August 2004

TAKS
Texas Assessment of Knowledge and Skills

Information Booklet

Science
Grade 11 Exit Level
Revised

Texas Education Agency • Student Assessment Division

INTRODUCTION

The Texas Assessment of Knowledge and Skills (TAKS) is a completely reconceived testing program. It assesses more of the Texas Essential Knowledge and Skills (TEKS) than the Texas Assessment of Academic Skills (TAAS) did and asks questions in more authentic ways. TAKS has been developed to better reflect good instructional practice and more accurately measure student learning. We hope that every teacher will see the connection between what we test on this new state assessment and what our students should know and be able to do to be academically successful. To provide you with a better understanding of TAKS and its connection to the TEKS and to classroom teaching, the Texas Education Agency (TEA) has developed this newly revised edition of the TAKS information booklet. The information booklets were originally published in January 2002, before the first TAKS field test. Now, after several years of field tests and live administrations, we are able to provide an even more comprehensive picture of the testing program. We have clarified some of the existing material and, in some cases, provided new sample items and/or more explanations of certain item types. However, it is important to remember that these clarifications do not signify any change in the TAKS testing program. The objectives and TEKS student expectations assessed on TAKS remain unchanged. We hope this revised version of the TAKS information booklet will serve as a user-friendly resource to help you understand that the best preparation for TAKS is a coherent, TEKS-based instructional program that provides the level of support necessary for all students to reach their academic potential.

BACKGROUND INFORMATION

The development of the TAKS program included extensive public scrutiny and input from Texas teachers, administrators, parents, members of the business community, professional education organizations, faculty and staff at Texas colleges and universities, and national content-area experts. The agency took these steps to involve as many stakeholders as possible because we believed that the development of TAKS was a responsibility that had to be shared if this new assessment was to be an equitable and accurate measure of learning for all Texas public school students.

The three-year test-development process, which began in summer 1999, included a series of carefully conceived activities. First, committees of Texas educators identified those TEKS student expectations for each grade and subject area assessed that should be tested on a statewide assessment. Then a committee of TEA Student Assessment and Curriculum staff incorporated these selected TEKS student expectations, along with draft objectives for each subject area, into eleventh-grade exit level surveys. These surveys were sent to Texas educators at the middle school and secondary levels for their review. Based on input we received from more than 27,000 survey responses, we developed a second draft of the objectives and TEKS student expectations. In addition, we used this input during the development of draft objectives and student expectations for grades 3 through 10 to ensure that the TAKS program, like the TEKS curriculum, would be vertically aligned. This vertical alignment was a critical step in ensuring that the TAKS tests would become more rigorous as students moved from grade to grade. For example, the fifth grade tests would be more rigorous than the fourth grade tests, which would be more rigorous than the third grade tests. Texas educators felt that this increase in rigor from grade to grade was both appropriate and logical since each subject-area test was closely aligned to the TEKS curriculum at that grade level.

In fall 2000 TEA distributed the second draft of the objectives and TEKS student expectations for eleventh grade exit level and the first draft of the objectives and student expectations for grades 3 through 10 for review at the campus level. These documents were also posted on the Student Assessment Division's website to encourage input from the public. Each draft document focused on two central issues: first, whether the objectives included in the draft were essential to measure on a statewide assessment; and, second, whether students would have received enough instruction on the TEKS student expectations included under each objective to be adequately prepared to demonstrate mastery of that objective in the spring of the school year. We received more than 57,000 campus-consensus survey responses. We used these responses, along with feedback from national experts, to finalize the TAKS objectives and student expectations. Because the state assessment was necessarily limited to a "snapshot" of student performance, broad-based input was important to ensure that TAKS assessed the parts of the TEKS curriculum most critical to students' academic learning and progress.

In the thorough test-development process that we use for the TAKS program, we rely on educator input to develop items that are appropriate and valid measures of the objectives and TEKS student expectations the items are designed to assess. This input includes an annual educator review and revision of all proposed test items before field-testing and a second annual educator review of data and items after field-testing. In addition, each year a panel of recognized experts in the fields of English language arts (ELA), mathematics, science, and social studies meet in Austin to critically review the content of each of the high school level TAKS assessments to be administered that year. This critical review is referred to as a content validation review and is one of the final activities in a series of quality-control steps to ensure that each high school test is of the highest quality possible. A content validation review is considered necessary at the high school grades (9, 10, and 11) because of the advanced level of content being assessed.

ORGANIZATION OF THE TAKS TESTS

TAKS is divided into test objectives. It is important to remember that the objective statements are not found in the TEKS curriculum. Rather, the objectives are "umbrella statements" that serve as headings under which student expectations from the TEKS can be meaningfully grouped. Objectives are broad statements that "break up" knowledge and skills to be tested into meaningful subsets around which a test can be organized into reporting units that help campuses, districts, parents, and the general public understand the performance of our students and schools. Test objectives are not intended to be "translations" or "rewordings" of the TEKS. Instead, the objectives are designed to be identical across grade levels rather than grade specific. Generally, the objectives are the same for third grade through eighth grade (an elementary/middle school system) and for ninth grade through eleventh grade (a high school system). In addition, certain TEKS student expectations may logically be grouped under more than one test objective; however, it is important for you to understand that this is not meaningless repetition—sometimes the organization of the objectives requires such groupings. For example, on the TAKS writing tests for fourth and seventh grades, some of the same student expectations addressing the conventions of standard English usage are listed under both Objective 2 and Objective 6. In this case, the expectations listed under Objective 2 are assessed through the overall strength of a student's use of language conventions on the written composition portion of the test; these same expectations under Objective 6 are assessed through multiple-choice items attached to a series of revising and editing passages.

ORGANIZATION OF THE INFORMATION BOOKLETS

The purpose of the information booklets is to help Texas educators, students, parents, and other stakeholders understand more about the TAKS tests. These booklets are not intended to replace the teaching of the TEKS curriculum, provide the basis for the isolated teaching of skills in the form of narrow test preparation, or serve as the single information source about every aspect of the TAKS program. However, we believe that the booklets provide helpful explanations as well as show enough sample items, reading and writing selections, and prompts to give educators a good sense of the assessment.

Each grade within a subject area is presented as a separate booklet. However, it is still important that teachers review the information booklets for the grades both above and below the grade they teach. For example, eighth grade mathematics teachers who review the seventh grade information booklet as well as the ninth grade information booklet are able to develop a broader perspective of the mathematics assessment than if they study only the eighth grade information booklet.

The information booklets for each subject area contain some information unique to that subject. For example, the mathematics chart that students use on TAKS is included for each grade at which mathematics is assessed. However, all booklets include the following information, which we consider critical for every subject-area TAKS test:

- an overview of the subject within the context of TAKS
- a blueprint of the test—the number of items under each objective and the number of items on the test as a whole
- information that clarifies how to read the TEKS
- the reasons each objective and its TEKS student expectations are critical to student learning and success
- the objectives and TEKS student expectations that will be included on TAKS
- additional information about each objective that will help educators understand how it is assessed on TAKS
- sample items that show some of the ways objectives are assessed

What Every Teacher Needs to Know About the TAKS Science Tests

Why do we test science?

As teachers and parents, we are preparing our children to be the next generation of educated and concerned citizens. An understanding of science will help our children be better informed and more capable of making decisions that will affect their lives and the environment. Being scientifically literate cannot be defined as simply having the ability to remember scientific facts; scientific literacy involves much more than that. It means that our students will not only understand important science concepts but also be able to apply what they know to the health, safety, and environmental issues that are at the center of our everyday lives. Science assessments play a critical role in determining whether our students are mastering the science knowledge and skills they need in order to be scientifically literate and academically successful.

What is the science TAKS based on?

The TAKS is based on the state-mandated science curriculum, the Texas Essential Knowledge and Skills (TEKS). All four science assessments were developed using selected knowledge and skills statements and student expectations from the science TEKS. The elementary science test was based on eligible science TEKS from grades 2–5. The middle school science test will be based on selected science TEKS from grades 6–8. The grade 10 and the exit level TAKS tests are based on selected TEKS for Integrated Physics and Chemistry (IPC) and Biology.

The TEKS were created to align closely with the *National Science Standards*, *Benchmarks for Science Literacy*, and *Science for All Americans*. These books are an excellent resource for guidance in finding grade-appropriate strategies for teaching many science concepts.

How were the TEKS chosen to be on TAKS?

The science TEKS knowledge and skills statements and student expectations eligible for assessment were determined to be appropriate for TAKS by educator review committees; feedback from over 74,000 surveys completed by Texas educators in 2000 and 2001 and input from national reviewers further refined the objectives. Because of the constraints of a single statewide assessment, not all science TEKS can be addressed.

> Although some student expectations within the TEKS are not assessed, it is important that educators teach all of the science curriculum so that students can develop a complete understanding of critical science concepts.

How are the TEKS organized within the TAKS?

The knowledge and skills statements, with their associated student expectations, are organized under objectives on the TAKS. These objectives group the eligible student expectations into categories with similar content and are used for score-reporting purposes. The elementary test has four objectives. The middle school, grade 10, and exit level tests have five objectives.

How do the knowledge and skills statements relate to items on the TAKS science tests?

Every item developed for the TAKS is grounded in the knowledge and skills statements. For example, in IPC (8)(C), students "investigate and identify the law of conservation of mass." This concept will be assessed within the framework of the overriding knowledge and skills statement, which reads, "The student knows that changes in matter affect everyday life."

Where does middle school fit in?

In 2003 the state legislature in Senate Bill 1108 mandated a middle school science test to be given at grade 8 no later than the 2006–2007 school year. The middle school science test will have five objectives that will include science TEKS from grades 6–8.

All educators should work together to align the curriculum across all grade levels so that unifying themes (strands) of learning are reinforced. TEKS instruction throughout elementary and middle school will lay the foundation for biology, chemistry, physics, and earth science concepts taught in high school.

