

Test and Item Specifications

Science

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¹ Sample Item Stems are examples of item stems that may be used; items are not limited to the examples shown in this document.

1) Science Blueprint

a) 2015–2016 (Forms D, E, and F)

Domain/ Reporting Category	Subdomain/Core Idea	Subdomain %	Domain %
Earth and Space Sciences	ESS1 Earth's Place in the Universe	15%	40%
	ESS2 Earth's Systems	15%	
	ESS3 Earth and Human Activity	10%	
Life Sciences	LS1 From Molecules to Organisms: Structures and Processes	12.5%	40%
	LS2 Ecosystems: Interactions, Energy, and Dynamics	12.5%	
	LS3 Heredity: Inheritance and Variation of Traits	7.5%	
	LS4 Biological Evolution: Unity and Diversity	7.5%	
Physical Sciences	PS1 Matter and Its Interactions	6%	20%
	PS2 Motion and Stability: Forces and Interactions	6%	
	PS3 Energy	5%	
	PS4 Waves and Their Applications in Technologies for Information Transfer	3%	

b) 2016–2017 (Forms G, H, and I)

Domain/ Reporting Category	Subdomain/Core Idea	Subdomain %	Domain %
Earth and Space Sciences	ESS1 Earth's Place in the Universe	12%	30%
	ESS2 Earth's Systems	12%	
	ESS3 Earth and Human Activity	6%	
Life Sciences	LS1 From Molecules to Organisms: Structures and Processes	15%	50%
	LS2 Ecosystems: Interactions, Energy, and Dynamics	15%	
	LS3 Heredity: Inheritance and Variation of Traits	12%	
	LS4 Biological Evolution: Unity and Diversity	8%	
Physical Sciences	PS1 Matter and Its Interactions	6%	20%
	PS2 Motion and Stability: Forces and Interactions	6%	
	PS3 Energy	5%	
	PS4 Waves and Their Applications in Technologies for Information Transfer	3%	

2) Science Subtest Form Design

In each operational year, three equated operational forms are selected for each subtest. The first operational TASC forms in 2014 were comprised of 40 selected-response/multiple-choice (SR/MC) items. In the 2015 and 2016 forms, both technology-enhanced (TE) and constructed-response (CR) items are being field tested and may be included as operational items in future years.

The table below shows the projected item numbers by item type in the 2016 forms. Research and data may necessitate minor adjustments to these numbers.

a) Design Table

Item Type	Total Items per Form	Testing Time (minutes)
MC	48	48
1-pt Autoscored	1	2
2-pt Autoscored	1	3
2-pt CR	1	4
Shared Stimuli	5	15

b) Testing Times are based on these estimates.

Item Type	Estimated Testing Time (minutes)
MC	1
1-pt Autoscored	2
2-pt Autoscored	3
2-pt CR	4
Shared Stimulus	3

3) TASC Science Item Specifications for Measured Standards

Item specifications are one of the key requirements for a high-quality, legally defensible, standards-based assessment. Item specifications help define important characteristics of the items (i.e., test questions) developed for each standard. These item specifications provide guidelines to help clarify the focus of what is to be assessed, what items may include, and what items may not include (i.e., assessment limits). Item specifications are used by item writers, item editors, and item reviewers as a common reference throughout the item-development process, from initial writing to final approval. The TASC Science item specifications are based on the TASC test standards for Science, which are based on the final results of the Next Generation Science Standards (NGSS). The assessment limits/content constraints have been further refined based on customer feedback and DRC | CTB item-performance data analyses targeting specific standard- and item-level assessment scope.

Domain	Earth and Space Sciences
Subdomain	ESS1 Earth's Place in the Universe
Standard	ESS1-1. Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy in the form of radiation.
Emphasis Level	Medium
Evidence Statements	<p>The examinee will demonstrate understanding that Earth's Sun is an average-size star.</p> <p>The examinee will demonstrate understanding that the stars differ from each other in size, temperature, and age. (Specific information about different categories of stars must be provided.)</p> <p>The examinee will demonstrate understanding that every object exerts gravitational force on every other object.</p> <p>The examinee will demonstrate understanding that gravitational force depends on how much mass given objects have and on how far apart they are from each other.</p> <p>The examinee will demonstrate understanding that stars form when gravity causes clouds of molecules to contract until nuclear fusion of light elements into heavier ones occurs.</p> <p>The examinee will demonstrate understanding that fusion releases great amounts of energy.</p> <p>The examinee will demonstrate understanding that the Sun is a major source of energy for Earth.</p> <p>The examinee will demonstrate understanding that energy can be transferred through space via radiation.</p> <p>The examinee will demonstrate understanding that different forms of electromagnetic energy have different wavelengths.</p> <p>The examinee will recognize some examples of electromagnetic energy including microwaves, infrared light, visible light, ultraviolet light, X-rays, and gamma rays. (A graphic model of the electromagnetic spectrum should be provided.)</p>
Assessment Limits/Content Constraints	<p><u>Beyond Scope</u></p> <ul style="list-style-type: none"> Stages of the life spans of stars
DOK(s)	1, 2
Stimulus	Items about stars or the electromagnetic spectrum must include graphic models.
Tools	Scientific calculator provided

Sample Item
Stem(s)

Based on the data presented in the table, how are the proportions of hydrogen and helium in the Sun changing over time?

Sample Item

The Sun produces tremendous amounts of energy. Some of that energy reaches Earth and affects Earth's systems.

Which statement explains how the Sun produces this energy?

- A. The Sun produces energy through fusion reactions in its core.
- B. The Sun produces energy through radioactive decay in its core.
- C. The Sun produces energy through convection cells on its surface.
- D. The Sun produces energy through combustion reactions on its surface.

Domain	Earth and Space Sciences
Subdomain	ESS1 Earth's Place in the Universe
Standard	ESS1-2. Construct an explanation of the Big Bang theory, based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe.
Emphasis Level	Medium
Evidence Statements	<p>The examinee will demonstrate understanding that Earth's sun is an average-size star.</p> <p>The examinee will demonstrate understanding that the stars differ from each other in size, temperature, and age. (Specific information about different categories of stars must be provided.)</p> <p>The examinee will demonstrate understanding that every object exerts gravitational force on every other object.</p> <p>The examinee will demonstrate understanding that gravitational force depends on how much mass given objects have and on how far apart they are from each other.</p> <p>The examinee will demonstrate understanding that stars form when gravity causes clouds of molecules to contract until nuclear fusion of light elements into heavier ones occurs.</p> <p>The examinee will demonstrate understanding that fusion releases great amounts of energy.</p> <p>The examinee will demonstrate understanding that the Sun is a major source of energy for Earth.</p> <p>The examinee will demonstrate understanding that energy can be transferred through space via radiation.</p> <p>The examinee will demonstrate understanding that different forms of electromagnetic energy have different wavelengths.</p> <p>The examinee will recognize some examples of electromagnetic energy including microwaves, infrared light, visible light, ultraviolet light, X-rays, and gamma rays. (A graphic model of the electromagnetic spectrum should be provided.)</p>
Assessment Limits/Content Constraints	<p><u>Beyond Scope</u></p> <ul style="list-style-type: none"> • Details of the Doppler effect and redshift
DOK(s)	1, 2
Stimulus	A diagram is recommended.

Tools	Scientific calculator provided
Sample Item Stem(s)	Which statement provides evidence that supports the Big Bang theory?

Domain	Earth and Space Sciences
Subdomain	ESS1 Earth's Place in the Universe
Standard	ESS1-3. Communicate scientific ideas about the way stars, over their life cycle, produce elements.
Emphasis Level	Medium
Evidence Statements	<p>The examinee will demonstrate understanding that Earth's Sun is an average-size star.</p> <p>The examinee will demonstrate understanding that the stars differ from each other in size, temperature, and age. (Note: Specific information about different categories of stars must be provided.)</p> <p>The examinee will demonstrate understanding that stars form when gravity causes clouds of molecules to contract until nuclear fusion of light elements into heavier ones occurs.</p> <p>The examinee will demonstrate understanding that the atoms of any one element are different from the atoms of other elements.</p> <p>The examinee will demonstrate understanding that fusion releases great amounts of energy.</p>
Assessment Limits/Content Constraints	<p><u>Beyond Scope</u></p> <ul style="list-style-type: none"> Memorization of the relative size of atoms of various elements
DOK(s)	1, 2
Stimulus	Items should include a chart or data on the characteristics of stars.
Tools	Scientific calculator provided
Sample Item Stem(s)	Which statement <u>best</u> explains how elements are produced within stars?

Domain	Earth and Space Sciences
Subdomain	ESS1 Earth's Place in the Universe
Standard	ESS1-4. Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.
Emphasis Level	High
Evidence Statements	<p>The examinee will demonstrate understanding that the solar system is comprised of a wide array of objects, a few of which can be seen by the unaided eye. Others can be observed only with the use of scientific instruments.</p> <p>The examinee will demonstrate understanding that distances between stars are vast compared to distances within our solar system.</p> <p>The examinee will demonstrate understanding that celestial objects are in motion relative to Earth and each other.</p> <p>The examinee will demonstrate understanding that measurements of the motions of celestial objects vary with the perspective of the observer.</p> <p>The examinee will demonstrate understanding that the Sun and the planets that revolve around it are the major bodies in the solar system. Other bodies include comets, moons, and asteroids.</p> <p>The examinee will demonstrate understanding that planets move around the Sun in nearly circular orbits.</p> <p>The examinee will demonstrate understanding that the orbit of each planet is an ellipse, with the Sun located at one of the foci.</p> <p>The examinee will demonstrate understanding that Earth is orbited by one moon and many artificial satellites.</p> <p>The examinee will demonstrate understanding that gravity influences the motions of celestial objects.</p> <p>The examinee will demonstrate understanding that the force of gravity between two objects in the universe depends on their masses and the distance between them.</p> <p>The examinee will demonstrate understanding that gravity is the force that keeps planets in orbit around the Sun and keeps the moon in orbit around the Earth.</p> <p>The examinee will demonstrate understanding that cyclical changes on Earth are caused by interactions between objects in the universe.</p> <p>The examinee will demonstrate understanding that most objects in the solar system have a regular and predictable motion. These motions explain such phenomena as a day, a year, phases of the Moon, eclipses, tides, meteor showers, and comets.</p>

The examinee will demonstrate understanding that the latitude/longitude coordinate system and our system of time are based on celestial observations.

The examinee will demonstrate understanding that Earth's coordinate system of latitude and longitude, with the equator and prime meridian as reference lines, is based upon Earth's rotation and our observation of the Sun and stars.

The examinee will demonstrate understanding that moons are seen by reflected light.

The examinee will recognize that the Moon orbits Earth, while Earth orbits the Sun.

The examinee will demonstrate understanding that the Moon's phases as observed from Earth are the result of seeing different portions of the lighted area of the Moon's surface.

The examinee will demonstrate understanding that the phases of the Moon repeat in a cyclic pattern in about one month.

The examinee will demonstrate understanding that the apparent motions of the Sun, moon, planets, and stars across the sky can be explained by Earth's rotation and revolution.

The examinee will demonstrate understanding that Earth's rotation causes the length of one day to be approximately 24 hours.

The examinee will demonstrate understanding that rotation provides the basis for our system of local time and meridians of longitude provide the basis for time zones.

The examinee will demonstrate understanding that Earth's rotation causes the Sun and Moon to appear to rise along the eastern horizon and to set along the western horizon.

The examinee will demonstrate understanding that Earth rotates on an imaginary axis at a rate of 15 degrees per hour.

The examinee will demonstrate understanding that more than half of Earth's surface is covered by a relatively thin layer of water, which responds to the gravitational attraction of the Moon and the Sun with a daily cycle of high and low tides.

The examinee will demonstrate understanding that Earth's revolution around the Sun defines the length of the year as 365 1/4 days. Seasonal changes in the apparent positions of constellations provide evidence of Earth's revolution.

The examinee will demonstrate understanding that Earth revolves around the Sun with its rotational axis tilted.

The examinee will demonstrate understanding that the North Pole is aligned with *Polaris*, the North Star.

	<p>The examinee will demonstrate understanding that the tilt of Earth's axis of rotation and the revolution of Earth around the Sun cause seasons on Earth.</p> <p>The examinee will demonstrate understanding that during Earth's one-year period of revolution, the tilt of its axis results in changes in the angle that the Sun's rays strike Earth at a given latitude; these changes cause variation in the heating of Earth's surface, producing seasonal variation in weather.</p> <p>The examinee will demonstrate understanding that the length of daylight varies depending on latitude and season.</p> <p>The examinee will demonstrate understanding that the Sun's apparent path through the sky varies with latitude and season.</p>
Assessment Limits/Content Constraints	<p><u>Beyond Scope</u></p> <ul style="list-style-type: none"> • Numbers and names of moons of planets other than Earth • Kepler's laws
DOK(s)	1, 2
Stimulus	Graphical representations showing orbiting objects in the solar system are recommended. Items may not test mathematical (equations) or computational representations of Kepler's laws; these concepts are <u>beyond the scope</u> of examinees at this time. Items should emphasize Newtonian gravitational laws governing orbital motions.
Tools	Scientific calculator provided
Sample Item Stem(s)	Which statement <u>best</u> describes the orbit of the planets around the sun?

Domain	Earth and Space Sciences
Subdomain	ESS1 Earth's Place in the Universe
Standard	ESS1-5. Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.
Emphasis Level	High
Evidence Statements	<p>The examinee will demonstrate understanding that folded, tilted, faulted, and displaced rock layers suggest past crustal movement.</p> <p>The examinee will demonstrate understanding that continents fitting together like puzzle parts and fossil correlations provided initial evidence that continents were once together.</p> <p>The examinee will demonstrate understanding that the theory of plate tectonics explains how the "solid" lithosphere consists of a series of plates that "float" on the partially molten layer of Earth's interior.</p> <p>The examinee will demonstrate understanding that the lithosphere consists of separate plates that ride on the partially molten layer of Earth's interior and move slowly in relationship to one another.</p> <p>The examinee will demonstrate understanding that plates may collide, move apart, or slide past one another.</p> <p>The examinee will recognize that compared to continental crust, oceanic crust is thinner and denser. (Crust density information should be provided.)</p> <p>The examinee will recognize that new oceanic crust continues to form at mid-ocean ridges.</p> <p>The examinee will demonstrate understanding that convection cells within the mantle may be the driving force for the movement of the tectonic plates. (A diagram showing convection cells should be provided.)</p> <p>The examinee will demonstrate understanding that the outward transfer of Earth's internal heat drives convective circulation in the mantle, which moves the lithospheric plates comprising Earth's surface.</p> <p>The examinee will demonstrate understanding that differences in density resulting from heat flow within Earth's interior caused the changes explained by the theory of plate tectonics. These changes include the following:</p> <ul style="list-style-type: none"> • Movement of the lithospheric plates • Earthquakes • Volcanoes • Deformation and metamorphism of rocks during the formation of young mountains

The examinee will demonstrate understanding that most volcanic activity and mountain building occur at the boundaries of the tectonic plates, often resulting in earthquakes.

The examinee will demonstrate understanding that many processes of the rock cycle are consequences of plate motion, such as the production of magma (and subsequent igneous rock formation and contact metamorphism) at both subduction and rifting regions and regional metamorphism within subduction zones.

The examinee will demonstrate understanding that many of Earth's surface features—such as mid-ocean ridges/rifts, trenches/subduction zones/ island arcs, mountain ranges (folded, faulted, and volcanic), and hot spots—are consequences of forces associated with plate motion and interaction.

The examinee will demonstrate understanding that plate motions have resulted in global changes in geography, climate, and the patterns of organic evolution.

The examinee will demonstrate understanding that landforms are the result of the interaction of tectonic forces and the processes of weathering, erosion, and deposition.

The examinee will demonstrate understanding that rocks are composed of minerals.

The examinee will demonstrate understanding that only a few rock-forming minerals make up most of the rocks of Earth.

The examinee will demonstrate understanding that minerals are the naturally occurring inorganic solid elements, compounds, and mixtures from which rocks are made.

The examinee will demonstrate understanding that minerals are classified on the basis of their chemical composition and observable properties.

The examinee will demonstrate understanding that minerals can be identified by well-defined physical and chemical properties, such as cleavage, fracture, color, density, hardness, streak, luster, crystal shape, and reaction with acid.

The examinee will demonstrate understanding that rocks are generally classified by their method of formation (igneous, metamorphic, or sedimentary), texture, and mineral content.

