-7

returning materials in usable, clean condition to storage places, and participating in work area cleanup, on at least three separate occasions when being observed by the teacher or another designated observer without his knowledge.

CP
01-Core-8

When asked to work in the laboratory with fellow students, the student chooses to cooperate with fellow students in the laboratory by being polite, waiting his turn, being orderly when moving about, and observing the right of his classmates to work without being unnecessarily disturbed, when observed without his knowledge by the teacher or another designated person on at least three occasions.

CP
01-Core-9

When asked to work with the equipment and text materials of the ISCS course, the student chooses to show personal responsibility for returning laboratory equipment no longer needed to the proper storage places during the activity period by returning such equipment and materials to the designated storage places on at least three occasions when observed by the teacher or another designated observer without his knowledge of being checked.

CP
01-Core-10

When asked questions in the textbook, the student chooses to write in his *Record Book* his answers to 90% or more of the questions in his textbook by exhibiting the written responses when the teacher spot checks to determine if he is doing so.

CP
01-Core-11

When working independently in the laboratory, the student chooses to show proper care and use of ISCS laboratory materials by using the materials only for their intended purpose or by requesting permission to do other specific experiments with them, when being observed without his knowledge by the teacher or another designated person on three or more occasions.

CP
01-Res 1-1

When asked to describe evidence from the Ice Age, cited by geologists to support their theory of continental drift, the student recalls, as evidence of continental drift left in rock by the glaciers, glacial grooves and glacial drift of about the same age found on continents that are widely separated today but which could have formed one super continent millions of years ago by responding to that effect.

CP
01-Res 2-1

Given three pairs of rock sequences and told that in each pair the rock sequences were found on different continents and asked which pair represents two continents that could have been joined together and what evidence supports his answer, the student applies the concept that rock layers can be correlated using location of key fossils and similarities of rocks by selecting the correct pair and responding with the essence of the concept.

CP
01-Res 3-1

When asked why a baked apple is considered to be a model to explain mountain building, the student recalls that a baked apple is like the earth in that it has a tough skin around a core which was once very hot but is now cooling, causing the skin to shrink and buckle, by responding to that effect.

Given a diagram illustrating linear magnetic anomalies in an ocean basin and four statements concerning the anomalies and asked to indicate which statements are not observations, the student classifies as observations any statements which are consistent with the data and are directly perceivable by the senses by selecting the statements that are inferences and are not observations.

CP
01-Res 4-1

Given a meterstick, a clinometer, some books, and instructions for building an inclined plane with a specified inclination between 8° and 20° and asked to measure the dip angle of the incline, the student manipulates a clinometer to determine the angle of dip by reporting the size of the dip angle within $\pm 2^{\circ}$.

CP
02-Core-1

Given a prepared cutout block illustrating tilted rock strata and five statements and asked to label each statement as either an observation or an interpretation and to state the observation on which each interpretation is based, the student classifies statements relating to a model of tilted rocks as observations if they are verifiable precepts and as interpretations if they are inferences of cause, condition, or relation based on an observation by labeling the statements as observations or interpretations and stating the observation upon which each interpretation is based.

CP
02-Core-2

Given an igneous or a metamorphic rock sample such as granite, gabbro, schist, or gneiss and a hand lens and asked if the texture of the rock sample is interlocking or noninterlocking, the student classifies the texture of a rock as interlocking if the grains are interwoven by stating to the effect that the texture is interlocking, since the grains are interwoven rather than cemented together.

CP
02-Core-3

Given a sedimentary rock such as sandstone or conglomerate and a hand lens and asked if the texture of the rock is interlocking or noninterlocking and to state the evidence on which his decision is based, the student classifies the texture of a rock as noninterlocking if the grains are cemented together rather than interwoven by responding to the effect that the texture is noninterlocking, since the grains are cemented, not interwoven.

CP
02-Core-4

Given a rock sample composed of interlocking, randomly oriented grains, a hand lens, a steel nail, and the rock classification table on page 47 and asked to indicate the type of rock and to explain the reason for his answer, the student classifies a rock as igneous if the grains are interlocking and randomly oriented by responding that the rock is igneous and with the essence of the concept.

CP
02-Core-5

Given four characteristics of a rock sample, all of which determine the sample's texture, and the options "all of these" and "none of these" and asked which of the characteristics determine a rock's texture, the student classifies the presence of cementing agents, the orientation of grains, the interlocking or noninterlocking of grains, and grain size as the factors which determine the texture of a rock by selecting the option "all of these."