What are "unifying themes"?

The science TEKS contain unifying themes, or conceptual strands, that are developed across grade levels in a grade-appropriate progression. To ensure proper teaching of the TEKS, educators should ensure that learning is connected throughout the grade levels and that there are varied opportunities for students to learn the concepts within a strand.

An example of a "systems" strand is given below:

(2.9) **Science concepts.** The student knows that living organisms have basic needs. The student is expected to

- (B) compare and give examples of the ways living organisms depend on each other and on their environments. (Tested at grade 5)

(7.12) **Science concepts.** The student knows that there is a relationship between organisms and the environment. The student is expected to

- (B) observe and describe how organisms, including producers, consumers, and decomposers, live together in an environment and use existing resources. (Tested at grade 8)

Biology (12) Science concepts. The student knows that interdependence and interactions occur within an ecosystem. The student is expected to

(E) investigate and explain the interactions in an ecosystem including food chains, food webs, and food pyramids. (Tested at grade 10)

Biology (9) Science concepts. The student knows metabolic processes and energy transfers that occur in living organisms. The student is expected to

(D) analyze the flow of matter and energy through different trophic levels and between organisms and the physical environment. (Tested at exit level)

How are science integrations and interdisciplinary issues handled on the TAKS science tests?

It is essential for teachers to expose students to science content in a variety of ways. Teachers must also help students make connections among the science disciplines by showing the natural integrations among the life, earth, and physical sciences. An example of this might be when students study different soil types (earth science) and learn how nutrients (chemistry) in the soil affect the types of plants (biology) that grow there.

Teachers should emphasize to students that science is not isolated from the other academic disciplines. The development of reading, writing, and mathematical skills will help students understand and communicate scientific ideas.

Is there a State-Developed Alternative Assessment (SDAA II) for the TAKS science tests?

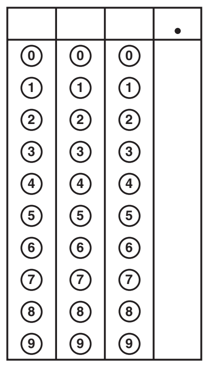
Currently, there is not an SDAA II for TAKS science at any grade. Therefore, the admission, review, and dismissal (ARD) committee can recommend that a student take the grades 5, 8, 10, and exit level science assessment, if appropriate. If the ARD committee determines that the TAKS science tests are not an appropriate assessment for a specific student, then the student may be exempt. However, if a student is exempted, the ARD committee must determine the type of Locally Developed Alternative Assessment (LDAA) the student must take. An LDAA can be a portfolio, a modified released test, or any other locally developed assessment that the ARD committee deems appropriate.

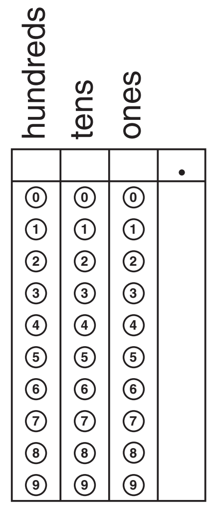
What is the format of the TAKS science tests?

Most items will be in a multiple-choice format with four options. Some multiple-choice items will be written as part of a cluster. A cluster will have a stimulus, which may be a diagram, a brief passage, a chart, or a combination of these, followed by a series of items that will involve the application of prior knowledge and analysis of the given information. Cluster items will appear together on the TAKS test, but items may not always appear on facing pages.

A limited number of items will be griddable, requiring students to bubble responses on grids that are the same as those used in the TAKS mathematics tests. The griddable format is intended to give students the opportunity to solve a problem or measure with precision and then determine an appropriate answer independently. The level of precision necessary for an item will be given to the student in the item. For instance, an item may direct the student to measure an object to the nearest millimeter.

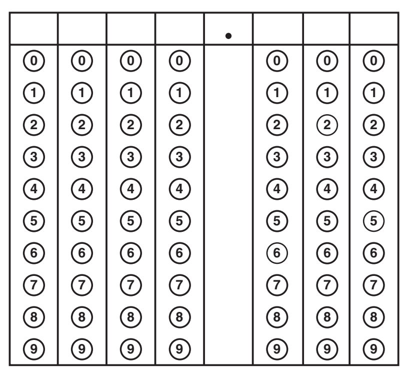
A three-column grid will be the only type of grid for the Elementary Science—Grade 5 TAKS test. The same grid format is used in the grade 5 TAKS Mathematics test. Answers must be recorded in the column of the correct place value. See the following examples:





The decimal on the grid defines the place values of the columns that precede it. Students must record their answer on the grid using the correct place values.

A seven-column grid will be the only type of grid for the grade 10 and exit level TAKS Science tests. The same grid format is used in the grade 10 and exit level TAKS Mathematics tests.



The decimal on the grid defines the place values of the columns that precede it. Students must record their answer on the grid using the correct place values. If an answer is a whole number, students may add zeros after the decimal, or if the answer is fractional, students may add a zero in front of the decimal.

Will any of the TAKS science tests be performance based?

The only performance testing that will occur on the TAKS science tests is using a ruler to measure with precision. Some items will require students to physically use a ruler to measure a drawing of an object in centimeters or millimeters.

> Remember that when the 20-centimeter paper ruler or measurement item that accompanies the TAKS science test is photocopied, the image may be distorted and improper measurements can result.

What is the purpose of the highlights that appear after each objective?

The highlights that appear after each objective are meant to clarify some of the student expectations in the TEKS. These highlights focus attention on some of the important aspects of certain student expectations and explain how these expectations might be assessed on the TAKS science tests. The highlights came from comments and concerns expressed on teacher surveys and in educator meetings.

Introduction to the Grade 10 and the Exit Level Science TAKS

Who will be required to take the Grade 10 and the Exit Level TAKS Science tests?

As mandated by Senate Bill 103, all tenth and eleventh grade students will be required to take the high school TAKS science test unless exempted by an admission, review, and dismissal (ARD) committee. All students who are exempted from the science TAKS by an ARD committee must take a Locally Developed Alternative Assessment (LDAA) for that grade as set by the ARD committee. Limited English proficient (LEP) students can be exempted from the grade 10 science test. But LEP students can receive only a one-time postponement from the exit level science test. For more information about ARD and LPAC committees, refer to *ARD Committee Decision-Making Process for the Texas Assessment Program* and *LPAC Decision-Making Process for the Texas Assessment Programs (Grades 3–10).*

How should the TEKS be approached at the high school level?

Students learn science by doing science. At the high school level, science must be more than the memorization of facts. Students should be provided with multiple opportunities to experience science directly, thereby giving them the tools and skills necessary to understand the methods scientists use to investigate the world. High school students must be able to examine concrete examples of science phenomena in order to understand and apply abstract science concepts.

How will the TAKS affect course and curriculum options?

The new testing requirements in science have an impact on both course selection and curriculum decisions at the high school level. Schools should take into account the state recommendations for graduation plans and the TAKS science tests when considering options involving science instruction. Biology and Integrated Physics and Chemistry (IPC) are the courses designated in the legislation to be tested on the TAKS. High school students are now required to have one credit of biology. Students who choose to take IPC will be exposed to the IPC TEKS assessed on the TAKS science tests. However, those who take separate chemistry and physics courses should be equally or better prepared to be successful on this assessment. Beginning in the 2004–2005 school year, all students will be required to complete three science courses in order to graduate. For more information on the science requirements for graduation, refer to the TEA website.

Where does the middle school science program fit in?

In 2003 the state legislature in Senate Bill 1108 mandated a middle school science test to be given at grade 8 no later than the 2006–2007 school year. The middle school science test will have five objectives that will include science TEKS from grades 6, 7, and 8.

What is the difference between the grade 10 and the exit level TAKS Science tests?

The high school TAKS tests at both grades 10 and 11 are based on TEKS from Biology and IPC. The TEKS tested at tenth grade are quite similar to those tested at eleventh grade. However, there are some differences between the grade levels. The differences are based on the expectation that eleventh grade students will have had more science instruction and therefore more opportunities to develop critical-thinking skills. For example, the TAKS tests at both grade levels require students to examine interactions in food chains, food webs, and food pyramids [Bio (12)(E)]. However, at grade 11 students are also required to analyze the flow of matter and energy through the various trophic levels [Bio (9)(D)].

Student expectations found only in the grade 10 test include the following:

Objective 2—Biology (6)(D); Objective 4—IPC (7)(E); Objective 5—IPC (5)(A) and IPC (6)(F)

Student expectations found only in the exit level test include the following:

Objective 2—Biology (6)(B) and Biology (10)(B); Objective 3—Biology (7)(A) and Biology (9)(D); Objective 4—IPC (7)(D) and IPC (9)(B); Objective 5—IPC (4)(D), IPC (5)(B), and IPC (6)(D)

What is the role of the untested TEKS in the grade 10 and exit level TAKS Science?

Because of the constraints of a single statewide assessment, not all TEKS can be addressed.

> Although some student expectations within the TEKS are not assessed, it is important that educators teach all of the science curriculum so that students can develop a complete understanding of critical science concepts.

For example, student expectation IPC (4)(C), "analyze the effects caused by changing force or distance in simple machines as demonstrated in household devices, the human body, and vehicles," is not included in a TAKS objective. However, in order to fully comprehend the student expectation IPC 4(D), which is listed in exit level Objective 5, the student must recognize how changes in a force can affect work, power, momentum, acceleration, and efficiency, which are assessed.

What is the purpose of the Grade 10 Science test?

The grade 10 TAKS Science test should serve as an indicator of students' science knowledge and skills. If a student does not pass the grade 10 test, it will be necessary for the student to receive some supplemental science instruction. However, just because a student passes the grade 10 test, it cannot be assumed that the student will pass the exit level test. Students will need to maintain their science knowledge and will most likely need additional instruction on the TEKS that are tested at eleventh grade but not at tenth grade.

What tools will be available to students during the TAKS science tests?