The examinee will demonstrate understanding that minerals are formed inorganically by the process of crystallization as a result of specific environmental conditions including the following:

- Cooling and solidification of magma
- Precipitation from water caused by such processes as evaporation, chemical reactions, and temperature changes
- Rearrangement of atoms in existing minerals subjected to conditions of high temperature and pressure

	<p>The examinee will demonstrate understanding that rocks are usually composed of one or more minerals.</p> <p>The examinee will demonstrate understanding that rocks are classified by their origin, mineral content, and texture.</p> <p>The examinee will recognize that conditions that existed when a rock formed can be inferred from the rock's mineral content and texture.</p> <p>The examinee will recognize that rocks and minerals help us understand Earth's historical development and its processes.</p> <p>The examinee will demonstrate understanding that the three classes of rocks are sedimentary, metamorphic, and igneous.</p> <p>The examinee will demonstrate understanding that sedimentary rocks form when sediments are compacted and/or cemented after burial, or as the result of chemical precipitation from seawater.</p> <p>The examinee will demonstrate understanding that most rocks show characteristics that give clues to their formation conditions.</p> <p>The examinee will demonstrate understanding of the rock cycle model showing how types of rock or rock material may be transformed from one type of rock to another.</p>
Assessment Limits/Content Constraints	<p><u>Beyond Scope</u></p> <ul style="list-style-type: none"> • Knowledge of specific tectonic plates, faults, and plate movements • Definition of divergent, convergent, transforming, and subduction • Identification of Earth's interior layers: asthenosphere, mantle, outer core, inner core • Identification of specific rocks or minerals
DOK(s)	1, 2
Stimulus	<p>Most items should include a chart, data table, graphical representation, or map.</p> <ul style="list-style-type: none"> • A model/diagram of the rock cycle must be provided with items about the rock cycle. • A rock identification chart must be provided for items about specific rock types. • A chart showing mineral properties must be provided for items about specific types of minerals. • Maps of current and historical tectonic plate movements should be provided with most items on plate tectonics.
Tools	Scientific calculator provided
Sample Item Stem(s)	Based on the information in the diagram, which layer of crustal rock is the oldest?

Domain	Earth and Space Sciences
Subdomain	ESS1 Earth's Place in the Universe
Standard	ESS1-6. Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history.
Emphasis Level	Medium
Evidence Statements	<p>The examinee will demonstrate understanding that the solar system formed about five billion years ago from a giant cloud of gas and debris.</p> <p>The examinee will demonstrate understanding that gravity caused Earth and the other planets to become layered according to density differences in their materials.</p> <p>The examinee will demonstrate understanding that the characteristics of the planets of the solar system are affected by each planet's location in relationship to the Sun.</p> <p>The examinee will demonstrate understanding that the inner planets are small, rocky, and dense, and the outer planets are large, gaseous, and of low density.</p> <p>The examinee will demonstrate understanding that asteroids, comets, and meteors are components of our solar system.</p> <p>The examinee will demonstrate understanding that impact events have been correlated with mass extinction and global climatic change.</p> <p>The examinee will recognize that impact craters can be identified in Earth's crust.</p> <p>The examinee will demonstrate understanding that Earth's early atmosphere formed as a result of the outgassing of water vapor, carbon dioxide, nitrogen, and lesser amounts of other gases from its interior.</p> <p>The examinee will demonstrate understanding that Earth's oceans formed as a result of precipitation over millions of years.</p> <p>The examinee will demonstrate understanding that the presence of an early ocean is indicated by sedimentary rocks of marine origin dating back about four billion years.</p> <p>The examinee will demonstrate understanding that the evolution of life caused dramatic changes in the composition of Earth's atmosphere. (Note: Atmospheric composition data should be provided.)</p> <p>The examinee will demonstrate understanding that free oxygen did not form in the atmosphere until oxygen-producing organisms evolved.</p> <p>The examinee will demonstrate understanding that geologic history can be reconstructed by observing sequences of rock types and fossils to correlate bedrock at various locations.</p>

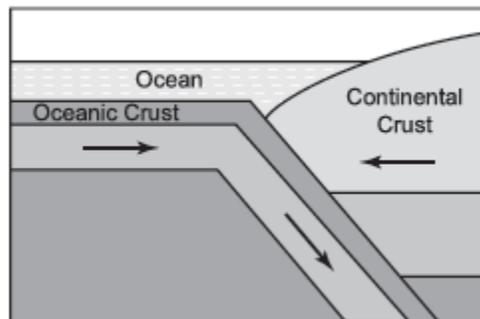
	<p>The examinee will demonstrate understanding that the characteristics of rocks indicate the processes by which they formed and the environments in which these processes took place.</p> <p>The examinee will recognize that rocks and minerals help us understand Earth's historical development and its processes.</p> <p>The examinee will recognize that geologists have divided Earth history into time units based upon the fossil record. (Note: Geologic eras must be defined.)</p> <p>The examinee will demonstrate understanding that the presence of volcanic ash layers, index fossils, and meteoritic debris can provide information to reconstruct geologic history.</p> <p>The examinee will recognize that fossils are usually found in sedimentary rocks.</p> <p>The examinee will demonstrate understanding that fossils can be used to study past climates and environments.</p> <p>The examinee will demonstrate understanding that running water erodes mountains that were originally uplifted by Earth's internal heat energy and transports sediments to other locations, where they are deposited and may undergo the processes that transform them into sedimentary rocks.</p> <p>The examinee will demonstrate understanding that the regular rate of nuclear decay (half-life time period) of radioactive isotopes allows geologists to determine the absolute age of materials found in some rocks. (Note: Specific information about half-life must be provided.)</p>
Assessment Limits/Content Constraints	<p><u>Beyond Scope</u></p> <ul style="list-style-type: none"> • Identification of the names of geologic eras, periods, and epochs
DOK(s)	2
Stimulus	Items should include a data table or chart. Specific planetary information must be included in a chart or table.
Tools	Scientific calculator provided
Sample Item Stem(s)	Which planet is <u>most</u> like Earth, based on the information in the chart?

Domain	Earth and Space Sciences
Subdomain	ESS2 Earth's Systems
Standard	ESS2-1. Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.
Emphasis Level	Medium
Evidence Statements	<p>The examinee will demonstrate understanding that topographic maps represent landforms through the use of contour lines that are isolines connecting points of equal elevation.</p> <p>The examinee will demonstrate understanding that gradients and profiles can be determined from changes in elevation over a given distance. (Note: The equation for gradient will be supplied.)</p> <p>The examinee will demonstrate understanding that the rock at Earth's surface forms a nearly continuous shell around Earth called the lithosphere.</p> <p>The examinee will demonstrate understanding that heat flow and movement of material within Earth cause sections of Earth's crust to move. This may result in earthquakes, volcanic eruption, and creation of mountains and ocean basins.</p> <p>The examinee will demonstrate understanding that the theory of plate tectonics explains how the "solid" lithosphere consists of a series of plates that "float" on the partially molten section of the mantle.</p> <p>The examinee will demonstrate understanding that convection cells within the mantle may be the driving force for the movement of the tectonic plates.</p> <p>The examinee will demonstrate understanding that plates may collide, move apart, or slide past one another.</p> <p>The examinee will demonstrate understanding that most volcanic activity and mountain building occur at the boundaries of the tectonic plates, often resulting in earthquakes.</p> <p>The examinee will demonstrate understanding that folded, tilted, faulted, and displaced rock layers suggest past crustal movement.</p> <p>The examinee will demonstrate understanding that continents fitting together like puzzle parts and fossil correlations provided initial evidence that continents were once together. (Note: Maps of current and historical tectonic plate movements will be provided.)</p>

	The examinee will demonstrate understanding that climate variations, structure, and characteristics of bedrock influence the development of landscape features including mountains, plateaus, plains, valleys, ridges, escarpments, and stream drainage patterns.
Assessment Limits/Content Constraints	Beyond Scope <ul style="list-style-type: none"> • Knowledge of specific tectonic plates, faults, and plate movements • Memorization of the gradient equation
DOK(s)	1, 2
Stimulus	A diagram is recommended.
Tools	Scientific calculator provided
Sample Item Stem(s)	Which of these features provides evidence of past crustal movement?

Sample Item

The diagram shows a cross-section of an area where two tectonic plates of Earth's surface are moving toward each other. The leading edge of one tectonic plate has oceanic crust, while the leading edge of the other tectonic plate has continental crust.



Several types of geological features would be predicted to form over time in the area shown in the diagram. Which geological feature would not be predicted to occur in this area?

- A. volcanoes
- B. mountains
- C. ocean ridge
- D. ocean trench

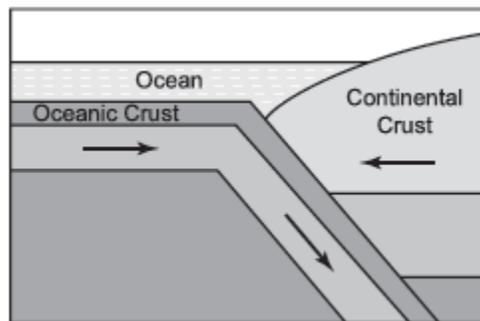
Domain	Earth and Space Sciences
Subdomain	ESS2 Earth's Systems
Standard	ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.
Emphasis Level	Low
Evidence Statements	<p>The examinee will demonstrate understanding that Earth is a set of closely interrelated systems that provide the framework to investigate four major interacting components: lithosphere or geosphere (land), hydrosphere (water), atmosphere (air), and biosphere (life).</p> <p>The examinee will demonstrate understanding that processes act within and between the lithosphere, hydrosphere, atmosphere, and biosphere on a wide range of time scales to bring about continuous change in Earth's crust, oceans, air, and living organisms.</p> <p>The examinee will demonstrate understanding that the atmosphere, hydrosphere, lithosphere, and biosphere interact, evolve, and change.</p> <p>The examinee will demonstrate understanding that water circulates through the atmosphere, lithosphere, biosphere, and hydrosphere in what is known as the water cycle.</p> <p>The examinee will demonstrate understanding that the evolution of life caused dramatic changes in the composition of Earth's atmosphere.</p> <p>The examinee will demonstrate understanding that free oxygen did not form in the atmosphere until oxygen-producing organisms evolved.</p> <p>The examinee will demonstrate understanding that populations living in one place form a community. The community and the physical factors with which it interacts compose an ecosystem.</p>
Assessment Limits/Content Constraints	<p><u>Beyond Scope</u></p> <ul style="list-style-type: none"> The terms "lithosphere," "geosphere," and "biosphere" need to be defined within the item, if included.
DOK(s)	2
Stimulus	Most items should include a data table.
Tools	Scientific calculator provided
Sample Item Stem(s)	Based on the diagram, how would an increase in precipitation <u>most likely</u> affect the geosphere?

Domain	Earth and Space Sciences
Subdomain	ESS2 Earth's Systems
Standard	ESS2-3. Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.
Emphasis Level	Medium
Evidence Statements	<p>The examinee will demonstrate understanding that Earth systems have internal and external sources of energy, both of which create heat.</p> <p>The examinee will demonstrate understanding that Earth's internal energy is in the form of heat from the decay of radioactive materials and residual heat from Earth's formation.</p> <p>The examinee will demonstrate understanding that differences in density resulting from heat flow within Earth's interior cause the changes explained by the theory of plate tectonics. These changes include the following:</p> <ul style="list-style-type: none"> • Movement of the lithospheric plates • Earthquakes • Volcanoes <p>The examinee will demonstrate understanding that the rock at Earth's surface forms a nearly continuous shell around Earth called the lithosphere. (Note: Lithosphere should be defined by way of a model.)</p> <p>The examinee will demonstrate understanding that heat flow and movement of material within Earth cause sections of Earth's crust to move and sometimes break apart. This may result in earthquakes, volcanic eruption, and creation of mountains and ocean basins.</p> <p>The examinee will demonstrate understanding that the analysis of earthquake waves allows the determination of the location of earthquake epicenters and the measurement of earthquake magnitude. (Note: Seismic wave graph should be supplied.)</p> <p>The examinee will demonstrate understanding that the analysis of earthquake waves leads to the inference that Earth's interior is composed of layers that differ in composition and states of matter.</p> <p>The examinee will demonstrate understanding about how the theory of plate tectonics explains how the "solid" lithosphere consists of a series of plates that "float" on the partially molten section of the mantle. (Note: Maps of current and historical tectonic plate movements should be supplied.)</p> <p>The examinee will recognize that plates may collide, move apart, or slide past one another. (Note: Maps of current and historical tectonic plate movements should be supplied.)</p> <p>The examinee will demonstrate understanding that most volcanic activity and mountain building occur at the boundaries of the tectonic plates, often resulting in earthquakes.</p>

	<p>The examinee will demonstrate understanding that folded, tilted, faulted, and displaced rock layers suggest past crustal movement.</p> <p>The examinee will demonstrate understanding that continents fitting together like puzzle parts and fossil correlations provided initial evidence that continents were once together. (Note: Maps of current and historical tectonic plate movements should be supplied.)</p>
Assessment Limits/Content Constraints	<p>Beyond Scope</p> <ul style="list-style-type: none"> • Knowledge of specific tectonic plates, faults, and plate movements
DOK(s)	2
Stimulus	A graphical model/illustration is recommended.
Tools	Scientific calculator provided
Sample Item Stem(s)	Which of Earth's internal processes is <u>most likely</u> responsible for earthquakes?

Sample Item

The diagram shows a cross-section of an area where two tectonic plates of Earth's surface are moving toward each other. The leading edge of one tectonic plate has oceanic crust, while the leading edge of the other tectonic plate has continental crust.



Which of these could explain the motion of the tectonic plates shown in the diagram?

- rotation of Earth's axis
- currents within Earth's ocean
- convection of material within Earth's interior
- gravitational pull of the Sun and Moon on Earth's surface

Domain	Earth and Space Sciences
Subdomain	ESS2 Earth's Systems
Standard	ESS2-4. Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.
Emphasis Level	High
Evidence Statements	<p>The examinee will demonstrate understanding that Earth systems have internal and external sources of energy, both of which create heat.</p> <p>The examinee will demonstrate understanding that Earth's external heat is powered primarily by solar energy and influenced by gravity.</p> <p>The examinee will demonstrate understanding that nearly all the energy for circulating the atmosphere and oceans is supplied by the Sun. As the Sun's radiation strikes the atmosphere, a small percentage is directly absorbed, especially by gases such as ozone, carbon dioxide, and water vapor clouds. Earth's surface absorbs some energy and reflects some energy back to space.</p> <p>The examinee will recognize that energy is transferred between Earth's surface and the atmosphere by radiation, conduction, convection, and evaporation.</p> <p>The examinee will demonstrate understanding that the heating of Earth's surface and atmosphere by the Sun drives convection within the atmosphere and oceans, producing winds and ocean currents.</p> <p>The examinee will demonstrate understanding that a location's climate is influenced by latitude, nearness to large bodies of water, ocean currents, prevailing winds, vegetative cover, elevation, and mountain ranges.</p> <p>The examinee will demonstrate understanding that temperature and precipitation patterns are altered by natural events, such volcanic eruptions, and human influences, including deforestation, urbanization, and production of greenhouse gases such as carbon dioxide and methane.</p> <p>The examinee will demonstrate understanding that temperature variations within the atmosphere cause differences in density that cause atmospheric circulation, which is affected by Earth's rotation.</p> <p>The examinee will recognize that Earth has had climate changes. Throughout geologic time, ice ages occurred. (Note: Geologic eras should be supplied.) Average temperatures may have been significantly warmer at times in the geologic past.</p> <p>The examinee will demonstrate understanding that nearly all the atmosphere is confined to a thin shell surrounding Earth.</p> <p>The examinee will recognize that the atmosphere is a mixture of gases. (Note: Atmospheric content should be supplied.)</p>

The examinee will demonstrate understanding that weather describes the conditions of the atmosphere at a given location for a short period of time.

The examinee will demonstrate understanding that climate is the characteristic weather pattern that occurs over a long period of time.

The examinee will demonstrate understanding that the uneven heating of Earth's surface is the cause of weather and climate conditions.

The examinee will demonstrate understanding that during Earth's one-year period of revolution, the tilt of its axis results in changes in the angle of the Sun's rays that strike Earth at a given latitude; these changes cause variation in the heating of the surface producing seasonal variation in weather.

The examinee will demonstrate understanding that weather patterns become evident when weather variables are observed, measured, and recorded.

The examinee will demonstrate understanding of weather variables. These variables may include the following:

- Air temperature
- Air pressure
- Moisture (relative humidity and dew point)
- Precipitation (rain, snow, hail, sleet, etc.)
- Wind speed and direction
- Cloud cover

The examinee will recognize that weather variables are measured using instruments such as thermometers, barometers, and precipitation gauges.

The examinee will demonstrate understanding that weather variables are interrelated. For example, temperature and humidity affect air pressure and probability of precipitation.

The examinee will demonstrate understanding that weather variables can be represented in a variety of formats, including radar and satellite images, weather maps, and computer models.

The examinee will demonstrate understanding that air masses form when air remains nearly stationary over a large section of Earth's surface and takes on the conditions of temperature and humidity from that location.

The examinee will demonstrate understanding that weather conditions at a location are determined primarily by temperature, humidity, and pressure of air masses over that location.

The examinee will demonstrate understanding that the movement of air masses is determined by prevailing winds and upper air currents.

The examinee will demonstrate understanding that most local weather condition changes are caused by movement of air masses.

	<p>The examinee will recognize that fronts are boundaries between air masses. (Note: Key to weather symbols should be supplied.)</p> <p>The examinee will demonstrate understanding that precipitation is likely to occur at the boundaries of fronts.</p> <p>The examinee will demonstrate understanding that high-pressure systems generally bring fair weather and low-pressure systems generally bring cloudy, unstable conditions.</p> <p>The examinee will recognize that the general movement of highs and lows is from west to east across the United States.</p> <p>The examinee will recognize hazardous weather conditions including thunderstorms, tornadoes, hurricanes, ice storms, and blizzards.</p> <p>The examinee will demonstrate understanding that observable patterns occur for atmospheric conditions. These observable patterns may be identified in the following:</p> <ul style="list-style-type: none"> • Moisture • Temperature and air pressure distributions • Jet streams and wind • Air masses and frontal boundaries • Tornadoes, thunderstorms, and hurricanes <p>The examinee will demonstrate understanding that as altitude increases, air pressure decreases.</p> <p>The examinee will demonstrate understanding that substances that can affect weather, climate, and living things enter the atmosphere naturally (e.g., dust from volcanic eruptions) and from human activity (e.g., greenhouse gases, such as carbon dioxide and methane).</p>
Assessment Limits/Content Constraints	<p><u>Beyond Scope</u></p> <ul style="list-style-type: none"> • Insolation
DOK(s)	1, 2, 3
Stimulus	A data table, chart, or graphical model is recommended.
Tools	Scientific calculator provided
Sample Item Stem(s)	Based on the weather map, which area is <u>most likely</u> to experience hazardous weather conditions and why?