CP
02-Core-6

Given an extrusive igneous rock such as rhyolite or basalt and asked to describe the conditions of temperature and pressure required for its formation and to state where in or on the earth it was formed, the student applies the concept that igneous rocks with fine-grained texture are formed under conditions of high temperature and relatively low pressure which allowed rapid cooling and that such conditions exist

CP
02-Core-7

at or near the surface of the crust by responding that the conditions included high temperature and low pressure and that they occur at or near the surface of the earth's crust.

CP
02-Core-8

Given descriptive data concerning the location, the chief rock type, and the external appearance of a faulted mountain and three other mountain types and asked to select the description of a faulted mountain, the student classifies as block-fault mountains those (1) composed of sedimentary and metamorphic marine rocks, (2) existing in scarp and basin regions, and (3) having long, asymmetrical (wedge-shaped) slopes by selecting the entry with those characteristics.

CP
02-Core-9

Given samples of gray granite, gneiss, sandstone, and obsidian and a list of rock-forming environments and asked to match the environment in which each sample probably was formed with the rock sample, the student applies the concept that different environments of rock-formation result in rocks with different characteristics and that the environment of formation for (1) gray granite is deep within the crust, (2) gneiss is at or near the surface of the earth and under pressure, (3) sandstone is in an ocean basin, and (4) obsidian is from the flow of volcanic material by matching the rocks with their environments of formation.

CP
02-Core-10

Given four diagrams of movements along a fault plane and a photograph of Death Valley and asked to select the diagram which shows the probable movement which formed Death Valley and to state two pieces of evidence for his choice, the student classifies the movement that caused Death Valley as evidenced by (1) the down-dropped block, (2) the wedge shape of the ridge, and (3) the lowering of strata from the surrounding walls by selecting the correct diagram and stating at least one of the criteria as evidence.

CP
02-Core-11

Given descriptive data concerning the location, the chief rock type, and the external appearance of an erosional mountain and three other mountains and asked to select the description of an erosional mountain, the student classifies as erosional mountains those (1) composed of deep-cooled igneous rocks, (2) having a round or a dome shape, and (3) existing singly on a plain by selecting the entry with those characteristics.

CP
02-Core-12

Given a cross-sectional diagram illustrating a dome-shaped mountain composed of a single kind of igneous rock and a sample of that kind of igneous rock and asked to explain the formation of a mountain made entirely of the igneous rock, the student applies the concept that dome-shaped mountains composed of coarse-grained igneous rocks were formed deep in the crust and put in place by the uplift of the igneous rock and erosion of the softer rock in which it was formed by responding with the essence of the concept.

CP
02-Core-13

Given descriptive data concerning the location, the chief rock type, and the external appearance of a folded mountain and three other mountains and asked to select the description of a folded mountain, the student classifies as folded mountains those

(1) composed of sedimentary and metamorphic rocks of marine origin, (2) existing in valley and ridge regions, and (3) having groups of long, parallel slopes by selecting the entry, with those characteristics.

Given descriptive data concerning the location, the chief rock type, and the external appearance of an old volcanic crater and three other mountains and asked to select the description of the old volcanic crater, the student classifies as old volcanic craters those mountains (1) composed of surface-cooled igneous rocks, (2) having a cone shape, and (3) existing in earthquake or geyser regions by selecting the entry with those characteristics.

CP
02-Core-14

Given a list of five erosional features, three of which are glacial in origin, and asked to select those that are formed by glacial action, the student classifies erosional features such as cirques, rock grooves, horns, hanging valleys, and U-shape valleys as glacial in origin by selecting the three glacial erosional features from the list.

CP
02-Core-15

Given a diagram showing a long axial view of a glacial valley and asked to indicate whether each of four selected features in the valley is depositional or erosional, the student classifies moraines in a glacial valley as depositional and cirques, horns, and hanging valleys as erosional by labeling at least three of the four indicated features correctly.

CP
02-Core-16

Given a cutout block showing folded strata and the information that all the rocks in those strata are sedimentary and asked to describe a process that would explain the structure in the cutout block, the student applies the concept that sedimentary rocks compressed under high pressure yield to the pressures by forming folds by responding with the essence of the concept.