Students will be provided with a 20-centimeter ruler, a periodic table, and a formula chart. (Remember that when the 20-centimeter paper ruler or measurement items are photocopied, the image may be distorted and improper measurements can result.)

Because calculations may involve multiple steps and realistic data, each student must have access to a calculator for use during the grade 10 and exit level TAKS Science tests. A four-function calculator, scientific calculator, or graphing calculator may be used. Any kind of graphing calculator may be used except one with a typewriter-style keypad (known as QWERTY) or one that includes a computer algebra system (CAS). Handheld minicomputers, personal digital assistants, and laptop computers may not be used. All types of memory, including standard memory, ROM, and flash ROM, must be cleared to factory default both before and after testing. In addition, any programs or applications must be removed prior to the test administration.

Students need to have classroom experience using a calculator in their science classes so that they are comfortable using it on the day of the test. There should be a minimum of one calculator for every five students in the testing situation. If graphing calculators are shared among students, the test administrator must erase all memory between student uses.

What is on the formula chart?

The formula chart has two sides (see pages 16–17). One side has a periodic table, and the other side has a list of many commonly used formulas and a 20 cm ruler. Even though these formulas may not be directly addressed in the TEKS, they are important for a complete understanding of many chemistry and physics concepts, such as density, momentum, force, and waves.

What about significant figures and scientific notation?

Items will be developed so that answer choices will take into account significant figures, as appropriate. There may be some items whose answers are not in correct significant-figure format, because it would cause confusion for students who are not familiar with the format, such as those in IPC. Though the significant-figure format will not be assessed, it is still recommended that students learn the proper use of significant figures in courses where significant figures are appropriate, such as in chemistry and physics. Griddable items will always give the level of precision in the stem.

Some items may have data and/or answer choices represented in scientific notation.

GRADE 10 AND EXIT LEVEL SCIENCE TAKS BLUEPRINTS

TAKS Objectives	Number of Items Grade 10	Number of Items Grade 11
Objective 1: Nature of Science	17	17
Objective 2: Organization of Living Systems	11	8
Objective 3: Interdependence of Organisms	11	8
Objective 4: Structures and Properties of Matter	8	11
Objective 5: Motion, Forces, and Energy	8	11
Total items scored	**55**	**55**
Field test items	10	10
Total items on test	**65**	**65**

The grade 10 and exit level TAKS Science blueprints will remain the same from one testing cycle to the next.

A Key to Understanding the TEKS
Included on the Exit Level TAKS Science

Example from Objective 1

A

IPC (9) Science Concepts. The student knows how solution chemistry is a part of everyday life. The student is expected to

B → (C) relate the structure of water to its function [as the universal solvent].

C

KEY

A. Knowledge and Skills Statement

This broad statement describes what students should know and be able to do for IPC. The number preceding the statement identifies the number of the knowledge and skills statement. It is important to read the knowledge and skills statement along with the student expectations associated with it for a full understanding of the concept.

B. Student Expectation

This specific statement describes what students should be able to do to demonstrate proficiency in what is described in the knowledge and skills statement. Students will be tested on skills outlined in the student expectation statement.

C. [bracketed text]

The student expectation has been presented in its entirety for two reasons: to clarify the link to the curriculum and to provide background information for test items. However, bracketed text will not be specifically tested on the TAKS.

NOTE: The full TEKS curriculum can be found at www.tea.state.tx.us/teks/.

TEKS STUDENT EXPECTATIONS—IMPORTANT VOCABULARY

For every subject area and grade level, two terms—*such as* and *including*—are used to help make the TEKS student expectations more concrete for teachers. However, these terms function in different ways. To help you understand the effect each of the terms has on specific student expectations, we are providing the following:

- a short definition of each term
- an example from a specific student expectation for this subject area
- a short explanation of how this term affects this student expectation

Such as

The term *such as* is used when the specific examples that follow it function only as representative illustrations that help define the expectation for teachers. These examples are just that—examples. Teachers may choose to use them when teaching the student expectation, but there is no requirement to do so. Other examples can be used in addition to those listed or as replacements for those listed.

IPC (6)(D) "The student is expected to investigate and compare economic and environmental impacts of using various energy sources such as rechargeable or disposable batteries and solar cells."

For this student expectation, students must understand the potential impacts of various energy sources on the environment. The examples listed in this student expectation are common examples of energy sources that can easily be demonstrated in the classroom. However, there are many other examples that can be used, and the list of examples in this student expectation is not exhaustive or exclusive.

Including

The term *including* is used when the specific examples that follow it must be taught. However, other examples may also be used in conjunction with those listed.

Biology (2)(A) "The student is expected to plan and implement investigative procedures including asking questions, formulating testable hypotheses, and selecting equipment and technology."

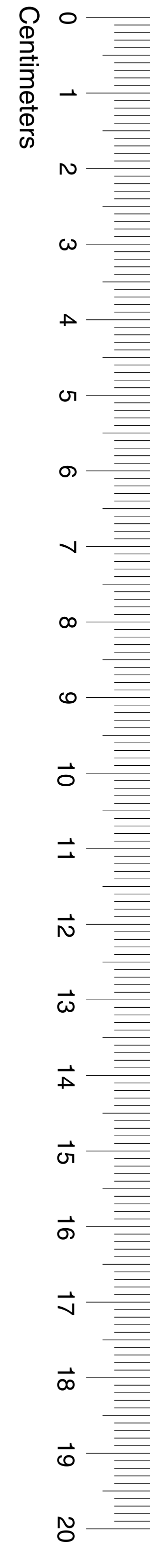
For this student expectation, students must be able to perform the same kinds of investigative activities used by professional scientists. This expectation lists some of the procedures that students must be able to perform in order to properly perform scientific investigations. Other procedures, such as making a graph or writing a scientific paper, can be used as well as those listed, but it is required that students be able to perform the procedures listed in the student expectation.

Remember

For the TAKS tests, teachers should remember two things with regard to these terms.

- Any example preceded by the term *such as* in a particular student expectation may or may not provide the basis for an item assessing that expectation. Because these examples do not necessarily have to be used to teach the student expectation, it is equally likely that other examples may be used in assessment items. The rule here is that an example be used only if it is central to the knowledge, concept, or skill the item assesses.
- It is more likely that some of the examples preceded by the term *including* in a particular student expectation will provide the basis for items assessing that expectation, since these examples must be taught. However, it is important to remember that the examples that follow the term *including* do not represent all of the examples possible, so other examples may also provide the basis for an assessment item. As above, the rule here is that an example should be used only if it is central to the knowledge, concept, or skill the item assesses.

FORMULA CHART
for Grades 10–11 Science Assessment



Density = $\frac{\text{mass}}{\text{volume}}$	$D = \frac{m}{v}$
$\left(\begin{array}{c}\text{heat gained}\\\text{or lost}\end{array}\right) = \left(\begin{array}{c}\text{mass in}\\\text{grams}\end{array}\right)\left(\begin{array}{c}\text{change in}\\\text{temperature}\end{array}\right)\left(\begin{array}{c}\text{specific}\\\text{heat}\end{array}\right)$	$Q = (m)(\Delta T)(C_p)$
Speed = $\frac{\text{distance traveled}}{\text{time}}$	$v = \frac{d}{t}$
Acceleration = $\frac{\text{final velocity} - \text{initial velocity}}{\text{change in time}}$	$a = \frac{v_f - v_i}{\Delta t}$
Momentum = mass × velocity	$p = mv$
Force = mass × acceleration	$F = ma$
Work = force × distance	$W = Fd$
Power = $\frac{\text{work}}{\text{time}}$	$P = \frac{W}{t}$
% efficiency = $\frac{\text{work output}}{\text{work input}} \times 100$	$\% = \frac{W_O}{W_I} \times 100$
Kinetic energy = $\frac{1}{2}(\text{mass} \times \text{velocity}^2)$	$KE = \frac{mv^2}{2}$
Gravitational potential energy = mass × acceleration due to gravity × height	$PE = mgh$
Energy = mass × $(\text{speed of light})^2$	$E = mc^2$
Velocity of a wave = frequency × wavelength	$v = f\lambda$
Current = $\frac{\text{voltage}}{\text{resistance}}$	$I = \frac{V}{R}$
Electrical power = voltage × current	$P = VI$
Electrical energy = power × time	$E = Pt$

Constants/Conversions		
g = acceleration due to gravity = 9.8 m/s^2		
c = speed of light = 3×10^8 m/s		
speed of sound = 343 m/s at sea level and 20°C		
1 cm^3 = 1 mL		
1 wave cycle/second = 1 hertz (Hz)		
1 calorie (cal) = 4.18 joules		
1000 calories (cal) = 1 Calorie (Cal) = 1 kilocalorie (kcal)		
newton (N) = kg m/s^2		
joule (J) = Nm		
watt (W) = J/s = Nm/s		
volt (V)	ampere (A)	ohm (Ω)