Domain	Earth and Space Sciences
Subdomain	ESS2 Earth's Systems
Standard	ESS2-5. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.
Emphasis Level	High
Evidence Statements	<p>The examinee will demonstrate understanding that the rock at Earth's surface forms a nearly continuous shell around Earth called the lithosphere. (Note: Lithosphere should be defined by way of a model.)</p> <p>The examinee will demonstrate understanding that the majority of the lithosphere is covered by a relatively thin layer of water called the hydrosphere.</p> <p>The examinee will demonstrate understanding that water circulates through the atmosphere, lithosphere, and hydrosphere in what is known as the water cycle. Water is returned from the atmosphere to Earth's surface by precipitation. Water returns to the atmosphere by evaporation or transpiration from plants. A portion of precipitation becomes runoff over the land or seeps into the ground to become stored in the soil as groundwater below the water table.</p> <p>The examinee will demonstrate understanding that the amount of precipitation that seeps into the ground or runs off is influenced by climate, slope of the land, soil, rock type, vegetation, land use, and amount of water in the soil.</p> <p>The examinee will demonstrate understanding that the processes that transform Earth's surface include weathering and erosion.</p> <p>The examinee will demonstrate understanding that precipitation supplies the moisture to Earth's surface that contributes to the weathering of rocks.</p> <p>The examinee will demonstrate understanding that the process of weathering breaks down rocks to form sediment.</p> <p>The examinee will demonstrate understanding that weathering is the physical and chemical breakdown of rocks at or near Earth's surface.</p> <p>The examinee will demonstrate understanding that natural agents of erosion, generally driven by gravity, can remove, transport, and deposit weathered rock particles.</p> <p>The examinee will demonstrate understanding that running water erodes mountains that were originally uplifted by Earth's internal heat. Water transports sediments to other locations, where they are deposited and may undergo the processes that transform them into sedimentary rocks.</p> <p>The examinee will demonstrate understanding that soil consists of sediment, organic material, water, and air.</p>

	<p>The examinee will demonstrate understanding that erosion is the transport of sediment.</p> <p>The examinee will demonstrate understanding that there are several natural agents of erosion. These natural agents include the following:</p> <ul style="list-style-type: none"> • Streams (running water): Sediments transported by streams tend to become rounded as a result of abrasion. Stream features include V-shaped valleys, deltas, and flood plains. A watershed is the area drained by a stream and its tributaries. • Glaciers (moving ice): Glacial erosional processes include the formation of U-shaped valleys, parallel scratches, and grooves in bedrock. Glacial deposits form distinct surface features. • Wave action: Erosion and deposition cause continuous changes in shoreline features, including beaches, sandbars, and barrier islands. Sediments become rounded as a result of abrasion. • Wind: Erosion of sediments by wind is most common in arid climates and along shorelines. Wind-generated features include dunes and sand-blasted bedrock. • Mass movement: Earth materials move downslope under the influence of gravity. Common examples of mass movement include landslides, avalanches, and mudslides. <p>The examinee will demonstrate understanding that sedimentary rocks form when sediments are compacted and/or cemented after burial, or as the result of chemical precipitation from seawater.</p> <p>The examinee will demonstrate understanding that landforms are the result of the interaction of tectonic forces and the processes of weathering, erosion, and deposition.</p>
Assessment Limits/Content Constraints	<p><u>Beyond Scope</u></p> <ul style="list-style-type: none"> • Definitions of meanders, moraines, kames, eskers, drumlins, kettle lakes, finger lakes, and outwash plains: these terms and concepts could be included in items, provided there is an explanation of the terminology
DOK(s)	2
Stimulus	Graphics/illustrations are recommended, especially if showing landforms influenced by water.
Tools	Scientific calculator provided
Sample Item Stem(s)	Which statement <u>best</u> describes how weathering and erosion work together to shape a river delta?

Domain	Earth and Space Sciences
Subdomain	ESS2 Earth's Systems
Standard	ESS2-6. Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.
Emphasis Level	Medium
Evidence Statements	<p>The examinee will demonstrate understanding that all organic matter contains carbon.</p> <p>The examinee will demonstrate understanding that matter is recycled in ecosystems.</p> <p>The examinee will demonstrate understanding that energy and matter flow from one organism to another.</p> <p>The examinee will demonstrate understanding that matter is transferred from one organism to another and between organisms and their physical environment.</p> <p>The examinee will recognize that water, carbon dioxide, and oxygen are examples of substances cycled between the living and nonliving environments.</p> <p>The examinee will demonstrate understanding that the major source of atmospheric oxygen is photosynthesis.</p> <p>The examinee will demonstrate understanding that carbon dioxide is removed from the atmosphere and oxygen is released during photosynthesis.</p>
Assessment Limits/Content Constraints	<p><u>Beyond Scope</u></p> <ul style="list-style-type: none"> n/a
DOK(s)	2
Stimulus	Data tables or graphics/illustrations are recommended.
Tools	Scientific calculator provided
Sample Item Stem(s)	As carbon moves through the carbon cycle as shown in the diagram, where are the largest reserves of carbon stored?

Domain	Earth and Space Sciences
Subdomain	ESS2 Earth's Systems
Standard	ESS2-7. Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.
Emphasis Level	Low
Evidence Statements	<p>The examinee will demonstrate understanding that the evolution of life caused dramatic changes in the composition of Earth's atmosphere.</p> <p>The examinee will demonstrate understanding that free oxygen did not form in the atmosphere until oxygen-producing organisms evolved. (Note: Geologic history should be supplied.)</p> <p>The examinee will demonstrate understanding that fossils are usually found in sedimentary rocks.</p> <p>The examinee will demonstrate understanding that fossils can be used to study past climates and environments. The pattern of evolution of life-forms on Earth is at least partially preserved in the rock record.</p> <p>The examinee will demonstrate understanding that fossil evidence indicates that a wide variety of life-forms has existed in the past and that most of these forms have become extinct.</p> <p>The examinee will demonstrate understanding that human existence has been very brief, compared to the expanse of geologic time.</p>
Assessment Limits/Content Constraints	<p><u>Beyond Scope</u></p> <ul style="list-style-type: none"> n/a
DOK(s)	2
Stimulus	A data table or graph is recommended.
Tools	Scientific calculator provided
Sample Item Stem(s)	Which conclusion is <u>best</u> supported by the fossil record shown?

Domain	Earth and Space Sciences
Subdomain	ESS3 Earth and Human Activity
Standard	ESS3-1. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
Emphasis Level	Low
Evidence Statements	<p>The examinee will demonstrate understanding that the use and distribution of mineral resources and fossil fuels have important economic, climatic, and environmental effects.</p> <p>The examinee will recognize hazardous weather conditions including thunderstorms, tornadoes, hurricanes, storm surges, ice storms, and blizzards.</p> <p>The examinee will recognize hazardous geologic events including volcanic eruptions and earthquakes.</p> <p>The examinee will demonstrate understanding that the survival of living things on our planet depends on the conservation and protection of Earth's resources.</p>
Assessment Limits/Content Constraints	<p><u>Beyond Scope</u></p> <ul style="list-style-type: none"> n/a
DOK(s)	2
Stimulus	A data table or graph is recommended.
Tools	Scientific calculator provided
Sample Item Stem(s)	Which factor <u>most</u> influenced where early humans first settled?

Domain	Earth and Space Sciences
Subdomain	ESS3 Earth and Human Activity
Standard	ESS3-2. Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.
Emphasis Level	Low
Evidence Statements	<p>The examinee will demonstrate understanding that the Sun is a major source of energy for Earth. Other sources of energy include nuclear and geothermal energy.</p> <p>The examinee will demonstrate understanding that fossil fuels contain stored solar energy and are considered nonrenewable resources.</p> <p>The examinee will demonstrate understanding that fossil fuels are a major source of energy in the United States.</p> <p>The examinee will recognize that solar energy, geothermal energy, wind, moving water, and biomass are some examples of renewable energy resources.</p> <p>The examinee will recognize that energy can change from one form to another, although, in the process, some energy is always converted to heat.</p> <p>The examinee will demonstrate understanding that some systems transform energy with less loss of heat than others.</p> <p>The examinee will demonstrate understanding that the use and distribution of mineral resources and fossil fuels have important economic and environmental impacts.</p> <p>The examinee will demonstrate understanding that chemical composition and physical properties determine how minerals are used by humans.</p> <p>The examinee will demonstrate understanding that the properties of rocks determine how they are used and also influence land usage by humans.</p> <p>The examinee will demonstrate understanding that as limited resources, mineral resources and fossil fuels must be used wisely.</p>
Assessment Limits/Content Constraints	<p><u>Beyond Scope</u></p> <ul style="list-style-type: none"> • Calculations
DOK(s)	2
Stimulus	A data table, graph, or chart is recommended.
Tools	Scientific calculator provided
Sample Item Stem(s)	Which energy sources are considered renewable and why?

Domain	Earth and Space Sciences
Subdomain	ESS3 Earth and Human Activity
Standard	ESS3-3. Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.
Emphasis Level	Low
Evidence Statements	<p>The examinee will demonstrate understanding that to ensure the survival of life on Earth, people have a responsibility to consider the effects of their actions on the environment.</p> <p>The examinee will demonstrate understanding that all organisms interact with one another and are dependent upon their physical environment.</p> <p>The examinee will demonstrate understanding that a lack of resources, habitat destruction, and other factors, such as the presence of predators and climate, limit the growth of certain populations in the ecosystem.</p> <p>The examinee will demonstrate understanding that the environment may contain dangerous levels of substances that are harmful to organisms (pollutants).</p> <p>The examinee will demonstrate understanding that since the Industrial Revolution, human activities have resulted in major pollution of air, water, and soil.</p> <p>The examinee will demonstrate understanding that pollution has ecological effects that add up over time, such as acid rain, global warming, or ozone depletion.</p> <p>The examinee will demonstrate understanding that the good health of environments and individuals requires the monitoring of soil, air, and water and taking steps to keep them safe.</p> <p>The examinee will demonstrate understanding that the survival of living things on our planet depends on the conservation and protection of Earth's resources.</p>
Assessment Limits/Content Constraints	<p><u>Beyond Scope</u></p> <ul style="list-style-type: none"> • Calculations • Creating a computational simulation
DOK(s)	2
Stimulus	A data table, graph, or chart is recommended.
Tools	Scientific calculator provided
Sample Item Stem(s)	Which factor would <u>most likely</u> lead to a decrease in the fish species at this location?

Domain	Earth and Space Sciences
Subdomain	ESS3 Earth and Human Activity
Standard	ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
Emphasis Level	Medium
Evidence Statements	<p>The examinee will demonstrate understanding that to ensure the survival of life on Earth, people have a responsibility to consider the effects of their actions on the environment.</p> <p>The examinee will demonstrate understanding that all organisms interact with one another and are dependent upon their physical environment.</p> <p>The examinee will demonstrate understanding that balance within ecosystems is the result of interactions between community members and their environment.</p> <p>The examinee will demonstrate understanding that the environment may be altered through the activities of organisms. Alterations are sometimes abrupt.</p> <p>The examinee will demonstrate understanding that overpopulation by any species affects the environment, due to the increased use of resources.</p> <p>The examinee will demonstrate understanding that human activities can bring about environmental degradation. These activities may include the following:</p> <ul style="list-style-type: none"> • Resource acquisition • Urban growth • Land-use decisions • Waste disposal <p>The examinee will demonstrate understanding that the number of organisms an ecosystem can support depends on factors influencing resource availability and other physical factors. These factors may include the following:</p> <ul style="list-style-type: none"> • Quantity of light, air, and water • Range of temperatures • Soil composition <p>The examinee will demonstrate understanding that a lack of resources, habitat destruction, and other factors such as the presence of predators and climate limit the growth of certain populations in the ecosystem.</p> <p>The examinee will demonstrate understanding that the environment may contain dangerous levels of substances that are harmful to organisms (pollutants).</p> <p>The examinee will demonstrate understanding that since the Industrial Revolution, human activities have resulted in major pollution of air, water, and soil.</p>

	<p>The examinee will demonstrate understanding that pollution has ecological effects that add up over time such as acid rain, global warming, or ozone depletion.</p> <p>The examinee will demonstrate understanding that the good health of environments and individuals requires the monitoring of soil, air, and water, and taking steps to keep them safe.</p> <p>The examinee will demonstrate understanding that the survival of living things on our planet depends on the conservation and protection of Earth's resources.</p>
Assessment Limits/Content Constraints	<p><u>Beyond Scope</u></p> <ul style="list-style-type: none"> n/a
DOK(s)	2, 3
Stimulus	A data table, graph, or chart is recommended.
Tools	Scientific calculator provided
Sample Item Stem(s)	What will <u>most likely</u> happen to the environment if a single species becomes too abundant?

Sample item

Which of these solutions would best help reduce the amount of carbon dioxide released into the atmosphere by human activities?

- using rechargeable batteries in small electrical devices
- finding more sources of fossil fuels to extract through drilling and mining
- manufacturing more vehicles, such as cars and trucks, for use in transportation
- using more alternative energy sources, such as solar and wind, to produce electricity

Domain	Earth and Space Sciences
Subdomain	ESS3 Earth and Human Activity
Standard	ESS3-5. Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.
Emphasis Level	High
Evidence Statements	<p>The examinee will demonstrate understanding that weather describes the conditions of the atmosphere at a given location for a short period of time.</p> <p>The examinee will demonstrate understanding that climate is the characteristic weather pattern that occurs over a long period of time.</p> <p>The examinee will demonstrate understanding that the uneven heating of Earth’s surface is the cause of weather.</p> <p>The examinee will demonstrate understanding that during Earth’s one-year period of revolution, the tilt of its axis results in changes in the angle of incidence of the Sun’s rays at a given latitude; these changes cause variation in the heating of the surface, producing seasonal variation in weather.</p> <p>The examinee will demonstrate understanding that the heating of Earth’s surface and atmosphere by the Sun drives convection within the atmosphere and oceans, producing winds and ocean currents.</p> <p>The examinee will demonstrate understanding that a location’s climate is influenced by latitude, nearness to large bodies of water, ocean currents, prevailing winds, vegetative cover, elevation, and mountain ranges.</p> <p>The examinee will demonstrate understanding that temperature and precipitation patterns are altered by natural events (e.g., volcanic eruptions) and human influences (e.g., deforestation, urbanization, and the production of greenhouse gases such as carbon dioxide and methane).</p> <p>The examinee will recognize that weather patterns become evident when weather variables are observed, measured, and recorded.</p> <p>The examinee will demonstrate understanding of weather variables. These variables may include the following:</p> <ul style="list-style-type: none"> • Air temperature • Air pressure • Moisture (relative humidity and dew point) • Precipitation (rain, snow, hail, sleet, etc.) • Wind speed and direction • Cloud cover

The examinee will recognize that weather variables are measured using instruments such as thermometers, barometers, and precipitation gauges.

The examinee will demonstrate understanding that weather variables are interrelated. Temperature and humidity affect air pressure and probability of precipitation. Air pressure gradients control wind velocity. Weather variables can be represented in a variety of formats including radar and satellite images, weather maps, and computer models.

The examinee will demonstrate understanding that air masses form when air remains nearly stationary over a large section of Earth's surface and takes on the conditions of temperature and humidity from that location.

The examinee will demonstrate understanding that weather conditions at a location are determined primarily by temperature, humidity, and pressure of air masses over that location.

The examinee will demonstrate understanding that most local weather condition changes are caused by movement of air masses.

The examinee will demonstrate understanding that the movement of air masses is determined by prevailing winds and upper air currents.

The examinee will recognize that fronts are boundaries between air masses.

The examinee will demonstrate understanding that precipitation is likely to occur at the boundaries of fronts.

The examinee will demonstrate understanding that high-pressure systems generally bring fair weather, and low-pressure systems usually bring cloudy, unstable conditions.

The examinee will demonstrate understanding that the general movement of highs and lows is from west to east across the United States.

The examinee will demonstrate understanding that substances enter the atmosphere naturally and from human activity, and can affect weather, climate, and living things.

The examinee will recognize hazardous weather conditions including thunderstorms, tornadoes, hurricanes, ice storms, and blizzards.

	<p>The examinee will demonstrate understanding that observable patterns on Earth occur due to several factors. These factors may include the following:</p> <ul style="list-style-type: none"> • Atmospheric moisture • Temperature and pressure distributions • Jet streams • Wind • Air masses and frontal boundaries • Tornadoes • Thunderstorms • Hurricanes <p>The examinee will demonstrate understanding that loss of property, personal injury, and loss of life can be reduced by effective emergency preparedness.</p>
Assessment Limits/Content Constraints	<p><u>Beyond Scope</u></p> <ul style="list-style-type: none"> • Layers of the atmosphere • Comprehensive data analyses
DOK(s)	2
Stimulus	A data table, graph, or chart is recommended
Tools	Scientific calculator provided
Sample Item Stem(s)	Which of these <u>most likely</u> describes the climate of the region?