CP
02-Core-17

Given a sample of an igneous, a sedimentary, and a metamorphic rock, a hand lens, dilute HCl, a steel nail and the rock test key found on pages 45 through 47 and asked to determine for each rock whether it is sedimentary, metamorphic, or igneous, the student classifies rocks on the basis of their origin, using a rock classification key, by naming each rock correctly as igneous, sedimentary, or metamorphic.

CP
02-Res 5-1

Given a diagram of four test tubes showing the crystalline structure of a material cooled at different rates and asked to order the rates at which the material in each test tube cooled from the slowest to the fastest, the student applies the concept that a melt generates smaller crystals with increasing rates of cooling by listing the numbers of the test tubes in the order of decreasing crystal size of their contents.

CP
02-Res 6-1

Given a hand lens and three igneous rocks each composed of a different average grain size and asked to order the rocks, based on rate of cooling from a melt, and to explain how he decided the order, the student applies the concept that the slower a melt cools, the larger the crystals that are generated, by responding with the correct order and the essence of the rule.

CP
02-Res 6-2

<p>CP 02-Res 7-1</p>	<p>Given a photograph showing sedimentary layers and asked how one of the layers was formed, the student <u>applies</u> the concept that sedimentary rocks are made of layers of sediment from <u>deposits</u> or precipitates settling from a liquid, the air, or a glacier by <u>responding</u> with the essence of the concept.</p>
<p>CP 02-Res 7-2</p>	<p>Given a description of a situation stating the results of applying dilute HCl to a rock and asked what kind of rock it is and what it is composed of, the student <u>applies</u> the operational definition that a limestone is composed of calcium carbonate and reacts with dilute HCl to release bubbles of CO₂ gas by <u>responding</u> that the rock is a limestone and that it is composed of calcium carbonate.</p>
<p>CP 02-Res 8-1</p>	<p>Given a description of a test performed on a sedimentary rock sample and asked to explain the reaction of acid with certain sedimentary rocks, the student <u>applies</u> the concept that certain dissolved minerals such as compounds of iron and carbonates serve as cementing agents to hold sedimentary grains together and they react with HCl by <u>responding</u> to the effect that the reaction was caused by a substance which reacts with the acid and is the cementing agent for the rock.</p>
<p>CP 02-Res 8-2</p>	<p>Given two samples of sand, one of which is held together by a cementing agent, and asked to state the difference between the two samples and to explain how that difference could occur in nature, the student <u>applies</u> the concept that dissolved minerals serve as cementing agents which hold grains of sediment together by <u>responding</u> that one sample has loose grains of sand and the other one has grains of sand which are cemented together and with the effect of the concept.</p>
<p>CP 02-Res 9-1</p>	<p>Given a hand lens, dilute HCl, and two sedimentary rocks, one of which is limestone and one of which is either shale or sandstone, and asked to name each rock as limestone, sandstone, or shale and to explain how he knows, the student <u>applies</u> the concepts (1) that sandstones are composed principally of visible and rounded sand grains which show no acid reaction, (2) that shales are composed principally of very small grains, show little reaction to acid, and smell like mud when breathed on, and (3) that limestones react to acid by <u>naming</u> the appropriate rocks in each case and <u>stating</u> the reasons for his choices.</p>
<p>CP 02-Res 10-1</p>	<p>Given a map of a partial distribution of rocks showing one type of sedimentary rock and three types of metamorphic rock and samples of slate, schist, and gneiss and asked where in the distribution the sample rocks might be found and to explain his answer, the student <u>applies</u> the concept that the grade of metamorphism (the degree of banding or foliation and the size of the minerals) increases as the intensity of heat and pressure increases by <u>stating</u> that slate would be found in the zone nearest the sedimentary rock, that schist would be found in the middle zone, and that gneiss would be found in the zone farthest away from the sedimentary rock.</p>
<p>CP 02-Res 11-1</p>	<p>When asked to define the <i>relative hardness</i> of a substance, the student <u>applies</u> the concept that a harder object will scratch a softer one when they are rubbed together by <u>responding</u> with the essence of the definition.</p>

Given samples of the minerals augite, quartz, muscovite mica, biotite mica, hornblende, olivine, galena, and hematite and asked to indicate whether each mineral has metallic or nonmetallic luster, the student identifies minerals which shine like a metal as having metallic luster and minerals which are glassy or vitreous as having nonmetallic luster by assigning augite, quartz, muscovite mica, biotite mica, hornblende, and olivine to the nonmetallic group and galena and hematite to the metallic group.