Periodic Table of the Elements

Key:
- Atomic number — 14
- Symbol — Si
- Atomic mass — 28.086
- Name — Silicon

Period	Group 1 IA	2 IIA	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8 VIII	9 VIII	10 VIII	11 IB	12 IIB	13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA
1	1 H 1.008 Hydrogen																	2 He 4.0026 Helium
2	3 Li 6.941 Lithium	4 Be 9.012 Beryllium											5 B 10.81 Boron	6 C 12.011 Carbon	7 N 14.007 Nitrogen	8 O 15.999 Oxygen	9 F 18.998 Fluorine	10 Ne 20.179 Neon
3	11 Na 22.990 Sodium	12 Mg 24.305 Magnesium											13 Al 26.982 Aluminum	14 Si 28.086 Silicon	15 P 30.974 Phosphorus	16 S 32.066 Sulfur	17 Cl 35.453 Chlorine	18 Ar 39.948 Argon
4	19 K 39.098 Potassium	20 Ca 40.08 Calcium	21 Sc 44.956 Scandium	22 Ti 47.88 Titanium	23 V 50.942 Vanadium	24 Cr 51.996 Chromium	25 Mn 54.938 Manganese	26 Fe 55.847 Iron	27 Co 58.933 Cobalt	28 Ni 58.69 Nickel	29 Cu 63.546 Copper	30 Zn 65.39 Zinc	31 Ga 69.72 Gallium	32 Ge 72.61 Germanium	33 As 74.922 Arsenic	34 Se 78.96 Selenium	35 Br 79.904 Bromine	36 Kr 83.80 Krypton
5	37 Rb 85.468 Rubidium	38 Sr 87.62 Strontium	39 Y 88.906 Yttrium	40 Zr 91.224 Zirconium	41 Nb 92.906 Niobium	42 Mo 95.94 Molybdenum	43 Tc (98) Technetium	44 Ru 101.07 Ruthenium	45 Rh 102.906 Rhodium	46 Pd 106.42 Palladium	47 Ag 107.868 Silver	48 Cd 112.41 Cadmium	49 In 114.82 Indium	50 Sn 118.71 Tin	51 Sb 121.763 Antimony	52 Te 127.60 Tellurium	53 I 126.904 Iodine	54 Xe 131.29 Xenon
6	55 Cs 132.905 Cesium	56 Ba 137.33 Barium	57 La 138.906 Lanthanum	72 Hf 178.49 Hafnium	73 Ta 180.948 Tantalum	74 W 183.84 Tungsten	75 Re 186.207 Rhenium	76 Os 190.23 Osmium	77 Ir 192.22 Iridium	78 Pt 195.08 Platinum	79 Au 196.967 Gold	80 Hg 200.59 Mercury	81 Tl 204.383 Thallium	82 Pb 207.2 Lead	83 Bi 208.980 Bismuth	84 Po (209) Polonium	85 At (210) Astatine	86 Rn (222) Radon
7	87 Fr (223) Francium	88 Ra 226.025 Radium	89 Ac 227.028 Actinium	104 Rf (261) Rutherfordium	105 Db (262) Dubnium	106 Sg (263) Seaborgium	107 Bh (262) Bohrium	108 Hs (265) Hassium	109 Mt (266) Meitnerium	110 (269)								

Mass numbers in parentheses are those of the most stable or most common isotope.

Series														
Lanthanide Series	58 Ce 140.12 Cerium	59 Pr 140.908 Praseodymium	60 Nd 144.24 Neodymium	61 Pm (145) Promethium	62 Sm 150.36 Samarium	63 Eu 151.97 Europium	64 Gd 157.25 Gadolinium	65 Tb 158.925 Terbium	66 Dy 162.50 Dysprosium	67 Ho 164.930 Holmium	68 Er 167.26 Erbium	69 Tm 168.934 Thulium	70 Yb 173.04 Ytterbium	71 Lu 174.967 Lutetium
Actinide Series	90 Th 232.038 Thorium	91 Pa 231.036 Protactinium	92 U 238.029 Uranium	93 Np 237.048 Neptunium	94 Pu (244) Plutonium	95 Am (243) Americium	96 Cm (247) Curium	97 Bk (247) Berkelium	98 Cf (251) Californium	99 Es (252) Einsteinium	100 Fm (257) Fermium	101 Md (258) Mendelevium	102 No (259) Nobelium	103 Lr (262) Lawrencium

Revised October 15, 2001

TEXAS ASSESSMENT OF KNOWLEDGE AND SKILLS—EXIT LEVEL

Objective 1: The student will demonstrate an understanding of the nature of science.

Objective 1 is focused on the student as a scientist. This objective is found in grades 5, 8, 10, and exit level. The nature of science is at the heart of all sciences, K–16. The skills developed in Objective 1 progress in sophistication and complexity as the student matures and advances academically. In order to understand scientific processes, students must perform the activities of scientists, which include making observations, collecting data, and drawing conclusions. For instance, student expectation Bio/IPC (2)(B) states that students are expected to "collect data and make measurements with precision." Rather than just lecturing to students on how to use lab equipment, the teacher should give students the opportunity to work in a lab setting with equipment such as thermometers, balances, and graduated cylinders.

Activities related to the TEKS of Objective 1 develop students' critical-thinking skills and problem-solving abilities. Using critical-thinking skills to apply science concepts is the primary goal of science education. To best develop these skills, scientific processes should be taught and reinforced throughout the curriculum instead of as an isolated unit.

Biology (1) and Integrated Physics and Chemistry (1) Scientific Processes. The student, for at least 40% of instructional time, conducts field and laboratory investigations using safe, environmentally appropriate, and ethical practices. The student is expected to

(A) demonstrate safe practices during field and laboratory investigations.

Biology (2) and Integrated Physics and Chemistry (2) Scientific Processes. The student uses scientific methods during field and laboratory investigations. The student is expected to

(A) plan and implement investigative procedures including asking questions, formulating testable hypotheses, and selecting equipment and technology;

(B) collect data and make measurements with precision;

(C) organize, analyze, evaluate, make inferences, and predict trends from data; and

(D) communicate valid conclusions.

Integrated Physics and Chemistry (3) Scientific Processes. The student uses critical thinking and scientific problem solving to make informed decisions. The student is expected to

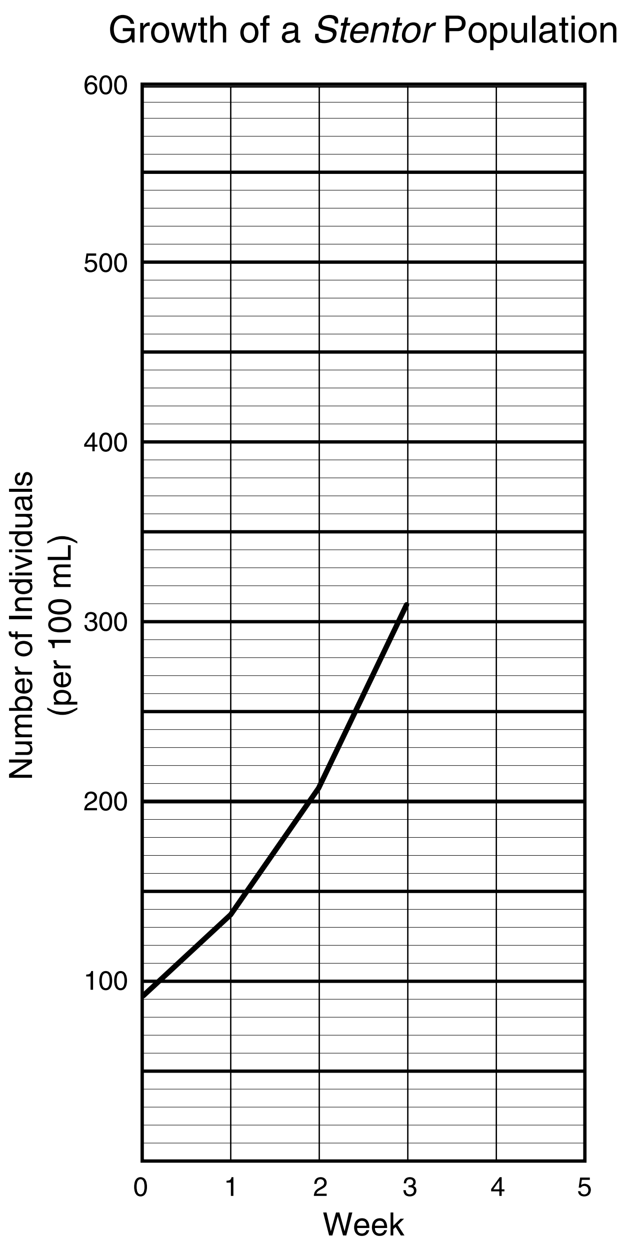
(A) analyze, review, [and critique] scientific explanations, including hypotheses and theories, as to their strengths and weaknesses using scientific evidence and information; and

(B) draw inferences based on data related to [promotional materials for] products and services.

Highlights of Objective 1

- Scientists use many methods in their research. Students should learn a variety of methods to solve problems and make sense of the world.
- Students should be actively participating in laboratory and field activities. Classrooms, hallways, school grounds, and community resources can be used for these investigations.
- *Texas Safety Standards*, which can be obtained through TEA's Office of Publications, should be referenced as students learn about and use safe practices in the classroom, laboratory, and field.
- Students need to be able to draw inferences, recognize meaningful data, and manipulate data from various sources, such as product labels, advertisements, flyers, Web pages, and brochures.
- Students may be required to interpret and evaluate graphs, charts, and maps.
- Students must be able to calculate percentages, determine probability, and use the slope of a line to make predictions.
- The use of the tools, equipment, and materials included in the middle and high school science TEKS is part of this objective. Students will be required to recognize these tools and know how to properly use them. Precise measurements will be necessary on test items.
- Students may be asked to apply basic earth/space science concepts to questions that assess scientific processes, such as testing a hypothesis, predicting trends in data, or communicating valid conclusions.

Objective 1 Sample Items



1 The graph shows the increase in a *Stentor* population. If this trend continues, what will be the approximate size of the *Stentor* population after 4 weeks?

A 325 per 100 mL

B 348 per 100 mL

C 401 per 100 mL

D* 454 per 100 mL

Bio (2)(C)
This item requires students to recognize a pattern in data and then make a prediction based on that pattern. Although an answer can be obtained by drawing the curve freehand, an accurate answer can best be obtained by using the changes in slope to predict where the last data point would be found.

2 Which of these would have the greatest percent of fat content by mass?

A A food with a net mass of 29 grams and with 10 grams of fat

B* A food with a net mass of 35 grams and with 13 grams of fat

C A food with a net mass of 45 grams and with 15 grams of fat

D A food with a net mass of 56 grams and with 17 grams of fat

IPC (3)(B)

This item tests a life skill: reading and analyzing nutrition labels. All these choices could be considered low-fat foods, but students must be able to recognize that some foods labeled low-fat will still have a higher percentage of fat than other low-fat foods. Items of this type require students to apply their mathematics skills to science.