Domain	Earth and Space Sciences
Subdomain	ESS3 Earth and Human Activity
Standard	ESS3-6. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.
Emphasis Level	Medium
Evidence Statements	<p>The examinee will demonstrate understanding that Earth is a complex system of interacting rock, water, air, and life.</p> <p>The examinee will demonstrate understanding that cycles (such as the water cycle, the rock cycle, the carbon cycle, and others) involve the interactions of Earth's systems.</p> <p>The examinee will recognize that water, carbon dioxide, and oxygen are examples of substances cycled between the living and nonliving environments.</p> <p>The examinee will demonstrate understanding that substances that can affect weather, climate, and living things enter the atmosphere naturally and from human activity. Volcanic eruptions release large amounts of ash and dust. Burning fossil fuels produces greenhouse gasses such as carbon dioxide and methane.</p> <p>The examinee will demonstrate understanding that water circulates through the atmosphere, lithosphere, and hydrosphere in what is known as the water cycle. Water is returned from the atmosphere to Earth's surface by precipitation. Water returns to the atmosphere by evaporation or transpiration from plants. A portion of precipitation becomes runoff over the land or infiltrates into the ground to become stored in the soil or groundwater below the water table.</p> <p>The examinee will demonstrate understanding that the amount of precipitation that seeps into the ground or runs off is influenced by climate, slope of the land, soil, rock type, vegetation, land use, and degree of saturation.</p> <p>The examinee will demonstrate understanding that a lack of resources, habitat destruction, and other factors such as the presence of predators and climate conditions limit the growth of certain populations in the ecosystem.</p> <p>The examinee will demonstrate understanding that human activities can bring about environmental degradation. These activities may include the following:</p> <ul style="list-style-type: none"> • Resource acquisition • Urban growth • Land-use decisions • Waste disposal

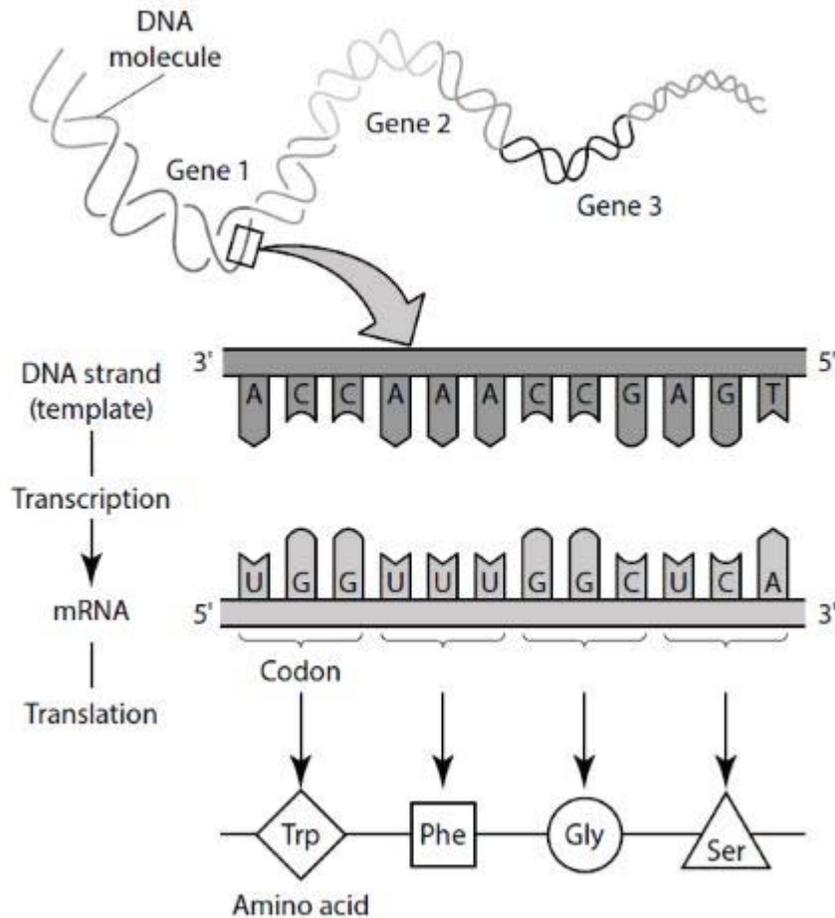
	The examinee will demonstrate understanding that temperature and precipitation patterns are altered by natural events (e.g., volcanic eruptions), and human influences (e.g., deforestation, urbanization, and production of greenhouse gases, such as carbon dioxide and methane).
Assessment Limits/Content Constraints	<u>Beyond Scope</u> <ul style="list-style-type: none"> Definitions of geosphere, lithosphere, biosphere, and cryosphere
DOK(s)	2
Stimulus	A data table or graph is recommended.
Tools	Scientific calculator provided
Sample Item Stem(s)	Which of these human activities would <u>most likely</u> lead to negative changes in the environment?

Domain	Life Sciences
Subdomain	LS1 From Molecules to Organisms: Structures and Processes
Standard	LS1-1. Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins, which carry out the essential functions of life through systems of specialized cells.
Emphasis Level	High
Evidence Statements	<p>The examinee will demonstrate understanding that the coded instructions for specifying the characteristics for all organisms are carried in DNA.</p> <p>The examinee will demonstrate understanding that DNA is a large molecule formed from subunits arranged in a sequence of bases.</p> <p>The examinee will demonstrate understanding that the chemical and structural properties of DNA are the basis for how the genetic information that underlies heredity is encoded in genes (as a string of molecular bases).</p> <p>The examinee will demonstrate understanding that DNA replicates.</p> <p>The examinee will demonstrate understanding that genes are segments of DNA, located in the chromosomes of each cell, and are passed from parents to offspring during reproduction.</p> <p>The examinee will demonstrate understanding that the nucleus of the cell contains the chromosomes.</p> <p>The examinee will demonstrate understanding that a human cell contains many thousands of different genes in its nucleus.</p> <p>The examinee will demonstrate understanding that any alteration of the DNA sequence is a mutation and will be passed on to every cell that develops from it.</p> <p>The examinee will demonstrate understanding that an inherited trait can be determined by one or by many genes.</p> <p>The examinee will demonstrate understanding that a single gene can influence more than one trait.</p> <p>The examinee will demonstrate understanding that genes are inherited but their expression can be modified by interactions with the environment.</p> <p>The examinee will demonstrate understanding that heredity is the passage of coded instructions for specifying traits from one generation to another.</p> <p>The examinee will demonstrate understanding that the work of the cell is carried out by the many different types of molecules it assembles, mostly proteins.</p>

	<p>The examinee will demonstrate understanding that proteins may form cellular structures or perform cellular functions.</p> <p>The examinee will demonstrate understanding that the genetic information stored in DNA is used to direct the synthesis of proteins that each cell requires.</p> <p>The examinee will demonstrate understanding that protein molecules are long, usually folded chains made from several different kinds of amino acids in a specific sequence.</p> <p>The sequence of amino acids influences the shape of the protein.</p> <p>The examinee will demonstrate understanding that the shape of the protein determines its function.</p> <p>The examinee will demonstrate understanding that offspring resemble their parents because they inherit similar genes that code for the production of proteins. These proteins form similar structures and perform similar functions.</p>
Assessment Limits/Content Constraints	<p><u>Beyond Scope</u></p> <ul style="list-style-type: none"> • Nucleotide • Allele • Specific nucleotide names • Translation • Transcription • RNA • Stages of meiosis • Specific pairing of nucleotides (A—T, G—C)
DOK(s)	1, 2
Stimulus	A diagram is highly recommended.
Tools	Scientific calculator provided
Sample Item Stem(s)	Which type of molecule is produced using the coded information in DNA?

Sample Item

The diagram shows transcription and translation. Both of these processes begin with a specific strand of DNA.



Part 1. What type of molecule is the end product of the process shown in the diagram?

Part 2. Why is it important that a section of DNA be copied in a specific order?

Domain	Life Sciences
Subdomain	LS1 From Molecules to Organisms: Structures and Processes
Standard	LS1-2. Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.
Emphasis Level	High
Evidence Statements	<p>The examinee will recognize that each cell is an independent living unit.</p> <p>The examinee will demonstrate understanding that some organisms are single cells, while other organisms, including humans, are multicellular.</p> <p>The examinee will demonstrate understanding that the cells of the body are of different kinds and are grouped in ways that enhance how they function together.</p> <p>The examinee will demonstrate understanding that multicellular animals often have similar organs and specialized systems for carrying out major life activities.</p> <p>The examinee will demonstrate understanding that many plants have roots, stems, leaves, and reproductive structures. These organized groups of tissues are responsible for a plant's life activities.</p> <p>The examinee will recognize the hierarchy of specialization from cells to tissues to organs to organ systems to organisms.</p> <p>The examinee will demonstrate understanding that tissues, organs, and organ systems help to provide all cells with nutrients, oxygen, and waste removal.</p> <p>The examinee will be able to identify the major human organ systems in diagram form and identify their functions.</p> <p>The examinee will demonstrate understanding that the digestive system consists of organs that are responsible for the mechanical and chemical breakdown of food. The breakdown process results in molecules that can be absorbed and transported to cells.</p> <p>The examinee will demonstrate understanding that during respiration, cells use oxygen to release the energy stored in food. The respiratory system supplies oxygen and removes carbon dioxide (gas exchange).</p> <p>The examinee will demonstrate understanding that the excretory system functions in the disposal of dissolved waste molecules and the elimination of liquid and gaseous wastes.</p> <p>The examinee will demonstrate understanding that the circulatory system transports nutrients and oxygen to cells and wastes, including carbon dioxide, away from cells.</p>

The examinee will demonstrate understanding that locomotion needed to escape danger, locate food and shelter, and reproduce is accomplished by the interaction of the skeletal and muscular systems and is coordinated by the nervous system.

The examinee will demonstrate understanding that the nervous and endocrine systems interact to control and coordinate the body's responses to changes in the environment and to regulate growth, development, and reproduction. Hormones are chemicals produced by the endocrine system; hormones regulate many bodily functions.

The examinee will demonstrate understanding that the male and female reproductive systems are responsible for producing gametes necessary for the production of offspring.

The examinee will demonstrate understanding of how organ systems interact to perform life functions.

The examinee will recognize parallels between organs for multicellular organisms and organelles for single-celled organisms.

The examinee will demonstrate understanding of the similarity of organ systems in various types of organisms and recognize this as evidence for evolution.

The examinee will demonstrate understanding of how the basic interactions between organ systems help to maintain homeostasis.

The examinee will demonstrate understanding of the differences among arteries, veins, and capillaries.

The examinee will demonstrate understanding of the basic functioning of the reproductive system, including internal versus external fertilization and development.

The examinee will demonstrate understanding that living things are similar in that they rely on many of the same processes to stay alive yet are different in the ways that they carry out these processes.

The examinee will demonstrate understanding to distinguish between the characteristics of living and non-living things. Living things have cellular organization, carry out metabolic processes, maintain internal stability (homeostasis), and pass on hereditary information through reproduction.

The examinee will demonstrate understanding that reproduction and development are necessary for the continuation of any species.

The examinee will demonstrate understanding that reproduction and development are subject to environmental effects.

The examinee will demonstrate understanding that living things go through a life cycle involving both reproductive and developmental stages.

The examinee will demonstrate understanding that some organisms reproduce asexually and some organisms reproduce sexually.

The examinee will demonstrate understanding that there are many methods of asexual reproduction, including division of a cell into two cells and separation of part of an animal or plant from the parent, resulting in the growth of another individual.

The examinee will demonstrate understanding that methods of sexual reproduction depend upon the species. All methods involve the merging of gametes to begin the development of a new individual.

The examinee will demonstrate understanding that in many species, including plants and humans, eggs and sperm are produced.

The examinee will demonstrate understanding that fertilization and/or development in organisms may be internal or external.

The examinee will demonstrate understanding that the male gamete is the sperm and the female gamete is the egg.

The examinee will demonstrate understanding that the fertilization of an egg by a sperm results in a fertilized egg, also known as a zygote.

The examinee will demonstrate understanding that in sexual reproduction, the sperm and the egg each carry one-half of the genetic information for the new individual.

The examinee will demonstrate understanding that multicellular organisms exhibit complex changes in development, which begins after fertilization.

The examinee will demonstrate understanding that the zygote undergoes numerous cellular divisions that result in a multicellular organism, with each cell having identical genetic information.

The examinee will demonstrate understanding that the zygote grows into tissue that develops into organs and organ systems before birth.

The examinee will demonstrate understanding that bodily structures and functions change as an organism goes through its lifecycle.

The examinee will demonstrate understanding that disease breaks down the structures or functions of an organism. Some diseases are the result of failures of the system. Other diseases are the result of damage by infection from other organisms (germ theory).

The examinee will demonstrate understanding that specialized cells protect the body from infectious disease. The chemicals that they produce identify and destroy microbes that enter the body.

Assessment Limits/Content Constraints	Beyond Scope <ul style="list-style-type: none"> • Specific glands and hormones of the endocrine system • Details of the anatomy of individual organs • Names of individual bones, arteries, veins, muscles, and nerves • Categories of vertebrae and ribs
DOK(s)	1, 2
Stimulus	A diagram is highly recommended.
Tools	Scientific calculator provided
Sample Item Stem(s)	What is the function of the respiratory system in the body?

Sample Items

LS1-2 Sample 1.

An important part of the body is the heart. The heart is made mostly of muscle and connective tissues. The heart's primary function is to pump blood.

Which level of organization best classifies the heart?

- A. cell
- B. organ
- C. system
- D. tissue

LS1-2 Sample 2.

Plants and animals have both similarities and differences in the structure of their cells.

Part 1. Identify one part of a cell that can be found in both a plant cell and an animal cell.

Part 2. Describe one difference in the parts of a plant cell and an animal cell.

Domain	Life Sciences
Subdomain	LS1 From Molecules to Organisms: Structures and Processes
Standard	LS1-3. Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.
Emphasis Level	High
Evidence Statements	<p>The examinee will demonstrate understanding that response to internal or external environmental change, which keeps the internal environment within certain limits, is called homeostasis, or “dynamic equilibrium” or “steady state.”</p> <p>The examinee will demonstrate understanding that homeostatic feedback mechanisms maintain the physical and chemical aspects of the internal environment within narrow limits that are favorable for cellular activities.</p> <p>The examinee will demonstrate understanding that animals and plants have a variety of body plans and internal structures that contribute to their ability to maintain a balanced condition.</p> <p>The examinee will demonstrate understanding that dynamic equilibrium results from detection of and response to stimuli.</p> <p>The examinee will demonstrate understanding that organisms detect and respond to change in a variety of ways both at the cellular level and at the organismal level.</p> <p>The examinee will demonstrate understanding that the components of living systems, from a single cell to an ecosystem, interact to maintain balance.</p> <p>The examinee will demonstrate understanding that the structures present in some single-celled organisms act in a manner similar to the tissues and systems found in multicellular organisms, thus enabling them to perform all of the life processes needed to maintain homeostasis.</p> <p>The examinee will demonstrate understanding that the components of the human body, from organ systems to cell organelles, interact to maintain a balanced internal environment.</p> <p>The examinee will demonstrate understanding that because organisms are continuously exposed to changes in their external and internal environments, they must continually monitor and respond to these changes.</p> <p>The examinee will recognize that feedback mechanisms have evolved to maintain homeostasis. Examples of homeostasis may include the following:</p> <ul style="list-style-type: none"> • the changes in heart rate or respiratory rate in response to increased activity in muscle cells • the maintenance of blood sugar levels by insulin from the pancreas • the changes in openings in the leaves of plants to regulate water loss and gas exchange

The examinee will demonstrate understanding that responses to change can range in complexity from simple activation of a cell chemical process to elaborate learned behavior.

The examinee will demonstrate understanding that organisms possess a diversity of control mechanisms that detect deviations and make corrective actions to return their systems to the normal range.

The examinee will demonstrate understanding that homeostasis in an organism is constantly threatened.

The examinee will demonstrate understanding that if there is a disruption in any human system, there may be a corresponding imbalance in homeostasis.

Failure of homeostatic control mechanisms can result in disease or death.

The examinee will recognize that viruses, bacteria, fungi, and other parasites may infect plants and animals and interfere with normal life functions.

The examinee will demonstrate understanding that disease may also be caused by inheritance, toxic substances, poor nutrition, organ malfunction, and some personal behavior.

The examinee will recognize that some of the effects of disease show up right away, while others may not show up for years.

The examinee will recognize that the immune system protects against disease.

The examinee will demonstrate understanding that some viral diseases, such as AIDS, damage the immune system, leaving the body unable to deal with multiple infectious agents and cancerous cells.

The examinee will demonstrate understanding that white blood cells are an important part of the immune system. Some white blood cells engulf invaders, while some produce antibodies that attack invaders or mark them for killing.

The examinee will demonstrate understanding that vaccinations use dead or weakened microbes (or parts of them) to stimulate the immune system to react to and fight subsequent invasions by the same microbes.

The examinee will demonstrate understanding that some allergic reactions are caused by the body's immune responses to usually harmless environmental substances.