CP
02-Res 11-2

Given three mineral samples and asked to select each sample which shows cleavage and to explain how he knows, the student classifies a mineral as having cleavage if one or more surfaces flash when rotated in light by selecting such a mineral and responding with the essence of the cleavage test.

CP
02-Res 11-3

Given a "Mineral Classification Chart," three minerals from the ICS mineral kit, a glass plate, and a knife and asked to name the minerals, the student classifies the minerals, using a classification system based on the properties of luster, hardness, and cleavage, by stating their names.

CP
02-Res 11-4

Given a model depicting a rock cycle and asked to draw another cycle for a sedimentary rock, the student applies the concept that a rock can follow many geologic paths by drawing an arrow to show that sedimentary rocks may be melted or eroded.

CP
02-Res 12-1

Given a diagram of a volcanic mountain and asked to determine the origin of the mountain and cite the evidence for his answer, the student classifies a mountain as volcanic in origin based on the following criteria: (1) the cone shape, (2) the presence of lava flow, and (3) the crater, or depression, in the center of the cone, by stating that it is a volcanic mountain and citing at least one criterion.

CP
02-Res 13-1

Given a diagram illustrating the intrusion of basalt to form a sill and asked whether the igneous rock is an intrusion or a flow and to state how he knows, the student classifies the feature as an intrusion on the basis of the occurrence of a thin layer of metamorphosed rocks above and below the igneous rocks by stating that it is an intrusion and, in effect, the evidence.

CP
02-Res 14-1

Given two diagrams, one showing a sill and the other a dike, and asked to indicate which is the sill and which the dike and to explain his answers, the student classifies a sill as an igneous intrusion concordant to the intruded rocks (parallel to the adjacent layers) and a dike as an igneous intrusion discordant to the intruded rock (cutting across the surrounding layers) by naming the feature in each diagram and stating the criteria.

CP
02-Res 15-1

When asked the name for a crack or an opening in the surface of the earth, other than a volcano, from which lava spills onto the surface of the earth, the student recalls that a fissure is a long crack in the earth's surface, other than a volcano, from which lava flows by stating that a fissure is such a crack.

CP
02-Res 16-1

CP
02-Res 17-1

Given a block diagram showing a fault and asked to indicate the fault plane and the possible direction of movement along the fault, the student classifies a fault as the plane along which motion has occurred by labeling the fault line and showing on each side of it arrows parallel to the fault line but pointing in opposite directions.

CP
02-Res 18-1

Given a block diagram of folded sedimentary rocks with five lettered arrows and asked to select the arrow which indicates the direction that the applied force came from, the student applies the concept that the force to compress sediments into folds is lateral and from the direction of maximum folds by selecting a horizontal arrow toward the area of the greatest bending and perpendicular to the axis of the fold.

CP
02-Res 19-1

Given descriptive data for two mountains and asked to select the older mountain and to explain his answer, the student classifies old mountains on the basis of the presence of gentle slopes and broad valleys and relatively young mountains on the basis of the presence of high peaks, steep mountain sides, and narrow valleys by selecting the old mountain and stating the essence of the notion.

CP
02-Res 20-1

When asked to describe the process by which snow turns into glacial ice, the student recalls the process of snow's being turned into glacial ice as follows: (1) the process begins when more snow falls than melts, (2) then snow on the already accumulated snow produces pressure on the snowflakes at the bottom, turning them into ice grains, and (3) further packing and the addition of water from melting snow recrystallize the ice grains into solid ice by responding with the notions of at least two of the three steps of the process.

CP
02-Res 21-1

Given five climate conditions and asked to select the conditions that cause glaciers to change size, the student classifies as a condition which causes glacial advance (growth) snowfall which exceeds melting and evaporation and as a condition which causes glacial retreat (shrinking) melting and evaporation which exceeds snowfall by selecting the conditions which cause a change in glacial size.

Given a list of four geographical areas in the U.S. and asked to select those which are source areas for river systems and to state the reasons for his choices, the student applies the concept that river systems tend to originate in highland areas and areas of high precipitation by selecting three such locations and responding with the notion of the concept.

CP
03-Core-1

Given a blank map of Australia and two maps showing the average precipitation and the elevation and asked to locate source areas of river systems, the student applies the concept that most river systems originate in highlands or high precipitation areas by marking at least 75% of the area in which rivers would form on the blank map of Australia.