Acceleration of Toy Cars

	Group Q	Group R	Group S	Group T
Trial 1 Time (m/s^2)	0.98	1.02	0.98	1.05
Trial 2 Time (m/s^2)	0.94	1.14	1.15	1.14
Trial 3 Time (m/s^2)	0.87	1.15	0.98	1.16
Trial 4 Time (m/s^2)	0.82	1.19	0.56	1.18

3 These data were gathered by four groups of students doing the same investigation. Each group performed four trials to determine the acceleration rate of a toy car. Which group had the most-consistent data?

A Group Q

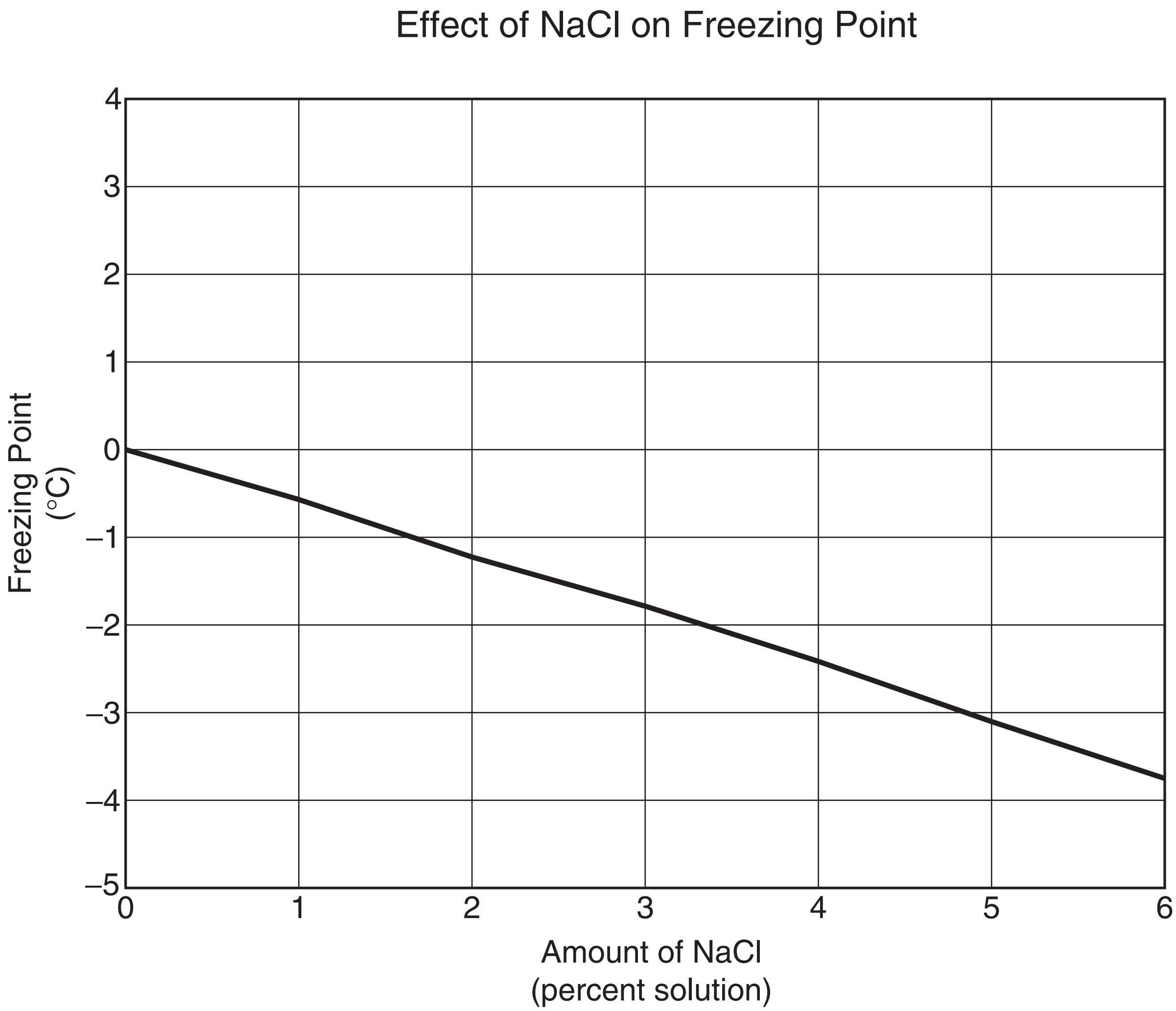
B Group R

C Group S

D* Group T

Bio/IPC (2)(B)

For this item, students must be able to read a chart, analyze data, and determine the consistency of the data.



4 Which statement is best supported by these data?

A The solution's freezing point remained constant with each increase in the amount of solute.

B* The freezing point of the solution decreased as the amount of dissolved solute increased.

C The rate of freezing increased when more solute was dissolved in the solvent.

D The solution remained a liquid because more solute was added to the solvent.

Bio/IPC (2)(D)

This item requires students to read and understand a graph and make a conclusion based on the information in the graph.

5 In the past, people thought that life arose spontaneously out of non-living material. This belief was based partly on the observation that vegetable broth swarmed with microorganisms after sitting out for a few hours. Louis Pasteur (1822–1895) believed spontaneous generation was impossible. Which statement below would best support Pasteur's belief?

A* Broth that was kept clean of airborne dust particles shows no signs of life after many days.

B A review of other scientists' work shows that those scientists made many observations.

C If distilled water is substituted for the broth, no microorganisms are revealed after a few hours.

D Philosophical arguments offer no support for spontaneous generation.

Bio/IPC (3)(A)

This item requires students to understand a hypothesis and evaluate results that could provide scientific support for the hypothesis.

Objective 2: The student will demonstrate an understanding of the organization of living systems.

Students should understand that patterns, organized in increasingly complex levels, help define the natural world. The most important pattern in living systems is the structure of the DNA molecule. DNA orchestrates the construction of cells, which in turn form organisms, populations, and communities. As students investigate and analyze living systems, they should recognize the similarities and differences between organisms. Understanding how these systems are organized, including having a basic knowledge of genetics, will increase students' abilities to address the medical, ecological, and technological issues that have an impact on the world.

Biology (4) Science Concepts. The student knows that cells are the basic structures of all living things and have specialized parts that perform specific functions, and that viruses are different from cells and have different properties and functions. The student is expected to

(B) investigate and identify cellular processes including homeostasis, permeability, energy production, transportation of molecules, disposal of wastes, function of cellular parts, and synthesis of new molecules.

Biology (6) Science Concepts. The student knows the structures and functions of nucleic acids in the mechanisms of genetics. The student is expected to

(A) describe components of deoxyribonucleic acid (DNA), and illustrate how information for specifying the traits of an organism is carried in the DNA;

(B) explain replication, transcription, and translation using models of DNA and ribonucleic acid (RNA); and

(C) identify and illustrate how changes in DNA cause mutations and evaluate the significance of these changes.

Biology (8) Science Concepts. The student knows applications of taxonomy and can identify its limitations. The student is expected to

(C) identify characteristics of kingdoms including monerans, protists, fungi, plants, and animals. **

Biology (10) Science Concepts. The student knows that, at all levels of nature, living systems are found within other living systems, each with its own boundary and limits. The student is expected to

(A) interpret the functions of systems in organisms including circulatory, digestive, nervous, endocrine, reproductive, integumentary, skeletal, respiratory, muscular, excretory, and immune; and

(B) compare the interrelationships of organ systems to each other and to the body as a whole.

**The TAKS will use the most current classification system.

Highlights of Objective 2

- Students should understand the importance of cellular processes and the cell parts that play a role in these processes. In addition, students should understand that cells form tissues and that tissues form organs with specialized functions.

- Organ systems are interdependent. The function of one system will directly or indirectly affect the functions of other systems. Knowledge of this interdependence will help students better understand personal health issues as well as new discoveries in medicine and veterinary science.

- The relationship of structure to function should be explored from the cellular level to the ecosystem level.

- Students must identify the structures of nucleic acids, such as DNA and RNA. They should know how nucleic acids are involved in the formation of the organism and the inheritance of traits. Students will need to be able to use Punnett squares and probability to find possible genotypes and phenotypes. Students may be asked to apply their knowledge of genetics to predict possible genotypes involving sex-linked traits and multiple alleles.

- Students may be required to apply their knowledge of genetics to biotechnology issues, such as genetic engineering and the Human Genome Project.

- Genetic principles will be applied to the understanding of ecology and evolution. For example, bacterial resistance to some antibiotics is a genetic trait passed on from generation to generation. Constant exposure to an antibiotic will kill the majority of individual bacteria in a population, but the few individuals that have a resistance to that antibiotic will live on to reproduce. Scientists predict that natural selection will cause a rise in antibiotic-resistant strains of bacteria that have been overexposed to some antibiotics.