The examinee will demonstrate understanding that sometimes the immune system may attack some of the body's own cells or transplanted organs.

The examinee will demonstrate understanding that if nerve or hormone signals are blocked, cellular communication is disrupted and the organism's stability is affected.

	The examinee will demonstrate understanding that biological research generates knowledge used to design ways of diagnosing, preventing, treating, controlling, or curing diseases in plants and animals.
Assessment Limits/Content Constraints	<p><u>Beyond Scope</u></p> <ul style="list-style-type: none"> • Neurotransmitters • Specific hormones other than insulin, estrogen, and testosterone • Antigens • Specific temperatures (body temperature, room temperature, etc.)
DOK(s)	1, 2
Stimulus	A diagram is highly recommended.
Tools	Scientific calculator provided
Sample Item Stem(s)	Which statement <u>best</u> defines homeostasis?

Domain	Life Sciences
Subdomain	LS1 From Molecules to Organisms: Structures and Processes
Standard	LS1-4. Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.
Emphasis Level	High
Evidence Statements	<p>The examinee will demonstrate understanding that the cell is a basic unit of structure and function of living things (cell theory).</p> <p>The examinee will demonstrate understanding that, for all living things, life activities are accomplished at the cellular level.</p> <p>The examinee will demonstrate understanding that some organisms are single-celled; others, including humans, are multicellular.</p> <p>The examinee will demonstrate understanding that the way in which cells function is similar in all living things.</p> <p>The examinee will recognize that cells grow and divide, producing more cells.</p> <p>The examinee will demonstrate understanding that cells take in nutrients, which they use to provide energy for the work that cells do and to make the materials that a cell or an organism needs.</p> <p>The examinee will demonstrate understanding that zygotes contain all of the information necessary for growth, development, and eventual reproduction of the organism.</p> <p>The examinee will demonstrate understanding that development is a highly regulated process involving mitosis and differentiation.</p> <p>The examinee will recognize that human development, birth, and aging should be viewed as a predictable pattern of events.</p> <p>The examinee will demonstrate understanding that cells have particular structures that perform specific jobs and perform the actual work of the cells.</p> <p>The examinee will recognize that in multicellular organisms, cell division is responsible for growth, maintenance, and repair.</p> <p>The examinee will demonstrate understanding that in one type of cell division, mitosis, chromosomes are duplicated and then separated into two identical and complete sets to be passed to each of the two resulting cells. In mitosis, the hereditary information is identical in all of the cells that result.</p>

	<p>The examinee will demonstrate understanding that another type of cell division, meiosis, accounts for the production of egg and sperm cells in sexually reproducing organisms. The eggs and sperm resulting from meiosis contain one-half of the hereditary information.</p> <p>The examinee will recognize that the many body cells in an individual can be very different from one another, even though they are all descended from a single cell and thus have essentially identical genetic instructions because different parts of the genetic instructions are used in different types of cells and are influenced by the cell's environment and past history.</p> <p>The examinee will recognize that just as organ systems are coordinated and work together, cell parts must also be coordinated and work together.</p> <p>The examinee will recognize that each cell is covered by a membrane that performs a number of important functions for the cell. These functions may include the following:</p> <ul style="list-style-type: none"> • Separation from the cell's outside environment • Control of which molecules enter and leave the cell • Diffusion and active transport that are important in the movement of materials in and out of cells <p>The examinee will recognize that a variety of specialized structures carry out functions inside the cell. These specialized structures and cells may include the following:</p> <ul style="list-style-type: none"> • Cytoplasm—transport of materials • Mitochondria—extraction of energy from nutrients • Ribosomes—protein building • Cell membrane—waste disposal • Vacuole—storage • Nucleus—information storage <p>The examinee will demonstrate understanding that gene mutations in a cell can result in uncontrolled cell division, called cancer.</p> <p>The examinee will demonstrate understanding that exposure of cells to certain chemicals and radiation increases mutations and thus increases the chance of cancer.</p>
Assessment Limits/Content Constraints	<p><u>Beyond Scope</u></p> <ul style="list-style-type: none"> • Stages of mitosis and meiosis • Organelles other than the six listed in the Evidence Statements section above
DOK(s)	1, 2
Stimulus	A diagram is highly recommended.
Tools	Scientific calculator provided
Sample Item Stem(s)	Which substance is stored in the nucleus of a cell?

Domain	Life Sciences
Subdomain	LS1 From Molecules to Organisms: Structures and Processes
Standard	LS1-5. Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.
Emphasis Level	High
Evidence Statements	<p>The examinee will demonstrate understanding that the energy for life comes primarily from the Sun.</p> <p>The examinee will demonstrate understanding that photosynthesis provides a vital connection between the Sun and the energy needs of living systems.</p> <p>The examinee will demonstrate understanding that photosynthesis is carried out by green plants and other organisms containing chlorophyll.</p> <p>The examinee will demonstrate understanding that plant cells and some single-celled organisms contain chloroplasts, the site of photosynthesis.</p> <p>The examinee will demonstrate understanding that in photosynthesis, the Sun's energy is converted into and stored as chemical energy in the form of a sugar, glucose.</p> <p>The examinee will demonstrate understanding that the quantity of sugar molecules increases in green plants during photosynthesis in the presence of sunlight.</p> <p>The examinee will demonstrate understanding that the primary source of atmospheric oxygen is photosynthesis.</p> <p>The examinee will demonstrate understanding that carbon dioxide is removed from the atmosphere and oxygen is released during photosynthesis.</p> <p>The examinee will demonstrate understanding that the process of photosynthesis uses solar energy to combine the inorganic molecules carbon dioxide and water into energy-rich organic compounds (e.g., glucose) and releases oxygen to the environment.</p> <p>The examinee will demonstrate understanding that green plants are the producers of food that is used directly or indirectly by consumers.</p> <p>The examinee will demonstrate understanding that many plants have roots, stems, leaves, and reproductive structures. These organized groups of tissues are responsible for a plant's life activities.</p> <p>The examinee will demonstrate understanding that patterns of development vary among plants. In seed-bearing plants, seeds contain stored food for early development.</p>

Assessment Limits/Content Constraints	<u>Beyond Scope</u> <ul style="list-style-type: none"> • The chemical equation for photosynthesis • The molecular formula of glucose
DOK(s)	2
Stimulus	A diagram is highly recommended.
Tools	Scientific calculator provided
Sample Item Stem(s)	Which substance is released during photosynthesis?

Domain	Life Sciences
Subdomain	LS1 From Molecules to Organisms: Structures and Processes
Standard	LS1-6. Construct and revise an explanation that is based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.
Emphasis Level	Low
Evidence Statements	<p>The examinee will demonstrate understanding that food provides molecules that serve as fuel and building material for all organisms.</p> <p>The examinee will demonstrate understanding that foods contain a variety of substances, which include carbohydrates, fats, vitamins, proteins, minerals, and water. Each substance is vital to the survival of the organism.</p> <p>The examinee will demonstrate understanding that, in order to maintain a balanced state, all organisms have a minimum daily intake of each type of nutrient, based on species, size, age, sex, activity, etc. An imbalance in any of the nutrients might result in weight gain, weight loss, or a diseased state.</p> <p>The examinee will demonstrate understanding that large organic food molecules must initially be broken down in order to enter cells. Proteins are digested to amino acids.</p> <p>The examinee will demonstrate understanding that starches are digested to simple sugars.</p> <p>The examinee will demonstrate understanding that once nutrients enter a cell, the cell will use them as building blocks in the synthesis of compounds necessary for life.</p> <p>The examinee will demonstrate understanding that in all organisms, organic compounds can be used to assemble other molecules, such as proteins, DNA, starch, and fats.</p> <p>The examinee will demonstrate understanding that amino acids are the building blocks of proteins.</p> <p>The examinee will demonstrate understanding that the chemical elements that make up the molecules of living things (such as carbon, hydrogen, and oxygen) pass through food webs and are returned to the environment when the energy in these compounds is eventually released by cells.</p> <p>The examinee will demonstrate understanding that biochemical processes, both breakdown and synthesis, are made possible by a large set of enzymes that serve as biological catalysts.</p> <p>The examinee will recognize that enzymes can affect the rates of chemical change.</p>

	The examinee will demonstrate understanding that proteins have specific shapes that influence both how they function and how they interact with other molecules.
Assessment Limits/Content Constraints	<u>Beyond Scope</u> <ul style="list-style-type: none"> • The molecular formula of glucose • Details of the pH scale
DOK(s)	2
Stimulus	Items may include a diagram.
Tools	Scientific calculator provided
Sample Item Stem(s)	Which substances are the building blocks of proteins?

Domain	Life Sciences
Subdomain	LS1 From Molecules to Organisms: Structures and Processes
Standard	LS1-7. Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed, resulting in a net transfer of energy.
Emphasis Level	High
Evidence Statements	<p>The examinee will recognize that food provides molecules that serve as fuel and building material for all organisms.</p> <p>The examinee will demonstrate understanding that all living things, including plants, must release energy from their food, using it to carry on their life processes.</p> <p>The examinee will demonstrate understanding that life is dependent upon availability of an energy source and raw materials that are used in the basic enzyme-controlled biochemical processes of living organisms.</p> <p>The examinee will demonstrate understanding that metabolism is the sum of all chemical reactions in an organism. Metabolism can be influenced by hormones, exercise, diet, and aging.</p> <p>The examinee will demonstrate understanding that all organisms require energy to survive. The amount of energy needed and the method for obtaining this energy vary.</p> <p>The examinee will recognize that energy in foods is measured in Calories.</p> <p>The examinee will demonstrate understanding that the total caloric value of each type of food varies.</p> <p>The examinee will demonstrate understanding that the number of Calories a person requires varies from person to person.</p> <p>The examinee will demonstrate understanding that cells use oxygen to release the energy stored in food.</p> <p>The examinee will demonstrate understanding that the chemical energy stored in bonds can be used as a source of energy for life processes.</p> <p>The examinee will demonstrate understanding that in all organisms, the energy stored in organic molecules may be released during cellular respiration. In cellular respiration oxygen is used and carbon dioxide and water are released as waste products.</p> <p>The examinee will demonstrate understanding that in many organisms, the process of cellular respiration is conducted in mitochondria.</p> <p>The examinee will demonstrate understanding that energy is used by the organism to obtain, transform, and transport materials, and to eliminate wastes.</p>

Assessment Limits/Content Constraints	<u>Beyond Scope</u> <ul style="list-style-type: none"> • Calculations involving bond energies • The chemical equation for cellular respiration • Molecular formulas
DOK(s)	1, 2
Stimulus	A diagram is highly recommended. Calculations are NOT recommended.
Tools	Scientific calculator provided
Sample Item Stem(s)	Which cellular process releases the energy from food?

Domain	Life Sciences
Subdomain	LS2 Ecosystems: Interactions, Energy, and Dynamics
Standard	LS2-1. Use mathematical and/or computational representations to support explanations of factors that affect the carrying capacity of ecosystems at different scales.
Emphasis Level	Medium
Evidence Statements	<p>The examinee will demonstrate understanding that the fundamental concept of ecology is that living organisms interact with and are dependent on their environment and each other.</p> <p>The examinee will demonstrate understanding that the average number of organisms that any habitat can support (carrying capacity) is limited by the available resources, such as energy, water, oxygen, and minerals.</p> <p>The examinee will demonstrate understanding that living organisms have the capacity to produce populations of unlimited size, but environments and resources are finite.</p> <p>The examinee will demonstrate understanding that given adequate resources and no disease or predators, populations (including those of humans) increase.</p> <p>The examinee will demonstrate understanding that a lack of resources, habitat destruction, and other factors such as the presence of predators and climate, can limit the growth of certain populations in the ecosystem.</p> <p>The examinee will demonstrate understanding that competition may be both between species and within species. Competition may be for the following resources:</p> <ul style="list-style-type: none"> • Space • Water • Air • Shelter • Food • Mates <p>The examinee will demonstrate understanding that in any particular environment, the growth and survival of organisms depend on the physical conditions. These conditions may include the following:</p> <ul style="list-style-type: none"> • Light intensity • Temperature range • Mineral availability • Soil/rock type • Relative acidity (pH)
Assessment Limits/Content Constraints	<p><u>Beyond Scope</u></p> <ul style="list-style-type: none"> • Mathematical calculations

DOK(s)	2, 3
Stimulus	Data tables and graphs are highly recommended.
Tools	Scientific calculator provided
Sample Item Stem(s)	Which is an example of competition within a species?

Sample Item (Online version)

The American robin is one of the most successful bird species in North America. To help maintain ecological stability, there are many interrelated factors that affect the American robin population.



Identify each factor that could affect a robin population as biotic or abiotic. Select the box next to each factor shown in the first column that matches the factor type shown in either the second or third column of the table. All factors match only one type of factor.

	Biotic	Abiotic
Air pollution	<input type="checkbox"/>	<input type="checkbox"/>
Ability to escape from predators	<input type="checkbox"/>	<input type="checkbox"/>
Competition with other birds	<input type="checkbox"/>	<input type="checkbox"/>
Weather conditions	<input type="checkbox"/>	<input type="checkbox"/>

Sample Item (Print version)

The American robin is one of the most successful bird species in North America. To help maintain ecological stability, there are many interrelated factors that affect the American robin population.



Part A:

Identify two biotic factors that could affect a robin population. Select two answers.

- A. Air pollution
- B. Ability to escape from predators
- C. Competition with other birds
- D. Weather conditions

Part B:

Identify two abiotic factors that could affect a robin population. Select two answers.

- A. Air pollution
- B. Ability to escape from predators
- C. Competition with other birds
- D. Weather conditions

Domain	Life Sciences
Subdomain	LS2 Ecosystems: Interactions, Energy, and Dynamics
Standard	LS2-2. Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
Emphasis Level	Medium
Evidence Statements	<p>The examinee will recognize that a wide diversity of physical conditions creates a variety of environments.</p> <p>The examinee will recognize that a population consists of all individuals of a species that are found together at a given place and time.</p> <p>The examinee will demonstrate understanding that populations living in one place form a community.</p> <p>The examinee will demonstrate understanding that the community and the physical factors with which it interacts comprise an ecosystem.</p> <p>The examinee will demonstrate understanding that the linked and changing interactions of populations and the environment comprise the total ecosystem.</p> <p>The examinee will demonstrate understanding that the interrelationships and interdependencies of organisms affect the development of stable ecosystems.</p> <p>The examinee will demonstrate understanding that some microorganisms are essential to the survival of other living things.</p> <p>The examinee will demonstrate understanding that an ecosystem is shaped by the nonliving environment and interacting species.</p> <p>The examinee will demonstrate understanding that competition can occur between members of different species for an ecological niche.</p> <p>The examinee will demonstrate understanding that relationships between organisms may be negative, neutral, or positive.</p> <p>The examinee will demonstrate understanding that organisms interact with each other in different ways. Different types of organism interaction may include the following:</p> <ul style="list-style-type: none"> • Producer/consumer relationship • Predator/prey relationship • Parasite/host relationship • One causing disease in another • One scavenging the other • One decomposing the other

	<p>The examinee will demonstrate understanding that in classifying organisms, biologists consider details of internal and external structures.</p> <p>The examinee will demonstrate understanding that biological classification systems are arranged from general (kingdom) to more specific (species).</p>
Assessment Limits/Content Constraints	<p><u>Beyond Scope</u></p> <ul style="list-style-type: none"> • Symbiosis • Mutualism • Taxonomic classifications other than “kingdom” and “species”
DOK(s)	2, 3
Stimulus	The inclusion of population data is recommended.
Tools	Scientific calculator provided
Sample Item Stem(s)	Which statement describes what will happen to the fox and coyote populations over time, if there is a disease that is affecting the rabbit population in an ecosystem?

Domain	Life Sciences
Subdomain	LS2 Ecosystems: Interactions, Energy, and Dynamics
Standard	LS2-4. Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.
Emphasis Level	Medium
Evidence Statements	<p>The examinee will demonstrate understanding that the interactions of living organisms with each other and with the environment result in a flow of energy and a cycling of materials that are essential for life.</p> <p>The examinee will demonstrate understanding that populations can be categorized by the function they serve (e.g., producers, consumers, decomposers).</p> <p>The examinee will demonstrate understanding that green plants are the producers of food that is used directly or indirectly by consumers.</p> <p>The examinee will demonstrate understanding that organisms can be linked by food webs and food chains and categorized by the food they eat (e.g., herbivore, carnivore, omnivore).</p> <p>The examinee will demonstrate understanding that energy flows through ecosystems in one direction, typically from the Sun, through photosynthetic organisms including green plants and algae, to herbivores to carnivores and decomposers.</p> <p>The examinee will demonstrate understanding that the atoms and molecules on Earth cycle between the living and nonliving components of the biosphere.</p> <p>The examinee will demonstrate understanding that the chemical elements that make up the molecules of living things, such as carbon, hydrogen, and oxygen pass through food webs and are returned to the environment when the energy in these compounds is eventually released by cells.</p> <p>The examinee will demonstrate understanding that at each link in a food web, some energy is stored in newly made structures, but much is dissipated into the environment as heat.</p> <p>The examinee will demonstrate understanding that continual input of energy from sunlight keeps the biological cycles going.</p> <p>The examinee will demonstrate understanding that the flow of energy within a community may be modeled by an energy pyramid.</p> <p>The examinee will demonstrate understanding that carbon dioxide and water molecules used in photosynthesis to form energy-rich organic compounds are returned to the environment when the energy in these compounds is eventually released by cells.</p>

Assessment Limits/Content Constraints	<p><u>Beyond Scope</u></p> <ul style="list-style-type: none"> • Calculations of energy losses through energy pyramid stages • The role within a food web of individual animal species without stimulus cues • The chemical equation for photosynthesis • Molecular formulas • Stages of consumers (primary, apex, etc.) • Calculations involving bond energies
DOK(s)	2
Stimulus	A diagram is highly recommended. Calculations are NOT recommended.
Tools	Scientific calculator provided
Sample Item Stem(s)	Which model correctly shows the flow of energy through the ecosystem?