CP
03-Core-2

Given diagrams of three stream profiles and asked to select the stream which would have the greatest potential energy and to explain his choice, the student applies the concept that the potential energy of a river increases as the average slope angle increases by selecting the river with the greatest average slope angle and responding, in effect, that it is the steepest.

CP
03-Core-3

Given a stream table, supply and catch buckets, and a 100-ml beaker and asked to adjust the flow of water in the stream table to a specified rate, the student manipulates the equipment to adjust the rate of water flow in the stream table kept at a constant slope by adjusting the screw clamps so that it takes 10 ± 2 seconds to fill a 100-ml beaker.

CP
03-Core-4

Given a data table showing a stream table's slope and measurements of the erosion time of a sand-gravel mixture and asked to state how he thinks the slope of the stream table is related to the erosion of the materials when the material and volume of water are held constant, the student generates a hypothesis that an increased slope in the stream table results in an increased rate of erosion in the stream bed by responding to the effect that the rate of erosion increases as the stream gradient increases.

CP
03-Core-5

Given a profile showing a stream with certain places lettered changing gradient to a much shallower slope in a valley and asked to select the letter of the place where deposits of gravel will pile up and to state the reason, the student applies the concept that deposits of gravel are the result of the reduction of a stream's kinetic energy by selecting the letter at the point of energy reduction, and responding with the essence of the concept.

CP
03-Core-6

Given four changes or events that could occur in some region of the U.S. and asked to select the change which would tend to increase a river's kinetic energy, the student classifies changes as increasing a river's kinetic energy if they increase the discharge or reduce the roughness of the river bottom by selecting the three appropriate changes from the list.

CP
03-Core-7

<p>CP 03-Core-8</p>	<p>Given a graph showing the rates of stream bed erosion at one location for a year and asked to indicate what variable could cause the varying erosional rates, the student <u>applies</u> the concept that increasing the volume of stream flow increases the erosional capabilities (kinetic energy) of the stream by <u>responding</u> with the essence of the concept.</p>
<p>CP 03-Core-9</p>	<p>Given a data table listing five changing stream conditions and asked to complete the table so as to show the effect of each change on the potential energy, the kinetic energy, and the rate of stream bed erosion, the student <u>applies</u> the concept that the rate of erosion of a stream bed, an application of the kinetic energy, varies directly with the potential energy and the friction of the bed by <u>completing</u> correctly at least ten of the fifteen possible changes in the table to show that (1) potential energy varies directly with source height or water volume, (2) kinetic energy varies directly with potential energy or slope and with increasing smoothness of the river bed, and (3) erosion, ease-of bed removal, varies directly with kinetic energy.</p>
<p>CP 03-Core-10</p>	<p>Given five features formed by the action of running water and asked to select the features which result from the reduction of kinetic energy, the student <u>classifies</u> depositional features (alluvial fans, sandbars, deltas, mud bars, and spits) as resulting from a reduction in a stream's kinetic energy by <u>selecting</u> the two depositional features found in the list.</p>
<p>CP 03-Core-11</p>	<p>Given a map of the United States with four geographical sites numbered and four causes of erosion and asked to select the erosional process most responsible for shaping the land at each site, the student <u>classifies</u> sites by the chief agents of erosion, which include (1) wind which erodes deserts, (2) flowing water which erodes humid areas and mountain valleys, and (3) wave action which erode beaches, by <u>selecting</u> the correct agent for at least three of the four sites.</p>
<p>CP 03-Core-12</p>	<p>Given two diagrammatic views showing the course of a river with four pairs of points marked and asked at which point in each pair of points the rate of flow (speed) is greater, the student <u>applies</u> the concept that the rate of flow in a river is greater (1) when the width of the river narrows, (2) when there are no obstacles in the river, (3) at the outside of a bend, and (4) where the river bed is V-shaped by <u>selecting</u> at least three of the four points of faster flow.</p>
<p>CP 03-Res 27-1</p>	<p>Given a diagram showing a cross section of a stream bed with five labeled points and four graphs of the velocities at those points on the cross section and asked to select the graph which correctly shows the rates of water flow in the stream, the student <u>applies</u> the concept that the velocity of water in a stream is greatest at the center point farthest from the stream's banks and bed because friction is at a minimum by <u>selecting</u> the graph showing the rate of flow to be greatest at the center point farthest from the stream's banks and bed.</p>
<p>CP 03-Res 29-1</p>	<p>Given a lettered profile of a stream table showing a reservoir, a stream channel, sand, and a lake and four statements about channel depth and asked to select the letter</p>

indicating the depth to which the channel will be cut and the statement explaining the reason for his choice, the student applies the concept that stream channel depth cannot be lower than the lake or ocean into which it flows by selecting the letter indicating a depth which is equal to the level of the lake and the statement which expresses the essence of the concept.