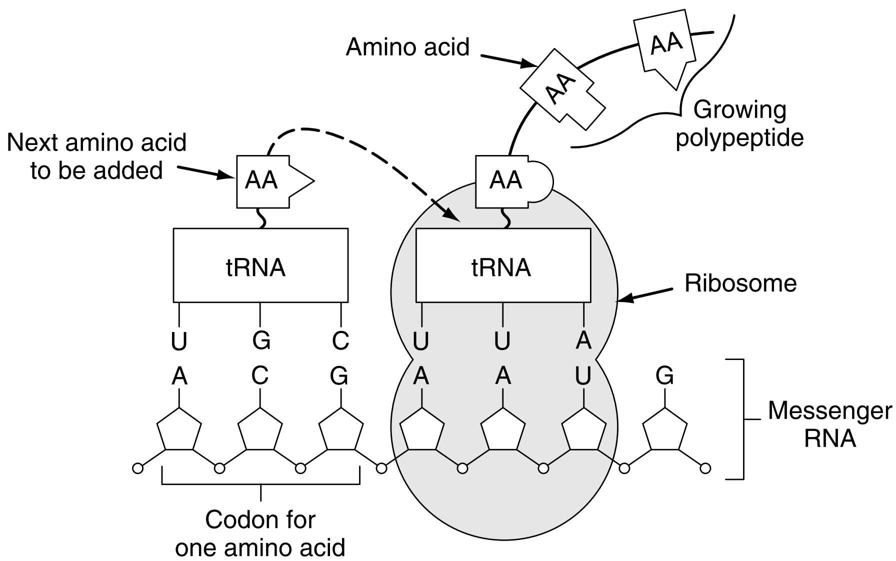
- TAKS will use the six-kingdom system that includes Archaebacteria, Eubacteria, Protista, Fungi, Plantae, and Animalia. Increasing knowledge of the world necessitates change. Therefore, classification of organisms can change over time. Though scientific names of organisms may be used on TAKS items, students will not be expected to memorize the scientific names.

- Students need to be familiar with the functions of plant and animal systems as well as with relationships among the systems within an organism.

- The study of systems requires an integration of all sciences. For example, students may apply knowledge of physics concepts to the human body (the elbow as a lever or light through the lens of an eye), chemistry concepts to cellular processes (the manufacture of carbohydrates by plants or the formation of proteins within a ribosome), and earth science concepts to ecosystems (soil composition or the nitrogen cycle).

- Students will not be asked to name specific types of macromolecules, such as fructose or sucrose. However, students will be expected to be familiar with carbohydrates, fats, and proteins and their role in living systems.

Objective 2 Sample Items



6 Which cellular function does this model represent?

A Respiration

B* Protein synthesis

C DNA replication

D Photosynthesis

Bio (6)(B)

This item requires students to understand and recognize a model of the structures and molecules involved in a physiological process, in this case protein synthesis.

Common Name	Scientific Name
Northern mockingbird	*Mimus polyglottos*
Green-winged teal	*Anas crecca*
Bald eagle	*Haliaeetus leucocephalus*
White-tailed hawk	*Buteo albicaudatus*
Mallard	*Anas platyrhynchos*

7 The table above lists several birds commonly found in Texas. Which two are the most closely related?

A Northern mockingbird and bald eagle

B* Green-winged teal and mallard

C Bald eagle and white-tailed hawk

D White-tailed hawk and northern mockingbird

Bio (8)(C)
This item uses species names to assess the students' understanding of biological classification. Though students will be expected to know the rules of classification, they will not be expected to memorize species or common names.

8 All these systems help bring materials to the cells except the —

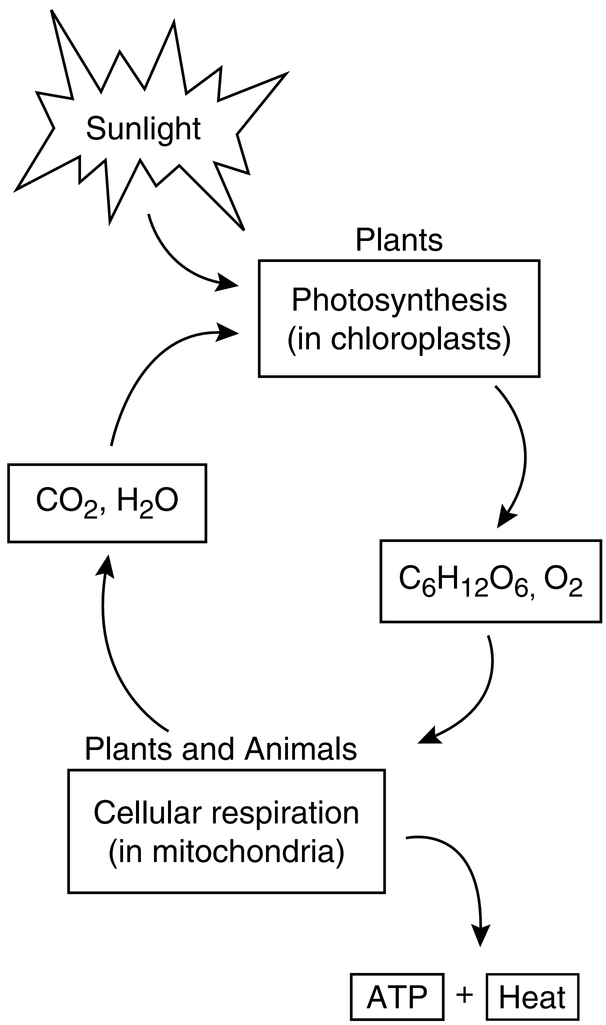
A digestive system

B respiratory system

C* excretory system

D circulatory system

Bio (10)(A)
Students must be familiar with the general functions of various body systems.



9 The diagram shows the flow of energy converted during photosynthesis. From this diagram it can also be inferred that —

A atmospheric gases are the source of energy for producers

B* organisms depend on organic compounds to transfer energy

C ultraviolet radiation from the sun is used for photosynthesis

D heat from plants and animals warms atmospheric gases

Bio (4)(B)
This item requires students to integrate the concepts of photosynthesis and cellular respiration. It is also important that students understand the transfer of energy between plants and animals.

10 On a hot summer day, a road-crew worker perspires and then feels thirsty as her body temperature increases. This response is an example of —

A releasing enzymes

B decreasing respiration

C assimilating proteins

D* maintaining homeostasis

Bio (10)(B)
This item demonstrates how various systems in the body, such as the integumentary, circulatory, and nervous systems, are integrated to maintain homeostasis. Perspiration and thirst are just two responses that help maintain homeostasis.

Objective 3: The student will demonstrate an understanding of the interdependence of organisms and the environment.

Organisms do not live in isolation. They rely on their environment and other species for survival. To comprehend these relationships, students must integrate concepts from environmental science, evolution, and population genetics. Understanding interdependence will help students make informed decisions about their health, the use of resources, and the well-being of the planet on which they live.

Biology (4) Science Concepts. The student knows that cells are the basic structures of all living things and have specialized parts that perform specific functions, and that viruses are different from cells and have different properties and functions. The student is expected to

(C) compare the structures and functions of viruses to cells and describe the role of viruses in causing diseases and conditions such as acquired immune deficiency syndrome, common colds, smallpox, influenza, and warts; and

(D) identify and describe the role of bacteria in maintaining health such as in digestion and in causing diseases such as in streptococcus infections and diphtheria.

Biology (7) Science Concepts. The student knows the theory of biological evolution. The student is expected to

(A) identify evidence of change in species using fossils, DNA sequences, anatomical similarities, physiological similarities, and embryology; and

(B) illustrate the results of natural selection in speciation, diversity, phylogeny, adaptation, behavior, and extinction.

Biology (9) Science Concepts. The student knows metabolic processes and energy transfers that occur in living organisms. The student is expected to

(D) analyze the flow of matter and energy through different trophic levels and between organisms and the physical environment.

Biology (12) Science Concepts. The student knows that interdependence and interactions occur within an ecosystem. The student is expected to

(B) interpret interactions among organisms exhibiting predation, parasitism, commensalism, and mutualism; and

(E) investigate and explain the interactions in an ecosystem including food chains, food webs, and food pyramids.

Biology (13) Science Concepts. The student knows the significance of plants in the environment. The student is expected to

(A) evaluate the significance of structural and physiological adaptations of plants to their environments.

Highlights of Objective 3

- Students should be aware that bacteria are not always harmful. The majority of bacteria have no direct effect on humans. Many times bacteria play a beneficial role in organisms and the environment.
- Students should learn about some of the plant and animal diseases caused by bacteria and viruses. However, students are not expected to be aware of all of them. Items that address this issue will be designed to provide background information on the specific disease used in the item.
- Evolution is change over time. Students must understand natural selection as a mechanism for evolution, not as a term synonymous with evolution.
- Students should be able to examine evidence of evolution, such as DNA sequences and homologous structures, to determine the relationship between organisms. Embryology will not be included as evidence of evolution.
- Students should know that solar energy drives ecosystems. Food chains combine to make more complex food webs, and these webs are limited by the amount of energy that can be transferred between levels. Students need to understand the concept of biomass and relate it to food chains, webs, and pyramids. Students should know that the arrows in a food web or chain point in the direction of energy flow through the system.
- The cycling of nutrients is essential to maintaining the ecosystem. An understanding of this concept helps students realize why Earth's resources may be limited. Students should be familiar with the water, carbon, and nitrogen cycles. They should be able to analyze how changes, caused by either humans or natural occurrences, affect the availability of these resources.
- Students should know the significance of the structures and adaptations of plants, such as the variety of leaf structures, methods of dispersing offspring, and methods of obtaining nutrients. The study of plant structures and adaptations helps students better understand the connection between plants and the survival of other life, including human life.

Objective 3 Sample Items

11 Bacteria are the only organisms that can —

A obtain energy by decomposing carbohydrates

B* transform atmospheric nitrogen into ammonia

C produce glucose from dissolved carbon dioxide

D synthesize proteins from amino acid molecules

Bio (4)(D)
This item integrates two major concepts: the characteristics of kingdoms and the nitrogen cycle. Students must be familiar with the characteristics of bacteria compared to the other kingdoms and must also understand the role of bacteria in the nitrogen cycle.

12 Which of these best represents a mutualistic relationship?

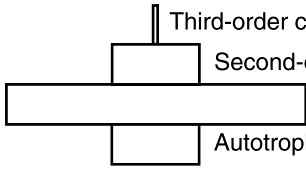
A Bull snake/mouse

B White-tailed deer/grass

C* Hummingbird/blossom

D Spadefoot toad/cricket

Bio (12)(B)
This item requires students to understand the terms used to describe ecological relationships, such as mutualism, parasitism, and commensalism, and to recognize examples of those relationships. Students should realize that new scientific information might change our understanding of the interactions in these examples.