Domain	Life Sciences
Subdomain	LS2 Ecosystems: Interactions, Energy, and Dynamics
Standard	LS2-5. Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.
Emphasis Level	Low
Evidence Statements	<p>The examinee will demonstrate understanding that matter is transferred from one organism to another and between organisms and their physical environment.</p> <p>The examinee will demonstrate understanding that water, carbon dioxide, and oxygen are examples of substances cycled between the living and nonliving environments.</p> <p>The examinee will demonstrate understanding that the major source of atmospheric oxygen is photosynthesis.</p> <p>The examinee will demonstrate understanding that carbon dioxide is removed from the atmosphere and oxygen is released during photosynthesis.</p> <p>The examinee will demonstrate understanding that the process of photosynthesis uses solar energy to combine the inorganic molecules carbon dioxide and water into energy-rich organic compounds (e.g., glucose) and release oxygen to the environment.</p> <p>The examinee will demonstrate understanding that in cellular respiration, carbon dioxide is released as waste.</p>
Assessment Limits/Content Constraints	<p><u>Beyond Scope</u></p> <ul style="list-style-type: none"> The nitrogen cycle
DOK(s)	2
Stimulus	A diagram is highly recommended.
Tools	Scientific calculator provided
Sample Item Stem(s)	What substance is released into the atmosphere during the process of photosynthesis?

Domain	Life Sciences
Subdomain	LS2 Ecosystems: Interactions, Energy, and Dynamics
Standard	LS2-6. Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.
Emphasis Level	Medium
Evidence Statements	<p>The examinee will demonstrate understanding that the interdependence of organisms in an established ecosystem often results in approximate stability over hundreds and thousands of years.</p> <p>The examinee will demonstrate understanding that as one population increases, it is held in check by one or more environmental factors or other species.</p> <p>The examinee will demonstrate understanding that in any particular environment, the growth and survival of organisms depend on physical conditions. These physical conditions may include the following:</p> <ul style="list-style-type: none"> • Light intensity • Temperature range • Mineral availability • Soil/rock type • Relative acidity (pH) <p>The examinee will demonstrate understanding that ecosystems tend to show cyclic changes around a state of approximate equilibrium (carrying capacity).</p> <p>The examinee will demonstrate understanding that every population is linked, directly or indirectly, with many others in an ecosystem.</p> <p>The examinee will demonstrate understanding that disruptions in the numbers and types of species and environmental changes can upset ecosystem stability.</p> <p>The examinee will demonstrate understanding that a stable ecosystem can be altered, either rapidly or slowly, through the activities of organisms (including humans) or through climatic changes or natural disasters.</p> <p>The examinee will demonstrate understanding that the altered ecosystem can usually recover, through gradual changes, back to a point of long-term stability.</p> <p>The examinee will demonstrate understanding that through ecological succession, all ecosystems progress through a sequence of changes during which one ecological community modifies the environment, making it more suitable for another community.</p> <p>The examinee will demonstrate understanding that the long-term gradual changes of ecological succession result in the community reaching a point of stability that can last for hundreds or thousands of years.</p>

Assessment Limits/Content Constraints	<u>Beyond Scope</u> <ul style="list-style-type: none"> • Details of the pH scale • Specific temperatures (body temperature, room temperature, etc.)
DOK(s)	2
Stimulus	Data tables or graphs are recommended.
Tools	Scientific calculator provided
Sample Item Stem(s)	Which graph shows a stable population in an ecosystem?

Domain	Life Sciences
Subdomain	LS2 Ecosystems: Interactions, Energy, and Dynamics
Standard	LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
Emphasis Level	Medium
Evidence Statements	<p>The examinee will demonstrate understanding that overpopulation by any species affects the environment due to the increased use of resources.</p> <p>The examinee will demonstrate understanding that population growth has placed new strains on the environment. Some of these strains on the environment may include the following:</p> <ul style="list-style-type: none"> • Pollution of air and water • Deforestation • Extinction of species • Global warming • Alteration of the ozone shield <p>The examinee will recognize that humans are included in Earth’s ecosystems.</p> <p>The examinee will demonstrate understanding that human activities can, deliberately or inadvertently, alter the equilibrium within ecosystems.</p> <p>The examinee will demonstrate understanding that humans modify ecosystems as a result of population growth, consumption, and technology.</p> <p>The examinee will demonstrate understanding that humans are changing many basic processes (in ways that may be detrimental). These processes may include the following:</p> <ul style="list-style-type: none"> • Maintenance of the quality of the atmosphere • Generation of soils • Control of the water cycle • Removal of wastes • Energy flow • Recycling of nutrients <p>The examinee will demonstrate understanding that human activities that degrade ecosystems result in a loss of diversity of the living and nonliving environments. The influence of humans on other organisms occurs through land use and pollution. Land use decreases the space and resources available to other species.</p> <p>The examinee will demonstrate understanding that the environment may contain dangerous levels of substances (pollutants) that are harmful to organisms. Therefore, the good health of environments and individuals requires the monitoring of soil, air, and water, and taking steps to keep them safe.</p>

	<p>The examinee will demonstrate understanding that pollution changes the chemical composition of air, soil, and water.</p> <p>The examinee will demonstrate understanding that when humans alter ecosystems either by adding or removing specific organisms, serious consequences may result. For example, planting large expanses of one crop reduces the biodiversity of the area.</p> <p>The examinee will demonstrate understanding that human destruction of habitats through direct harvesting, pollution, atmospheric changes, and other factors is threatening current global stability.</p> <p>The examinee will demonstrate understanding that Earth has finite resources. Increasing human consumption of resources places stress on the natural processes that renew some resources and depletes those resources that cannot be renewed.</p> <p>The examinee will demonstrate understanding that industrialization brings an increased demand for and use of energy and other resources, including fossil and nuclear fuels.</p> <p>The examinee will demonstrate understanding that since the Industrial Revolution, human activities have resulted in major pollution of air, water, and soil.</p> <p>The examinee will demonstrate understanding that pollution has ecological effects that add up over time, such as acid rain, global warming, and ozone depletion.</p> <p>The examinee will demonstrate understanding that resolving environmental issues will require increased global awareness, cooperation, and action.</p> <p>The examinee will demonstrate understanding that individual choices and societal actions can contribute to improving the environment. Societies must decide on proposals that involve the introduction of new technologies. Individuals need to make decisions that will assess risks, costs, benefits, and trade-offs.</p> <p>The examinee will demonstrate understanding that the decisions of one generation both provide and limit possibilities open to the next generation.</p> <p>The examinee will demonstrate understanding that the survival of living things on our planet depends on the conservation and protection of Earth's resources.</p>
Assessment Limits/Content Constraints	<p><u>Beyond Scope</u></p> <ul style="list-style-type: none"> • Calculations
DOK(s)	2
Stimulus	Items may include data tables, graphs, and diagrams.
Tools	Scientific calculator provided
Sample Item Stem(s)	Which example <u>best</u> illustrates how humans can negatively influence an ecosystem?

Domain	Life Sciences
Subdomain	LS2 Ecosystems: Interactions, Energy, and Dynamics
Standard	LS2-8. Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.
Emphasis Level	Low
Evidence Statements	<p>The examinee will demonstrate understanding that behaviors have evolved through natural selection.</p> <p>The examinee will demonstrate understanding that the broad patterns of behavior exhibited by organisms are those that have resulted in greater reproductive success.</p>
Assessment Limits/Content Constraints	<p><u>Beyond Scope</u></p> <ul style="list-style-type: none"> Organisms or behaviors not likely to be familiar to examinees
DOK(s)	2
Stimulus	Data tables or graphs are recommended.
Tools	Scientific calculator provided
Sample Item Stem(s)	Which statement <u>best</u> explains how cooperative hunting among lions benefits the entire pride?

Domain	Life Sciences
Subdomain	LS3 Heredity: Inheritance and Variation of Traits
Standard	LS3-1. Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.
Emphasis Level	High
Evidence Statements	<p>The examinee will demonstrate understanding that hereditary information is contained in genes.</p> <p>The examinee will demonstrate understanding that in all organisms, genetic traits are passed on from generation to generation.</p> <p>The examinee will demonstrate understanding that genes are composed of DNA that makes up the chromosomes of cells.</p> <p>The examinee will demonstrate understanding that each gene carries a single unit of information.</p> <p>The examinee will demonstrate understanding that a human cell contains thousands of different genes.</p> <p>The examinee will demonstrate understanding that each human cell contains a copy of all of the genes needed to produce a human being.</p> <p>The examinee will demonstrate understanding that some genes are dominant and some are recessive.</p> <p>The examinee will demonstrate understanding that some traits are inherited by mechanisms other than dominance and recessiveness.</p> <p>The examinee will demonstrate understanding that in asexually reproducing organisms, all of the genes come from a single parent.</p> <p>The examinee will demonstrate understanding that asexually produced offspring are normally genetically identical to the parent.</p> <p>The examinee will demonstrate understanding that the processes of meiosis and fertilization are keys to sexual reproduction in a wide variety of organisms.</p> <p>The examinee will demonstrate understanding that the process of meiosis results in the production of eggs and sperm, each of which contains half of the genetic information.</p> <p>The examinee will demonstrate understanding that during fertilization, gametes unite to form a zygote, which contains the complete genetic information for the offspring.</p>

The examinee will demonstrate understanding that the processes of gamete production, fertilization, and development follow an orderly sequence of events.

The examinee will demonstrate understanding that zygotes contain all of the information necessary for growth, development, and eventual reproduction of the organism.

The examinee will demonstrate understanding that the zygote divides by mitosis and differentiates to form the specialized cells, tissues, and organs of multicellular organisms.

The examinee will demonstrate understanding that in sexually reproducing organisms, the new individual receives half of the genetic information from its mother (via the egg) and half from its father (via the sperm).

The examinee will demonstrate understanding that human reproduction and development are influenced by factors such as gene expression, hormones, and the environment.

The examinee will demonstrate understanding that the reproductive cycle in both males and females is regulated by hormones such as testosterone, estrogen, and progesterone.

The examinee will demonstrate understanding that the structures and functions of the human female reproductive system, as in almost all other mammals, have the following characteristics:

- Produce gametes in ovaries
- Allow for internal fertilization
- Support the internal development of the embryo and fetus in the uterus
- Provide essential materials through the placenta
- Provide nutrition through milk for the newborn

The examinee will demonstrate understanding that the structures and functions of the human male reproductive system, as in other mammals, have the following characteristics:

- Produce gametes in the testes
- Make possible the delivery of gametes for fertilization

The examinee will demonstrate understanding that sexually produced offspring often resemble, but are not identical to, their parents.

The examinee will demonstrate understanding that in humans, the embryonic development of essential organs occurs in early stages of pregnancy.

The examinee will demonstrate understanding that the embryo may encounter risks from mutations in its genes or through exposure to environmental factors during pregnancy, such as an inadequate diet, alcohol/drugs/tobacco, other toxins, and infections.

	<p>The examinee will recognize that reproductive technology has medical, agricultural, and ecological applications.</p> <p>The examinee will demonstrate understanding that cloning is the production of identical genetic copies.</p>
Assessment Limits/Content Constraints	<p><u>Beyond Scope</u></p> <ul style="list-style-type: none"> • Stages of mitosis or meiosis • Allele • Codominance • Incomplete dominance
DOK(s)	2
Stimulus	Items may include data tables, graphs, or diagrams.
Tools	Scientific calculator provided
Sample Item Stem(s)	Which process of reproduction results in similar, but not identical, offspring?

Sample Item

Which statement describes the role of DNA in a cell?

- A. DNA is the material that forms into the cell's membrane.
- B. DNA produces the energy needed for the cell's activities.
- C. DNA provides the information to make proteins for the cell.
- D. DNA is the building block for the other molecules in the cell.

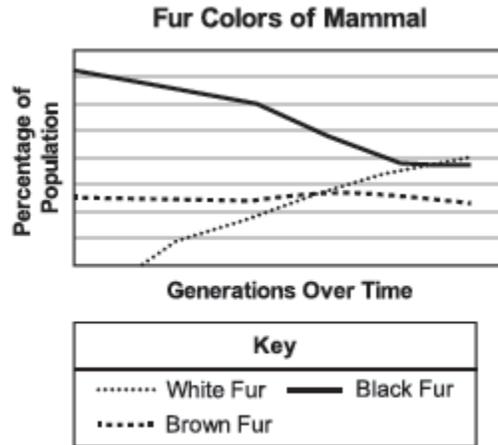
Domain	Life Sciences
Subdomain	LS3 Heredity: Inheritance and Variation of Traits
Standard	LS3-2. Make and defend a claim based on evidence that inheritable genetic variations may result from (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors.
Emphasis Level	Medium
Evidence Statements	<p>The examinee will demonstrate understanding that new inheritable characteristics can result from new combinations of existing genes or from mutations of genes in reproductive cells.</p> <p>The examinee will demonstrate understanding that mutation and the sorting and recombining of genes during meiosis and fertilization result in a great variety of possible gene combinations.</p> <p>The examinee will demonstrate understanding that genes may be changed through recombination, mutation, or genetic engineering.</p> <p>The examinee will demonstrate understanding that mutations occur as random, chance events.</p> <p>The examinee will demonstrate understanding that gene mutations can be caused by such agents as radiation and chemicals.</p> <p>The examinee will demonstrate understanding that when mutations occur in sex cells, the mutations can be passed on to offspring and can become the basis of evolutionary change.</p> <p>The examinee will demonstrate understanding that if mutations occur in cells other than sex cells, then they can be passed on to other body cells only.</p> <p>The examinee will demonstrate understanding that characteristics produced by the segments of DNA may be expressed when these segments are inserted into new organisms, such as bacteria.</p> <p>The examinee will demonstrate understanding that inserting, deleting, or substituting DNA segments can alter genes.</p> <p>The examinee will demonstrate understanding that an altered gene may be passed on to every cell that develops from it.</p> <p>The examinee will recognize that knowledge of genetics is making possible new fields of health care. For example, finding genes that may have mutations that can cause disease will aid in the development of preventive measures to fight disease.</p> <p>The examinee will demonstrate understanding that substances, such as hormones and enzymes, from genetically engineered organisms may reduce the cost and side effects of replacing missing body chemicals.</p>

Assessment Limits/Content Constraints	<u>Beyond Scope</u> <ul style="list-style-type: none"> • Stages of meiosis and mitosis • The phrase “recombinant DNA”
DOK(s)	2
Stimulus	Items may include diagrams, data tables, or graphs.
Tools	Scientific calculator provided
Sample Item Stem(s)	Which disease is a result of a mutation that occurred before birth?

Domain	Life Sciences
Subdomain	LS3 Heredity: Inheritance and Variation of Traits
Standard	HS-LS3-3. Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.
Emphasis Level	Low
Evidence Statements	<p>The examinee will demonstrate understanding that genetic traits are passed on from generation to generation in all organisms.</p> <p>The examinee will demonstrate understanding that some traits are inherited by mechanisms other than dominance and recessiveness.</p> <p>The examinee will demonstrate understanding that the variation of organisms within a species increases the likelihood that at least some members of the species will survive under changed environmental conditions.</p> <p>The examinee will demonstrate understanding that the probability of traits being expressed can be determined by using models of genetic inheritance. Two models of prediction are pedigree charts and Punnett squares.</p> <p>The examinee will demonstrate understanding of Punnett squares and pedigree charts that involve single traits.</p>
Assessment Limits/Content Constraints	<p><u>Beyond Scope</u></p> <ul style="list-style-type: none"> • Codominance • Incomplete dominance • Allele
DOK(s)	2
Stimulus	Diagrams are highly recommended. Data tables may be included. If Punnett squares or pedigree charts are used, they must be limited to testing a single trait.
Tools	Scientific calculator provided
Sample Item Stem(s)	According to the information in the Punnett square, what is the likelihood that the offspring would have attached earlobes?

Sample Item

A population of a certain species of mammal was studied over many generations. The graph shows the percentages of fur colors observed in the population over the generations.



Which explanation is the most likely reason for individuals that have white fur first appearing in the population?

- A. The mammals adapted to a change in climate by changing their fur color.
- B. The mammals chose a different food source that resulted in a new fur color.
- C. A mutation occurred in an individual's fur color gene and resulted in a new fur color.
- D. A new predator moved into the area that caused the individuals to change fur color.