Given a diagram showing a cross section of a delta deposit and asked whether the river flowed from the direction of the fine particles to the coarse particles at the time of deposition and to explain his answer, the student applies the concept that coarse particles in a stream bed are deposited close to shore and fine particles farther out by responding negatively and with the essence of the concept.

CP
03-Res 32-1

Given a lettered diagram showing a stream channel and the rock bed across which it cuts and asked to select the letter of the place where a waterfall would form and to state the reason for his choice, the student applies the concept that waterfalls form along a stream where the water flows across an interface from a relatively hard to a softer rock layer by selecting such a site and responding to the effect that the less resistant rock will erode much faster than the harder rock to form the waterfall.

CP
03-Res 33-1

Given a map showing a pattern of gullies and asked to indicate the direction of water flow and the direction in which the gullies will grow, the student applies the concept that water flows from branch channels into a central channel and that gullies develop and grow by headward erosion by drawing and labeling an arrow showing water flow from tributaries to the main channel and an arrow showing that erosion occurs headward, that is, up the tributaries.

CP
03-Res 34-1

Given a diagram showing a meandering stream with three locations marked and asked to select the locations where erosion is likely to occur and the locations where deposition is likely to occur and to explain his responses, the student applies the concept that erosion occurs on the outside of bends of streams where water velocity is high and deposition occurs on the inside of bends where water velocity is low by selecting high velocity sites as places of erosion and low velocity sites as places of deposition and responding with the essence of the concept.

CP
03-Res 36-1

Given a diagram of a meandering stream with four points marked on the land around the meander, one of which is at the neck of a meander, and asked to select the point of land which is likely to be eroded first and to state the reason for his answer, the student applies the concept that bed and stream wall erosion are greatest at the outside of a bend in a stream by selecting the point of land at the neck of the meander and stating the notion of the concept.

CP
03-Res 36-2

Given a relief map showing several crescent-shaped sand dunes and asked to state the prevailing wind direction and the evidence for his answer, the student applies the concept that steep slopes and pointed horns of crescent-shaped dunes point downwind by stating the wind direction and the essence of either piece of evidence.

CP
03-Res 37-1

Given diagrams of two beach profiles and asked to select the diagram which is the result of high-energy waves attacking the beach and to state the evidence which supports his answer, the student identifies a shoreline caused by high-energy waves by the offshore deposits (benches) of sand by selecting the appropriate illustration and citing the offshore deposits, the benches, as evidence.

CP
04-Core-1

Given a diagram showing a cross section of a sandy beach underlain by rocks and asked to state what would probably happen if a hurricane with high winds and waves attacked the beach and to draw another diagram showing the same beach after the hurricane, the student applies the concept that high-energy waves will carry sand to deeper water to form a bench by stating the essence of the concept and drawing a diagram of his answer.

CP
04-Core-2

Given three shoreline changes and asked to state the type of wave action on each at the time of the change, the student classifies the removal of sand to expose gravel and the formation of a bench as evidences of high-energy wave action and the build-up of a beach as evidence of low-energy wave action by stating the type of wave action appropriate to at least two of the three changes.

CP
04-Core-3

Given two diagrams, one showing a stream table set up for producing waves and the other showing a stream table in which the waves and beach formation have been produced, and asked to state how the waves were produced to form the beach in the stream table model and to state an important variable in the formation of the beach, the student recalls that waves are produced by gently moving a wooden block in the water and that the waves must be of low energy in order to form a beach by responding with the effect of those ideas.

CP
04-Core-4

Given a stream table, sand, water, and a wooden block and a diagram showing the setup and asked to set up the stream table and produce waves that will result in the formation of a sand bench and to state the important variable in its formation, the student manipulates a stream table which is set up for producing high-energy waves by pressing on the wood block to produce relatively high-energy waves and responding to the effect that strong waves are needed for the formation of sand benches.