13 The marine ecosystem represented above is able to thrive with a small autotroph biomass because —

A* autotrophs reproduce rapidly

B first-order consumers are small

C second-order consumers are rare

D third-order consumers eat very little

Bio (9)(D)
This item requires students to understand the nature of different food pyramids and to understand how an ecosystem can remain stable if lower trophic levels are smaller than higher levels. It is important that students understand and apply the concepts of energy transfer and biomass to many situations and not just the traditional biomass pyramid.

Note: This student expectation is not assessed at grade 10.

14 Viruses can only replicate —

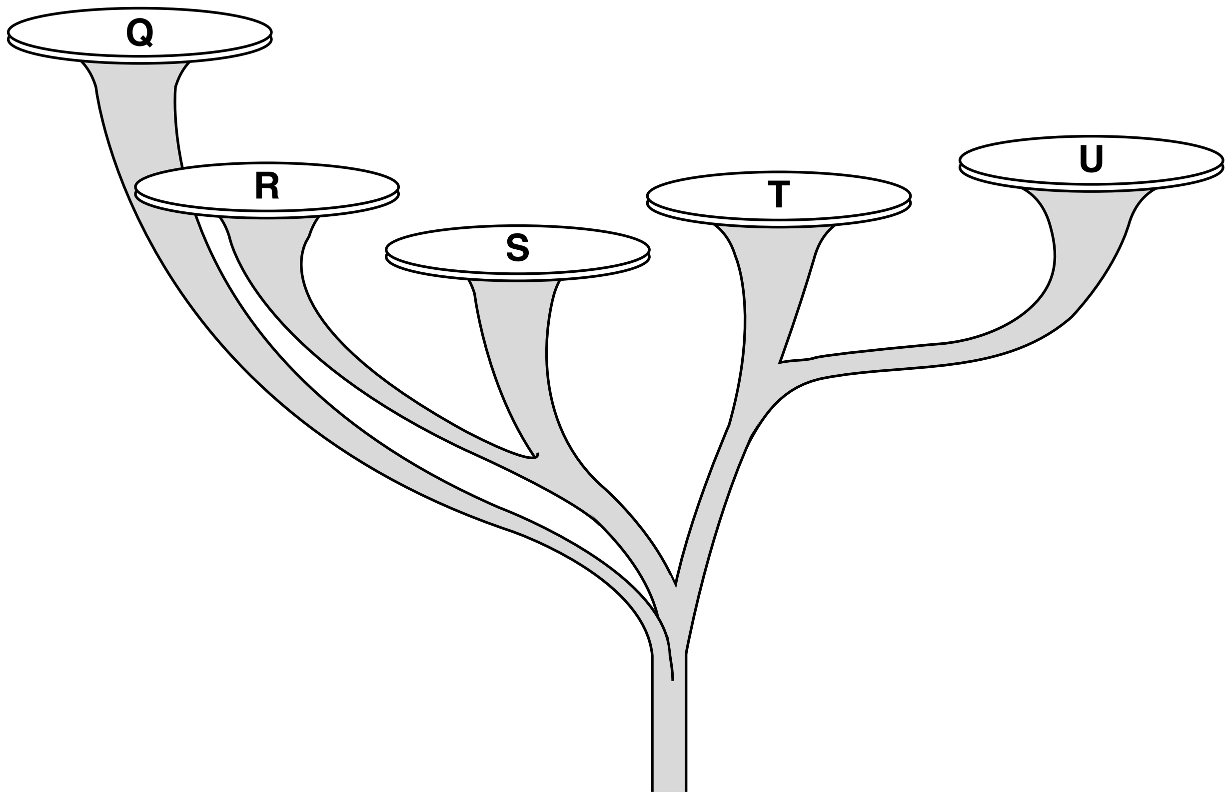
A* Inside a host cell

B Along a cellular membrane

C Outside a nucleus

D Between host cells

Bio (4)(C)
Students must know the structures, life cycle, and impact of viruses on other organisms.



15 According to this phylogenetic tree, which organism is most closely related to R?

A Q
B* S
C T
D U

Bio (7)(A)
Students must understand how to read a phylogenetic tree and know how it is used in evolutionary biology to determine how closely two species are related. This item also demonstrates how concepts like evolution can be assessed without using actual organisms.

Objective 4: The student will demonstrate an understanding of the structures and properties of matter.

Knowledge of the structures and properties of matter and the ways in which matter interacts to create new substances allows students to understand the molecular structures of living organisms and nonliving objects. An understanding of basic chemistry concepts helps students understand their world and enhances their lives. For example, chemistry concepts play a part in our daily lives in the manufacture of goods, increased agricultural productivity, and the development of pharmaceuticals.

Integrated Physics and Chemistry (7) Science Concepts. The student knows relationships exist between properties of matter and its components. The student is expected to

(A) investigate and identify properties of fluids including density, viscosity, and buoyancy; and

(D) relate the chemical behavior of an element including bonding, to its placement on the periodic table.

Integrated Physics and Chemistry (8) Science Concepts. The student knows that changes in matter affect everyday life. The student is expected to

(A) distinguish between physical and chemical changes in matter such as oxidation, digestion, changes in states, and stages in the rock cycle; and

(C) investigate and identify the law of conservation of mass.

Integrated Physics and Chemistry (9) Science Concepts. The student knows how solution chemistry is a part of everyday life. The student is expected to

(A) relate the structure of water to its function [as the universal solvent];

(B) relate the concentration of ions in a solution to physical and chemical properties such as pH, electrolytic behavior, and reactivity; and

(D) demonstrate how various factors influence solubility including temperature, pressure, and nature of the solute and solvent.

Highlights of Objective 4

- All organisms are composed mainly of water, and most of Earth is covered with water. It is important for students to understand the structure of water and how that structure dictates its characteristics.
- Students should be able to calculate density and apply it to different situations, such as buoyancy, density columns, and substance identification.
- Some items will integrate earth/space science concepts as these ideas relate to the chemical and physical concepts of IPC. For example, the weathering of limestone by groundwater (carbon dioxide and water react to yield carbonic acid) can form caverns.
- Students should be able to balance simple chemical equations. They may need to choose between different equations to find the one that is balanced, or they may have to select the correct set of coefficients.
- Students should be able to read solubility curves and be familiar with how temperature and pressure affect the solubility of both solids and gases.
- Students should be familiar with factors that affect the rate of solution.
- Students should be able to use and apply information from the periodic table to understand the relative reactivity of the various elements. This will help students understand the types of possible bonds and the structure and composition of many chemicals. Items will use information on atomic structure, periodic properties, and simple ionic and covalent bonding. Students will be expected to determine the formula and name for basic compounds.
- Ions have an impact on all areas of the natural world, including organisms. Students need to understand how ion concentrations can affect pH and electrolytic activity. This concept is important in studying the effects of ions on physical phenomena as well as on physiological processes.

Objective 4 Sample Items

16 The correct formula for calcium chloride is —

A CaCl

B* $CaCl_2$

C Ca_2Cl

D Ca_2Cl_3

IPC (7)(D)
When given the name of an element, an ion, or a compound, students should be able to use the periodic table to determine the chemical formula.

17 When a 1-kilogram log was burned, 0.05 kilogram of ash was produced. The mass of the ash is less than the mass of the log because —

A wind carried away some matter before it burned

B* some matter was converted to gases that were released

C combustion changed some matter into energy

D some matter was decomposed by organisms in the soil

IPC (8)(C)
This item tests students' understanding of the concept of a combustion reaction. Students may have the misconception that during combustion matter is only converted to energy or disappears. It is important for students to understand that during combustion some matter is converted into gases, such as carbon dioxide and water vapor.

Density Experiment with a Magnetic Steel Alloy

Mass of weighing bottle (g):	22.35
Mass of weighing bottle + alloy (g):	161.02
Mass of alloy (g):	?
Volume of water in graduated cylinder (mL):	40.3
Volume of water in graduated cylinder after alloy submerged (mL):	60.4
Volume of alloy (mL):	?
Density of alloy (g/mL):	?

18 What is the density of this magnetic steel alloy?

A 2.67 g/mL

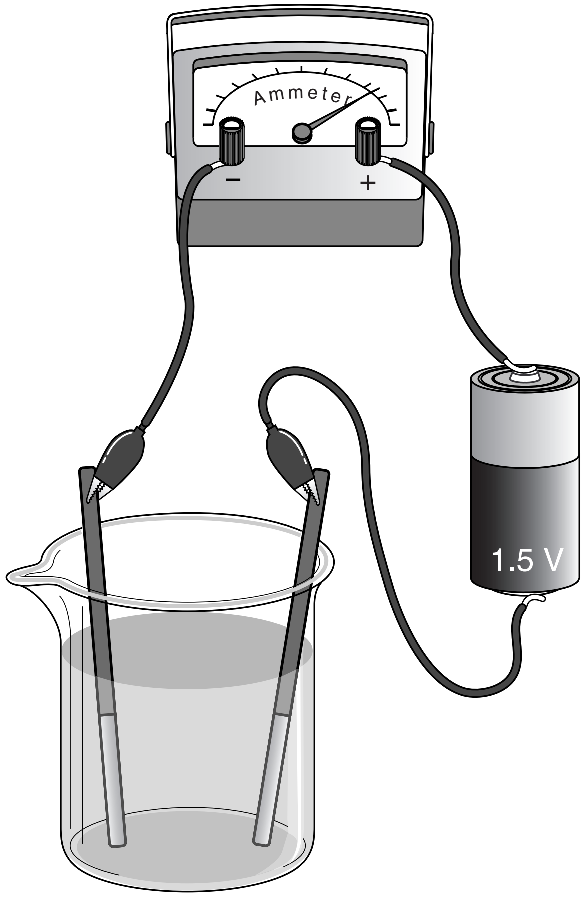
B 3.99 g/mL

C* 6.90 g/mL

D 8.01 g/mL

IPC (7)(A)

This item requires students to understand the concept of density and perform the proper calculation. The student would find the density formula on the Formula Chart. This item uses the format of a lab worksheet that may look familiar to some students and reinforces the importance of students participating in scientific investigations.