Domain	Life Sciences
Subdomain	LS4 Biological Evolution: Unity and Diversity
Standard	LS4-1. Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.
Emphasis Level	High
Evidence Statements	<p>The examinee will demonstrate understanding that evolution is the change of species over time.</p> <p>The examinee will demonstrate understanding that Earth’s present-day species developed from earlier, distinctly different species.</p> <p>The examinee will demonstrate understanding that the theory of evolution is the central unifying theme of biology.</p> <p>The examinee will demonstrate understanding that the theory of evolution is well documented by extensive evidence from a wide variety of sources.</p> <p>The examinee will demonstrate understanding that evolutionary theory provides a scientific explanation for the molecular and structural similarities observed between the diverse species of living organisms and the fossil record of ancient life-forms.</p> <p>The examinee will demonstrate understanding that many thousands of layers of sedimentary rock provide evidence for the long history of Earth and for the long history of changing life-forms whose remains are found in the rocks.</p> <p>The examinee will demonstrate understanding that fossils are evidence that a great variety of species existed in the past. Recently deposited rock layers are more likely to contain fossils resembling existing species.</p> <p>The examinee will demonstrate understanding that billions of years ago, life on Earth began as simple, single-celled organisms.</p> <p>The examinee will demonstrate understanding that about a billion years ago, increasingly complex multicellular organisms began to evolve.</p> <p>The examinee will demonstrate understanding that evolutionary change is distinguished from the changes that occur during the lifetime of an individual organism.</p> <p>The examinee will recognize that species evolve over time.</p>

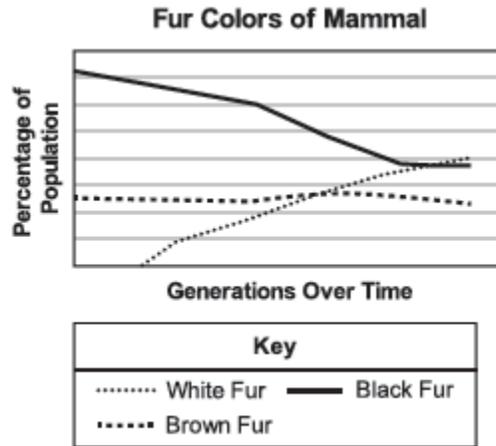
	<p>The examinee will demonstrate understanding that humans are like other living organisms. These similarities among humans and other living organisms may include the following:</p> <ul style="list-style-type: none"> • Are made up of cells • Have similar chemical composition • Have similar organ systems and physical characteristics • Reproduce in a similar way • Carry the same kind of genetic information system • Are part of a food web <p>The examinee will demonstrate understanding that the variation of organisms within a species increases the likelihood that at least some members of the species will survive under changed environmental conditions.</p>
Assessment Limits/Content Constraints	<p><u>Beyond Scope</u></p> <ul style="list-style-type: none"> • Calculations
DOK(s)	2
Stimulus	Items may include a chart or diagram.
Tools	Scientific calculator provided
Sample Item Stem(s)	Which statement <u>best</u> explains the theory of evolution?

Domain	Life Sciences
Subdomain	LS4 Biological Evolution: Unity and Diversity
Standard	LS4-2. Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species, due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.
Emphasis Level	Low
Evidence Statements	<p>The examinee will demonstrate understanding that organisms compete for vital resources in all environments.</p> <p>The examinee will demonstrate understanding that evolution is the consequence of the interactions among a variety of factors. These factors may include the following:</p> <ul style="list-style-type: none"> • The potential for a species to increase its numbers • The genetic variability of offspring, due to mutation and recombination of genes • A finite supply of the resources required for life • The ensuing selection by the environment of those offspring better able to survive and leave offspring
Assessment Limits/Content Constraints	<p><u>Beyond Scope</u></p> <ul style="list-style-type: none"> • Calculations
DOK(s)	2, 3
Stimulus	Data tables, graphs, or charts are recommended.
Tools	Scientific calculator provided
Sample Item Stem(s)	Based on the food web, which pair of species is <u>most likely</u> to compete for resources?

Domain	Life Sciences
Subdomain	LS4 Biological Evolution: Unity and Diversity
Standard	LS4-3. Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.
Emphasis Level	Low
Evidence Statements	<p>The examinee will demonstrate understanding that evolutionary changes may occur in structure, function, and behavior over time.</p> <p>The examinee will demonstrate understanding that competition for resources occurs within as well as between species.</p> <p>The examinee will demonstrate understanding that some characteristics give individuals an advantage over others in surviving and reproducing and the advantaged offspring, in turn, are more likely than others to survive and reproduce.</p> <p>The examinee will recognize that the proportion of individuals that have advantageous characteristics will increase.</p> <p>The examinee will demonstrate understanding that the variation of organisms within a species increases the likelihood that at least some members of the species will survive under changed environmental conditions.</p> <p>The examinee will demonstrate understanding that only changes in the genes of gametes can become the basis for evolutionary change in sexually reproducing organisms.</p>
Assessment Limits/Content Constraints	<p><u>Beyond Scope</u></p> <ul style="list-style-type: none"> Complex mathematical calculations
DOK(s)	2
Stimulus	Data tables, graphs, or diagrams are highly recommended.
Tools	Scientific calculator provided
Sample Item Stem(s)	Which statement correctly pairs the physical structure with the evolutionary challenge it <u>most likely</u> evolved to overcome?

Sample Item

A population of a certain species of mammal was studied over many generations. The graph shows the percentages of fur colors observed in the population over the generations.



Which statement would most likely help explain the changes over time in the percentages of the fur colors within the population?

- A. The mammals with white fur had an advantage in producing offspring.
- B. The mammals with brown fur had an advantage in producing offspring.
- C. The mammals with white fur had a disadvantage in producing offspring.
- D. The mammals with brown fur had a disadvantage in producing offspring.

Domain	Life Sciences
Subdomain	LS4 Biological Evolution: Unity and Diversity
Standard	LS4-4. Construct an explanation that is based on evidence for how natural selection leads to adaptation of populations.
Emphasis Level	Low
Evidence Statements	<p>The examinee will demonstrate understanding that biological evolution occurs through natural selection.</p> <p>The examinee will demonstrate understanding that natural selection is the result of multiple factors. These factors may include the following:</p> <ul style="list-style-type: none"> • Overproduction of offspring • Variations among offspring • The struggle for survival • The adaptive value of certain variations <p>• Survival and increased reproduction of those best adapted to a particular environment</p> <p>The examinee will demonstrate understanding that the diversity of life on Earth today is the result of natural selection occurring over a vast amount of geologic time for most organisms.</p>
Assessment Limits/Content Constraints	<p><u>Beyond Scope</u></p> <ul style="list-style-type: none"> • n/a
DOK(s)	2
Stimulus	A data table or graph is recommended.
Tools	Scientific calculator provided
Sample Item Stem(s)	Which statement <u>best</u> describes the effect of natural selection on a population?

Domain	Life Sciences
Subdomain	LS4 Biological Evolution: Unity and Diversity
Standard	LS4-5. Evaluate the evidence supporting claims that changes in environmental conditions may result in (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.
Emphasis Level	Low
Evidence Statements	<p>The examinee will demonstrate understanding that selection for individuals with a certain trait can result in changing the proportions of that trait in a population.</p> <p>The examinee will demonstrate understanding that for thousands of years, new varieties of cultivated plants and domestic animals have resulted from selective breeding for particular traits.</p> <p>The examinee will demonstrate understanding that in recent years, new varieties of farm plants and animals have been engineered by manipulating their genetic instructions to produce new characteristics.</p> <p>The examinee will demonstrate understanding that evolution does not necessitate long-term progress in some set direction.</p> <p>The examinee will demonstrate understanding that evolutionary changes appear to be like the growth of a bush. Some branches survive from the beginning with little or no change, many die out altogether, and others branch repeatedly, sometimes giving rise to more complex organisms.</p> <p>The examinee will demonstrate understanding that extinction of a species occurs when the environment changes and the adaptive characteristics of a species are insufficient to allow for its survival.</p> <p>The examinee will recognize that fossils indicate that many organisms that lived long ago are extinct.</p> <p>The examinee will demonstrate understanding that extinction of species is common.</p> <p>The examinee will demonstrate understanding that most of the species that have lived on Earth no longer exist.</p>
Assessment Limits/Content Constraints	<p><u>Beyond Scope</u></p> <ul style="list-style-type: none"> n/a
DOK(s)	2
Stimulus	Data tables or graphs are highly recommended.

Tools	Scientific calculator provided
Sample Item Stem(s)	Which factor would <u>most likely</u> lead to the extinction of a species?

Domain	Life Sciences
Subdomain	LS4 Biological Evolution: Unity and Diversity
Standard	LS4-6. Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.
Emphasis Level	Low
Evidence Statements	<p>The examinee will demonstrate understanding that biodiversity also ensures the availability of a rich variety of genetic material that may lead to future agricultural or medical discoveries with significant value to humankind.</p> <p>The examinee will demonstrate understanding that human activities that degrade ecosystems result in a loss of diversity of the living and nonliving environments.</p> <p>The examinee will demonstrate understanding that the influence of humans on other organisms occurs through land use and pollution.</p> <p>The examinee will demonstrate understanding that land use decreases the space and resources available to other species.</p> <p>The examinee will demonstrate understanding that pollution changes the chemical composition of air, soil, and water.</p> <p>The examinee will demonstrate understanding that when humans alter ecosystems either by adding or removing specific organisms, serious consequences may result. For example, planting large expanses of one crop reduces the biodiversity of the area.</p> <p>The examinee will demonstrate understanding that most of the species that have lived on Earth no longer exist.</p>
Assessment Limits/Content Constraints	<p><u>Beyond Scope</u></p> <ul style="list-style-type: none"> • Creating a simulation
DOK(s)	2
Stimulus	A data table or graph is highly recommended.
Tools	Scientific calculator provided
Sample Item Stem(s)	Which action would <u>most likely</u> increase biodiversity within this ecosystem?

Domain	Physical Sciences
Subdomain	PS1 Matter and Its Interactions
Standard	PS1-1. Use the Periodic Table as a model to predict the relative properties of elements, based on the patterns of electrons in the outermost energy level of atoms.
Emphasis Level	High
Evidence Statements	<p>The examinee will demonstrate understanding of the positions (nucleus or orbiting the nucleus) and charges for protons, neutrons, and electrons.</p> <p>The examinee will demonstrate understanding of the definitions of atom, element, and ion.</p> <p>The examinee will demonstrate understanding that atoms of any one element are the same, but different from the atoms of other elements.</p> <p>The examinee will demonstrate understanding that the properties of a compound are different from the properties of its constituent elements.</p> <p>The examinee will demonstrate understanding that the Periodic Table is a model for classifying elements.</p> <p>The examinee will demonstrate understanding of how to use the Periodic Table to identify an element as a metal, nonmetal, or noble gas.</p> <p>The examinee will demonstrate understanding that substances are often placed in categories if they react in similar ways. Examples include metals, nonmetals, and noble gases.</p> <p>The examinee will demonstrate understanding that atoms are far too small to see with a light microscope.</p> <p>The examinee will demonstrate understanding that elements combine in a multitude of ways to produce compounds that account for all living and nonliving substances.</p> <p>The examinee will demonstrate understanding that few elements are found in their pure forms.</p>
Assessment Limits/Content Constraints	<p><u>Beyond Scope</u></p> <ul style="list-style-type: none"> • Electron orbitals or shells • Reactivity • Valence electrons • Diatomic elements • Alkaline metals • Alkali Earth metals • Halogens
DOK(s)	1, 2

Stimulus	Items should include a partial Periodic Table when appropriate to help examinees answer the question.
Tools	Scientific calculator provided
Sample Item Stem(s)	Which element would <u>most likely</u> be identified as a nonmetal?

Domain	Physical Sciences
Subdomain	PS1 Matter and Its Interactions
Standard	PS1-2. Construct and revise an explanation for the outcome of a simple chemical reaction, based on the outermost electron states of atoms, trends in the Periodic Table, and knowledge of the patterns of chemical properties.
Emphasis Level	Medium
Evidence Statements	<p>The examinee will demonstrate the ability to identify products and reactants of a chemical reaction.</p> <p>The examinee will demonstrate understanding of the definitions of a compound and a molecule.</p> <p>The examinee will demonstrate understanding that atoms bond to form well-defined molecules or may be arranged in regular geometric patterns.</p> <p>The examinee will demonstrate understanding that the properties of a compound may be different from the properties of its constituent elements.</p> <p>The examinee will demonstrate understanding of how to interpret subscripts (number of atoms) and coefficients (number of molecules) for chemical formulas and chemical equations.</p>
Assessment Limits/Content Constraints	<p><u>Beyond Scope</u></p> <ul style="list-style-type: none"> • Electronegativity • Types of chemical bonds • Valence electrons • Lewis Dot models • Use of a Greek delta (Δ) without definition
DOK(s)	1, 2
Stimulus	A chemical equation or diagram is recommended.
Tools	Scientific calculator provided
Sample Item Stem(s)	Which of these would <u>most likely</u> be classified as a compound?

Domain	Physical Sciences
Subdomain	PS1 Matter and Its Interactions
Standard	PS1-3. Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.
Emphasis Level	High
Evidence Statements	<p>The examinee will demonstrate understanding of the three basic phases of matter: solid, gas, and liquid.</p> <p>The examinee will demonstrate understanding that gases have neither a definite shape nor a definite volume. Gases assume the shape and volume of a closed container.</p> <p>The examinee will demonstrate understanding that a liquid has a definite volume but takes the shape of a container.</p> <p>The examinee will demonstrate understanding that a solid has a definite shape and a definite volume. Particles resist a change in position.</p> <p>The examinee will demonstrate understanding that the motion of particles helps to explain the phases (states) of matter. The phase that matter exists in depends on the attractive forces between its particles.</p> <p>The examinee will demonstrate understanding that during a phase change, heat energy is absorbed or released.</p> <p>The examinee will demonstrate understanding that energy is absorbed when a solid changes to a liquid and when a liquid changes to a gas.</p> <p>The examinee will demonstrate understanding that energy is released when a gas changes to a liquid and when a liquid changes to a solid.</p> <p>The examinee will demonstrate understanding of the characteristic properties of substances including color, hardness, freezing points, and boiling points.</p> <p>The examinee will demonstrate understanding of calculations involving density, with formula supplied.</p> <p>The examinee will demonstrate understanding that most substances expand when heated and contract when cooled. The examinee will recognize that water is an exception, expanding when changing to ice.</p> <p>The examinee will demonstrate understanding that buoyancy is determined by comparative densities.</p>

	<p>The examinee will demonstrate understanding of physical changes including freezing, melting, condensation, boiling, evaporation, tearing, and crushing.</p> <p>The examinee will demonstrate understanding that chemical change involves forming new substances with different physical and chemical properties.</p> <p>The examinee will recognize examples of chemical change, such as the burning of wood, the cooking of an egg, the rusting of iron, and the souring of milk.</p> <p>The examinee will demonstrate understanding that mixtures are physical combinations of materials and can be separated by physical means.</p> <p>The examinee will demonstrate understanding that water freezes at 0°C (32°F) and boils at 100°C (212°F) at standard pressure.</p>
Assessment Limits/Content Constraints	<p><u>Beyond Scope</u></p> <ul style="list-style-type: none"> • Heat of vaporization or fusion • Specific gravity • Surface tension • Crystalline structure • Specific intermolecular forces
DOK(s)	2
Stimulus	A data table, graph, or diagram is recommended.
Tools	Scientific calculator provided
Sample Item Stem(s)	At which temperature will water change from a liquid to a solid?

Domain	Physical Sciences
Subdomain	PS1 Matter and Its Interactions
Standard	PS1-4. Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.
Emphasis Level	Medium
Evidence Statements	<p>The examinee will demonstrate understanding of the conservation of energy.</p> <p>The examinee will demonstrate understanding that energy can be stored in chemical bonds.</p> <p>The examinee will demonstrate understanding that ATP stores energy for biological processes.</p> <p>The examinee will demonstrate understanding that heat is a form of energy.</p> <p>The examinee will demonstrate understanding that in chemical reactions, energy is transferred into or out of a system. Light, electricity, or mechanical motion may be involved in such transfers, in addition to heat.</p>
Assessment Limits/Content Constraints	<p><u>Beyond Scope</u></p> <ul style="list-style-type: none"> • Specifics of bond energy • Enthalpy • Potential energy diagrams
DOK(s)	1, 2
Stimulus	A diagram is highly recommended.
Tools	Scientific calculator provided
Sample Item Stem(s)	Why does adding heat often increase the rate at which a reaction occurs?

Domain	Physical Sciences
Subdomain	PS1 Matter and Its Interactions
Standard	PS1-5. Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.
Emphasis Level	Low
Evidence Statements	<p>The examinee will demonstrate understanding that catalysts increase the rate of chemical reactions.</p> <p>The examinee will demonstrate understanding that enzymes serve as biological catalysts for chemical reactions.</p> <p>The examinee will demonstrate understanding that higher temperatures generally increase the rate of chemical reactions.</p> <p>The examinee will demonstrate understanding that solubility can be affected by the nature of the solute and solvent, temperature, and pressure.</p> <p>The examinee will demonstrate understanding that the rate of solution can be affected by the size of the particles, stirring, temperature, and the amount of solute already dissolved.</p>
Assessment Limits/Content Constraints	<p><u>Beyond Scope</u></p> <ul style="list-style-type: none"> • Le Châtelier's principle • The Haber process
DOK(s)	2, 3
Stimulus	A graph or diagram is recommended.
Tools	Scientific calculator provided
Sample Item Stem(s)	Which physical change would <u>most likely</u> increase the rate of reaction?