CP
04-Core-5

Given a diagram of an aerial view of a spit with the prevailing winds and a designated point on the spit marked and asked to indicate where most of the sand is likely to be deposited and the path that the sand will follow, the student applies the concepts that sand is deposited in the area at the tip of the spit and that waves cause long-shore transport in the direction of the prevailing winds by indicating deposition in the area along and around the tip of the spit and sketching arrows in a path along the spit in the direction of the prevailing winds.

CP
04-Core-6

Given an example of a fiord and an estuary and asked to state the difference between a fiord and an estuary, the student recalls that a fiord is a flooded, ice-carved valley, whereas an estuary is a flooded, river-carved valley by responding with a description of the difference between a fiord and an estuary.

CP
04-Core-7

CP
04-Res 38-1

Given a diagram of a rocky sea coast with five points on the rock face labeled and asked to indicate where on the rock face erosion will be greatest and to explain his answer, the student applies the concept that the kinetic energy of a wave is greatest at the crest, and therefore the work done on the rock face will be greatest where the crest hits the face by selecting the point on the rock face where the crest of the wave hits and responding with the essence of the concept.

CP
04-Res 38-2

Given five shoreline features including three which are characteristics of rocky or steeply inclined shorelines and asked to select those that are most commonly associated with rocky or steeply inclined shorelines, the student classifies caves, arches, pinnacles, and benches as features associated with rocky or steeply inclined shorelines by selecting at least two of the three found in the check.

CP
04-Res 39-1

Given a diagram of waves approaching a shoreline with several waves labeled and asked to select the wave that would give a surfer the best ride and to explain why he selected that wave and did not select the others, the student applies the concept that wave motion is circular in deep water and as a wave approaches the sloping beach, the motion is changed to forward motion by selecting the wave farthest from the shore which is becoming angular and stating that this wave would carry him to shore, whereas on the waves farther out, his motion would be up and down rather than forward.

CP
04-Res 40-1

Given three diagrams showing waves approaching different shorelines and asked to select the diagrams which show conditions for bending waves by refraction and the diagram which shows conditions for bending waves by diffraction and to explain his answers, the student applies the concepts that waves are bent by refraction as water becomes shallower and by diffraction when the waves encounter partial barriers by selecting the diagrams which correctly indicate the refraction and diffraction conditions and responding with the essence of the concepts.

CP
04-Res 40-2

Given two diagrams showing aerial views of a series of wave fronts, one about to encounter a headland and one about to encounter a bay, and asked to draw wave fronts to the breaker zones, the student applies the concept that wave fronts are refracted by headlands and bays by drawing wave fronts which are bent around the headland and at bays are bowed so that they tend to parallel the banks of the bay.

CP
04-Res 40-3

Given two diagrams showing aerial views of a series of wave fronts, one about to encounter a barrier and one about to pass through two barriers, and asked to draw wave fronts to the breaker zones, the student applies the concept that wave fronts are diffracted by barriers by drawing wave fronts which are bent around the ends of the barriers.

CP
04-Res 42-1

Given a graph showing a continuous record of tidal changes for twelve days at a particular station and asked to estimate the mean sea level in meters at the station and to state the group of readings he considered to arrive at that value, the student

applies the concept that the mean sea level is the average of the daily readings of the high-water level and the low-water level by estimating the mean sea level within ± 0.25 m and stating that he considered the daily high- and low-water level readings.

Given three diagrams showing relative positions of the earth, the moon, and the sun and asked to select the diagram which shows the position which would cause the highest tides on the earth, the student applies the concept that the gravitational force is greatest when the moon, the sun, and the earth are in a straight line and that causes the highest tides by selecting the diagram showing the earth, the moon, and the sun in conjunction.

CP
04-Res 43-1

Given a diagram showing several wave-cut benches and asked to state how these benches were formed and why there are several of them, the student applies the concepts that a bench is caused by wave erosion and the presence of several benches indicates a series of relative motions of the sea level, (either the land was uplifted or the sea level dropped) by responding with the essence of both concepts.

CP
04-Res 44-1

Given a diagram and a description of an ocean shoreline with an unprotected headland of relatively soft rock, the direction of current flow, the fact that the headland will erode, and three arrows purporting to show the direction the eroded material will take and asked to select the arrow indicating the direction the eroded material will take and to state the feature eroded material will form, the student applies the concepts that the sand will be transported in the direction of the current and will be deposited as a spit by selecting the arrow that points in the same direction as the ocean current and stating that the eroded material will form a spit.

CP
04-Res 46-1