19 The solute most likely to create a solution that produces the current reading shown on the ammeter is —

A sucrose, $C_{12}H_{22}O_{11}$

B ethyl alcohol, C_2H_5OH

C oxygen, O_2

D* nitric acid, HNO_3

IPC (9)(B)
Students should know that most acids will dissociate in solution and become electrical conductors. Students should be familiar with the types of compounds that can conduct electricity after the compounds dissolve. Notice that this item does not require students to memorize chemical formulas, but it does require students to recognize how compounds behave based on the elements and the bonding properties of the compound.

20 When deep-sea divers explore the ocean at great depths, nitrogen becomes 10 to 100 times more soluble in the blood. A disorder called the bends occurs when nitrogen bubbles out of the blood because of a rapid —

A* decrease in pressure

B increase in salt concentration

C decrease in temperature

D increase in blood pH

IPC (9)(D)
This item requires students to have a basic understanding of the solubility properties of gases. Also, this is an example of how biological and physical science concepts can be integrated.

Objective 5: The student will demonstrate an understanding of motion, forces, and energy.

Students need to understand force and motion in order to comprehend the concepts of speed, waves, and energy transformations. The study of motion, forces, and energy is necessary for understanding the physical world. Whether riding in a car, turning on lights, or listening to the radio, we are continually surrounded by examples of energy transformations and Newton's laws of motion.

Integrated Physics and Chemistry (4) Science Concepts. The student knows concepts of force and motion evident in everyday life. The student is expected to

(A) calculate speed, momentum, acceleration, work, and power in systems such as in the human body, moving toys, and machines;

(B) investigate and describe applications of Newton's laws such as in vehicle restraints, sports activities, geological processes, and satellite orbits; and

(D) investigate and demonstrate [mechanical advantage and] efficiency of various machines such as levers, motors, wheels and axles, pulleys, and ramps.

Integrated Physics and Chemistry (5) Science Concepts. The student knows the effects of waves on everyday life. The student is expected to

(B) demonstrate wave interactions including interference, polarization, reflection, refraction, and resonance within various materials.

Integrated Physics and Chemistry (6) Science Concepts. The student knows the impact of energy transformations in everyday life. The student is expected to

(A) describe the law of conservation of energy;

(B) investigate and demonstrate the movement of heat through solids, liquids, and gases by convection, conduction, and radiation; and

(D) investigate and compare economic and environmental impacts of using various energy sources such as rechargeable or disposable batteries and solar cells.

Highlights of Objective 5

- Students will be expected to perform calculations related to motion, force, and energy. Calculations may involve the use of more than one formula and/or the conversion of basic SI units. For example, the item may give the force, distance, and time of a moving object, and students will be asked to calculate the power of the object. All the formulas needed for the assessment will be listed on the formula chart. Items may require the use of more than one formula or step.

- Students should understand the movement of heat energy through materials. An understanding of specific heat will be needed to calculate the amount of heat energy gained or lost by a substance. Some items may not require calculations but instead will ask students to apply the ideas of specific heat, heat transfer, and phase changes.

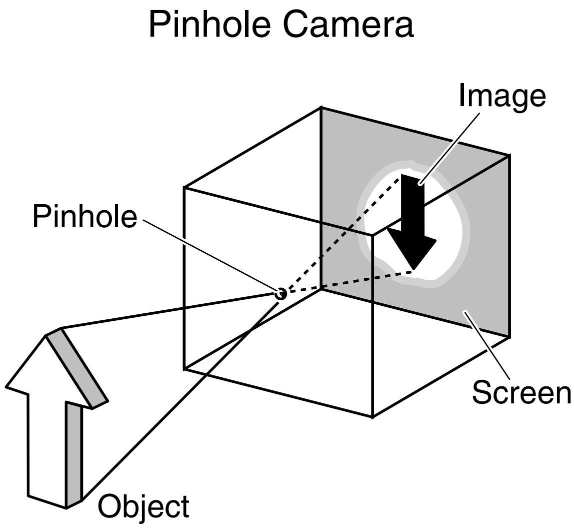
- Students should be able to demonstrate an understanding of the actions and interactions of waves. To apply student expectation IPC (5)(B), students may be required to demonstrate their understanding of the characteristics of waves and identify relationships between wavelength, frequency, and amplitude. Students should also be familiar with how temperature and density can affect wave behavior. The technological applications of different types of waves (for example, radios, microwave ovens, and x-rays) should be explored as well.

- The integration of biological and earth/space science concepts with the study of forces, motion, and energy may be seen in items that address ideas such as osmosis, blood pressure, muscle activity, weather, and plate tectonics.

- Students may have to evaluate the impact of technology on the environment. Students should understand that there are trade-offs when using technology. For example, rechargeable batteries can be recycled many times, but once they are no longer useful, the heavy metals they contain must be disposed of properly.

- Students will need to understand the relative efficiency of simple machines and motors.

Objective 5 Sample Items



21 The image on the screen is inverted because light rays —

A condense as they pass through the pinhole

B* travel through the opening in straight lines

C refract as they strike the screen

D are polarized by the materials of the screen

IPC (5)(B)
This item requires students to understand that light travels in a straight line and how images are formed.

22 The space shuttle orbits Earth at approximately 8000 m/s. The shuttle stays in orbit because the —

A shuttle's action is balanced by Earth's equal and opposite reaction

B* combination of gravity and the shuttle's inertia creates a curved path parallel to Earth's surface

C net gravitational force is zero at the shuttle's distance from Earth's center

D force of Earth's gravity pulls the shuttle downward and the force of the moon's gravity pulls the shuttle upward

IPC (4)(B)
This item requires that students have a strong conceptual understanding of Newton's laws and be able to apply these concepts to many different situations.

23 What is the efficiency of a pulley system if 25% of the energy applied to the system is converted to heat?

A 100%

B* 75%

C 50%

D 25%

IPC (4)(D)
This item requires that students have a basic understanding of efficiency in simple machines. This formula is provided on the Formula Chart.

24 How much heat is lost by 2.0 grams of water if the temperature drops from 31°C to 29°C? The specific heat of water is 4.184 J/g•°C.

A 4.0 J

B 6.2 J

C 8.4 J

D* 16.7 J

IPC (6)(B)

Students will be expected to describe the movement of heat through objects in mathematical terms as well as in terms such as convection, conduction, and radiation.

Cluster Example

Use the information below and your knowledge of science to answer questions 25 and 26.

Dr. Percy Lavon Julian
(1899–1975)

Not many years ago, people with rheumatoid arthritis suffered greatly. Their joints became swollen, inflamed, and painful, and many were unable to walk. Then doctors found that a natural chemical called cortisone helped reduce the symptoms of arthritis. However, cortisone was difficult to produce and too expensive for most people to afford.

Dr. Percy Lavon Julian, a chemist, came to the aid of people who suffered from rheumatoid arthritis. Dr. Julian developed a synthetic form of cortisone from soybean and yam plants. The synthetic form was easy to produce and affordable.

Dr. Julian found that soybeans provide other important chemicals as well. Using these chemicals, he developed waterproofing materials and a foam used to put out fires. The navy used this foam to protect ships and planes during World War II. Dr. Julian's work and the products he helped produce continue to improve the lives of thousands of people.

Dr. Percy Julian receives
Decalogue Society Award

Photo courtesy of © Bettmann/CORBIS.

25 Which of these tables best represents an experimental design used to test whether cortisone relieves inflammation?

A

Group n = 1000	Amount of Cortisone (mg)
1	100
2	200
3	300

B

Group n = 10	Amount of Cortisone (mg)
1	50
2	100
3	150

C

Group n = 10	Amount of Cortisone (mg)
1	0
2	200
3	210

D*

Group n = 1000	Amount of Cortisone (mg)
1	0
2	100
3	200

26 Dr. Julian's foam was most successful in extinguishing oil fires. What are the most likely physical characteristics of this foam?

A* Less dense than oil and does not allow oxygen in

B Waterproof and contains flammable materials

C More viscous than water and lighter than air

D Brightly colored and more porous than plastic

Bio/IPC (2)(A) and (7)(A)
Clusters will address more than one objective and integrate content areas. This cluster is an example of how biographical information can be a stimulus for items on experimental design, chemistry, and physics. The answers to the items in a cluster may not be directly found in the stimulus. Instead, the stimulus is used to focus students so that they can analyze new information and apply their knowledge.

Appendix: Science Educator Resources

Texas Education Agency (TEA) Websites

TEA website: www.tea.state.tx.us
Graduation Requirements for Science: www.tea.state.tx.us/curriculum/side1.doc
Certification Requirements and PD Provider Number: www.sbec.state.tx.us

Resources for Teaching Science

Texas Science Center at Region IV: www.texassciencecenter.org
Science Safety: www.tenet.edu/teks/science/stacks/safety/safetymain.html
Texas Regional Collaboratives for Excellence in Science Teaching: http://regcol.edb.utexas.edu
Charles A. Dana Center: www.tenet.edu/teks/science
Benchmarks for Science Literacy: www.project2061.org/tools/benchol/bolintro.htm
Science for All Americans: www.project2061.org/tools/sfaaol/sfaatoc.htm
National Science Education Standards: www.nap.edu/readingroom/books/nses/html/

Resources from Organizations

Science Teachers Association of Texas: www.statweb.org
National Science Teachers Association: www.nsta.org
National Association of Biology Teachers: www.nabt.org
American Association of Physics Teachers: www.aapt.org
American Chemical Society: www.acs.org
National Earth Science Teachers Association: www.nestanet.org

If you need any help in the area of science curriculum or assessment, please feel free to contact:

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Assessment: (512) 682-2200