Domain	Physical Sciences
Subdomain	PS1 Matter and Its Interactions
Standard	PS1-7. Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.
Emphasis Level	Low
Evidence Statements	<p>The examinee will demonstrate understanding that interactions between atoms and/or molecules result in chemical reactions.</p> <p>The examinee will recognize that the number and types of atoms are the same both before and after a reaction.</p> <p>The examinee will demonstrate understanding of the Law of Conservation of Mass, which states that the total mass of the reactants is equal to the total mass of the products.</p>
Assessment Limits/Content Constraints	<p><u>Beyond Scope</u></p> <ul style="list-style-type: none"> • Chemical formulas and/or names of specific compounds • Calculations
DOK(s)	2
Stimulus	A simplified equation or diagram is recommended.
Tools	Scientific calculator provided
Sample Item Stem(s)	Molecule X reacts with molecule Y, yielding XY_2 and no other products. If 2.5 grams of X are reacted with 5 grams of Y and the reaction goes to completion, how many grams of XY_2 would be collected?

Domain	Physical Sciences
Subdomain	PS2 Motion and Stability: Forces and Interactions
Standard	PS2-1. Analyze data to support the claim that Newton’s Second Law of Motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.
Emphasis Level	High
Evidence Statements	<p>The examinee will demonstrate understanding that energy and matter interact through forces that result in changes in an object’s motion.</p> <p>The examinee will demonstrate understanding that the motion of an object is always judged with respect to some other object or point and that the idea of absolute motion or rest is misleading.</p> <p>The examinee will demonstrate understanding that the motion of an object can be described by its position, direction of motion, and speed.</p> <p>The examinee will demonstrate understanding that forces are defined as a push or a pull.</p> <p>The examinee will demonstrate understanding of calculations using Newton’s Second Law, if the equation is given.</p> <p>The examinee will demonstrate understanding of common forces such as gravity, magnetism, and electricity.</p> <p>The examinee will demonstrate understanding that friction is a force that opposes motion, and should always be considered in a discussion of motion.</p> <p>The examinee will demonstrate understanding that when forces acting on an object are unbalanced, changes in that object’s motion occur.</p> <p>The examinee will demonstrate understanding that an object’s motion is the result of the combined effect of all forces acting on the object.</p> <p>The examinee will demonstrate understanding that force is directly related to an object’s mass and acceleration. The greater the force acting on an object, the greater the change in motion.</p> <p>The examinee will demonstrate understanding that a moving object that is not subjected to a force will continue to move at a constant speed in a straight line.</p> <p>The examinee will demonstrate understanding that object at rest will remain at rest.</p> <p>The examinee will demonstrate understanding that changes in motion could include a change in speed or a change in direction.</p>

	<p>The examinee will demonstrate understanding that when forces are balanced, the motion of an object will remain unchanged.</p> <p>The examinee will demonstrate understanding that the laws that govern motion allow us to predict changes in motion.</p> <p>The examinee will demonstrate understanding of how to find the resultant of forces acting in the same or opposite directions.</p>
Assessment Limits/Content Constraints	<p><u>Beyond Scope</u></p> <ul style="list-style-type: none"> • Units for acceleration and force • Memorization of Newton’s Laws of Motion and the formula of the Second Law • Calculation of the resultant of forces acting at angles other than 0 or 180 degrees (the same or opposite direction)
DOK(s)	2, 3
Stimulus	Diagrams are recommended. If the item includes a calculation about Newton’s Second Law, the equation MUST be included in the item.
Tools	Scientific calculator provided
Sample Item Stem(s)	What would be the acceleration of a 1-kilogram (kg) object after a 7-newton (N) force is applied from the left? Given: $F = ma$. F = force. m = mass. a = acceleration.

Sample Item

An object at rest with a mass of 4 kilograms (kg) is acted on by a force, causing the object to move. The table shows the measurements of the object's motion.

Time (s)	Velocity (m/s)
0	0
1	2
2	4
3	6
4	8
5	10

The relationship between the force acting on an object and the object's mass and acceleration (change in object's velocity over time) is defined by the formula:

$$\text{Acceleration} = (\text{final velocity} - \text{initial velocity}) / (\text{final time} - \text{initial time})$$

$$\text{Force} = \text{mass} \times \text{acceleration}$$

Based on the data in the table, which equation correctly calculates the amount of force, in newtons (N), acting on the object?

- A. $4 \text{ kg} \times 5 \text{ s} = 20 \text{ N}$
- B. $4 \text{ kg} \times 2 \text{ m/s}^2 = 8 \text{ N}$
- C. $4 \text{ kg} \times 10 \text{ m/s} = 40 \text{ N}$
- D. $4 \text{ kg} \times 0.5 \text{ m/s}^2 = 2 \text{ N}$

Domain	Physical Sciences
Subdomain	PS2 Motion and Stability: Forces and Interactions
Standard	PS2-2. Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.
Emphasis Level	Low
Evidence Statements	<p>The examinee will demonstrate understanding of calculating momentum for one object, given the momentum formula.</p> <p>The examinee will demonstrate understanding that momentum is directly affected by mass and velocity.</p> <p>The examinee will demonstrate understanding that for every action, there is an equal and opposite reaction.</p>
Assessment Limits/Content Constraints	<p><u>Beyond Scope</u></p> <ul style="list-style-type: none"> • Calculation of momentum involving multiple objects • Memorization of momentum formula
DOK(s)	1, 2
Stimulus	Items may include data, diagrams, and calculations involving single objects (with equation provided).
Tools	Scientific calculator provided
Sample Item Stem(s)	What would be the mass of an object moving at 23 meters per second (m/s) with 1,725 units of momentum? Given: $p = mv$. p = momentum. m = mass. v = velocity.

Domain	Physical Sciences
Subdomain	PS2 Motion and Stability: Forces and Interactions
Standard	PS2-3. Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.
Emphasis Level	Low
Evidence Statements	The examinee will demonstrate understanding of devices that reduce the force on an object during collision, such as air bags, padding, and parachutes.
Assessment Limits/Content Constraints	<u>Beyond Scope</u> <ul style="list-style-type: none"> • Impulse
DOK(s)	1, 2
Stimulus	Items can contain data tables or diagrams.
Tools	Scientific calculator provided
Sample Item Stem(s)	Which device is primarily used to reduce the amount of force on an object?

Sample Item

Which of these is an example of a safety feature that reduces the amount of force experienced during a collision involving a car?

- A concrete barrier on a road helps prevent cars from driving into a ditch.
- An engine helps supply power to the wheels to increase the velocity of a car.
- A car windshield is constructed from reinforced layers to help prevent shattering.
- An airbag in a car helps increase the amount of time that a person takes to slow down.

Domain	Physical Sciences
Subdomain	PS2 Motion and Stability: Forces and Interactions
Standard	PS2-4. Use mathematical representations of Newton’s Law of Gravitation and Coulomb’s Law to describe and predict the gravitational and electrostatic forces between objects.
Emphasis Level	Medium
Evidence Statements	<p>The examinee will demonstrate understanding of charges for protons, neutrons, and electrons.</p> <p>The examinee will demonstrate understanding that forces of attraction and repulsion are based on the charges of particles.</p> <p>The examinee will demonstrate understanding that forces between particles are dependent on charge and distance.</p> <p>The examinee will demonstrate understanding that material that has been electrically charged attracts uncharged material and may either attract or repel other charged material.</p> <p>The examinee will demonstrate understanding that every object exerts gravitational force on every other object.</p> <p>The examinee will demonstrate understanding that gravitational force depends on how much mass objects have and how far apart the objects are.</p> <p>The examinee will demonstrate understanding that gravity is one of the forces acting on orbiting objects and projectiles.</p>
Assessment Limits/Content Constraints	<p><u>Beyond Scope</u></p> <ul style="list-style-type: none"> • Calculations of forces based on Newton’s Law of Gravitation or Coulomb’s Law • Inverse square relationship of force and distance
DOK(s)	2, 3
Stimulus	The use of diagrams and appropriate formulas/equations is highly recommended.
Tools	Scientific calculator provided
Sample Item Stem(s)	What effect would increasing the distance between two objects have on the gravitational force between the objects?

Domain	Physical Sciences
Subdomain	PS2 Motion and Stability: Forces and Interactions
Standard	PS2-5. Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.
Emphasis Level	Low
Evidence Statements	<p>The examinee will demonstrate understanding that electrical circuits provide a means of transferring electrical energy.</p> <p>The examinee will demonstrate understanding that electric currents and magnets can exert forces on each other.</p> <p>The examinee will demonstrate understanding that a magnet attracts certain materials and either attracts or repels other magnets without direct contact.</p> <p>The examinee will demonstrate understanding that the attractive force of a magnet is greatest at its poles.</p>
Assessment Limits/Content Constraints	<p><u>Beyond Scope</u></p> <ul style="list-style-type: none"> • Specifics of electromagnetic induction • Calculations
DOK(s)	2
Stimulus	Items may include data tables, graphs, or diagrams.
Tools	Scientific calculator provided
Sample Item Stem(s)	Which statement would <u>best</u> describe the forces acting on two magnets?

Sample Item

Which statement would best describe the forces acting on two magnets?

- Like poles attract, and opposite poles repel.
- Like poles repel, and opposite poles attract.
- Like poles attract, and opposite poles attract.
- Like poles repel, and opposite poles repel.

Domain	Physical Sciences
Subdomain	PS3 Energy
Standard	PS3-1. Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.
Emphasis Level	Medium
Evidence Statements	<p>The examinee will demonstrate understanding of the Law of Conservation of Energy, which states that energy cannot be created or destroyed.</p> <p>The examinee will demonstrate understanding that heat is a calculated value that includes the temperature of the material, the mass of the material, and the type of material.</p> <p>The examinee will demonstrate understanding that temperature is a direct measurement of the average kinetic energy of the particles in a sample of material.</p> <p>The examinee will demonstrate understanding that temperature is not a measurement of heat.</p>
Assessment Limits/Content Constraints	<p><u>Beyond Scope</u></p> <ul style="list-style-type: none"> • Heat calculations • Specific heat capacity • Ambient temperature
DOK(s)	1, 2
Stimulus	Items may include diagrams, data tables, and graphs. Defined equations should be included with items requiring calculations.
Tools	Scientific calculator provided
Sample Item Stem(s)	Which statement <u>best</u> describes the energy within a closed system?

Domain	Physical Sciences
Subdomain	PS3 Energy
Standard	PS3-2. Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative positions of particles (objects).
Emphasis Level	Medium
Evidence Statements	<p>The examinee will demonstrate understanding that atoms and molecules are perpetually in motion, such that the greater the temperature, the greater the motion.</p> <p>The examinee will demonstrate understanding that energy can be either kinetic energy or potential energy. Kinetic energy is the energy of motion. Potential energy depends on relative position.</p> <p>The examinee will demonstrate understanding of different forms of energy including heat, light, electrical, mechanical, sound, nuclear, and chemical.</p> <p>The examinee will demonstrate understanding of calculations involving gravitational potential energy, with the equation given: $PE = mgh$.</p> <p>The examinee will demonstrate understanding of calculations involving kinetic energy, with the equation given: $KE = \frac{1}{2} mv^2$.</p>
Assessment Limits/Content Constraints	<p><u>Beyond Scope</u></p> <ul style="list-style-type: none"> Memorization of potential energy and kinetic energy formulas
DOK(s)	2, 3
Stimulus	A simple diagram is recommended. Items may also include simple data tables or graphs. Items with calculations MUST include appropriate formulas/equations.
Tools	Scientific calculator provided
Sample Item Stem(s)	At which temperature would the atoms within hydrogen gas have the <u>greatest</u> motion?

Domain	Physical Sciences
Subdomain	PS3 Energy
Standard	PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.
Emphasis Level	Low
Evidence Statements	<p>The examinee will demonstrate understanding that energy can be transformed from one form to another.</p> <p>The examinee will demonstrate understanding that energy is transformed in many ways.</p> <p>The examinee will demonstrate understanding that most activities in everyday life involve one form of energy being transformed into another. For example, chemical energy in gasoline is transformed into mechanical energy in an automobile engine.</p> <p>The examinee will demonstrate understanding of heat energy is almost always one of the products of energy transformations.</p> <p>The examinee will demonstrate understanding that electrical energy can be produced from a variety of energy sources. Electrical energy can be transformed into almost any other form of energy.</p> <p>The examinee will demonstrate understanding that machines transfer mechanical energy from one object to another.</p> <p>The examinee will demonstrate understanding that a machine can be made more efficient by reducing friction. A common way of reducing friction is lubricating or waxing surfaces.</p> <p>The examinee will demonstrate understanding that machines can change the direction of force, the amount of force, the distance of force, or the speed of force required to do work.</p> <p>The examinee will demonstrate understanding that simple machines include a lever, a pulley, a wheel and axle, and an inclined plane.</p> <p>The examinee will demonstrate understanding that a complex machine (e.g., a bicycle) uses a combination of interacting simple machines.</p>
Assessment Limits/Content Constraints	<p><u>Beyond Scope</u></p> <ul style="list-style-type: none"> • Applications of specific heat capacity
DOK(s)	2
Stimulus	A diagram is highly recommended. Items may also include data tables or graphs.

Tools	Scientific calculator provided
Sample Item Stem(s)	Which process is <u>most likely</u> to produce electrical energy?

Domain	Physical Sciences
Subdomain	PS3 Energy
Standard	PS3-4. Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).
Emphasis Level	Low
Evidence Statements	<p>The examinee will demonstrate understanding that heat moves in predictable ways, flowing from warmer objects to cooler ones, until both reach the same temperature.</p> <p>The examinee will demonstrate understanding that heat can be transferred through matter by the collisions of atoms and/or molecules (conduction), or through space (radiation).</p> <p>The examinee will demonstrate understanding that in a liquid or gas, currents will facilitate the transfer of heat (convection).</p>
Assessment Limits/Content Constraints	<p><u>Beyond Scope</u></p> <ul style="list-style-type: none"> • Memorization of the second law of thermodynamics • Entropy
DOK(s)	2, 3
Stimulus	A diagram is highly recommended. Items may also include data tables or graphs.
Tools	Scientific calculator provided
Sample Item Stem(s)	Which type of heat transfer occurs within the liquid in a pot of boiling water?

Domain	Physical Sciences
Subdomain	PS3 Energy
Standard	PS3-5. Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.
Emphasis Level	Low
Evidence Statements	<p>The examinee will demonstrate understanding that the force between two charged particles changes as the distance between the particles changes.</p> <p>The examinee will demonstrate understanding that the force between magnetized objects changes as the distance between the objects changes.</p> <p>The examinee will demonstrate understanding that energy may be stored in magnetic and/or electric fields.</p> <p>The examinee will demonstrate understanding that when two like charges or two like magnetic poles are moved closer together, the energy of the system increases.</p> <p>The examinee will demonstrate understanding that when two unlike charges or opposite magnetic poles are moved farther apart, the energy of the system increases.</p>
Assessment Limits/Content Constraints	<p><u>Beyond Scope</u></p> <ul style="list-style-type: none"> • Calculating the amount of energy stored or produced as the system changes • Calculating the change in force between the two charges/objects as the distance changes • Systems involving more than two charges/objects
DOK(s)	2, 3
Stimulus	A diagram is highly recommended. Calculations are NOT recommended. Items are limited to the foundational knowledge of a concept.
Tools	Scientific calculator provided
Sample Item Stem(s)	Which action would <u>most likely</u> increase the energy of this system?

Domain	Physical Sciences
Subdomain	PS4 Waves and Their Applications in Technologies for Information Transfer
Standard	PS4-1. Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.
Emphasis Level	Medium
Evidence Statements	<p>The examinee will demonstrate understanding that different forms of electromagnetic energy have different wavelengths.</p> <p>The examinee will recognize examples electromagnetic energy including microwaves, infrared light, visible light, ultraviolet light, X-rays, and gamma rays.</p> <p>The examinee will demonstrate understanding that light passes through some materials, sometimes refracting in the process.</p> <p>The examinee will demonstrate understanding that materials absorb and reflect light and may transmit light.</p> <p>The examinee will demonstrate understanding that to see an object, light emitted or reflected from that object must enter the eye.</p> <p>The examinee will demonstrate understanding that vibrations in materials set up wave-like disturbances (e.g., sound waves) that spread away from the source.</p> <p>The examinee will demonstrate understanding that vibrational waves move at different speeds in different materials.</p> <p>The examinee will demonstrate understanding of the definition of a vacuum.</p> <p>The examinee will demonstrate understanding that sound cannot travel in a vacuum.</p> <p>The examinee will demonstrate understanding of the formula for velocity, $v = f\lambda$, when the formula is given and variables are defined.</p>
Assessment Limits/Content Constraints	<p><u>Beyond Scope</u></p> <ul style="list-style-type: none"> • Calculations with quantities expressed in scientific notation employing negative exponents • Refractive indices • Snell's Law
DOK(s)	1, 2
Stimulus	Items/questions may include data tables, graphs, diagrams, and/or simple calculations. Items with calculations must include an appropriately defined formula/equation.
Tools	Scientific calculator provided
Sample Item Stem(s)	Through which media can sound waves <u>not</u> travel?

Domain	Physical Sciences
Subdomain	PS4 Waves and Their Applications in Technologies for Information Transfer
Standard	PS4-2. Evaluate questions about the advantages of using a digital transmission and storage of information.
Emphasis Level	Low
Evidence Statements	<p>The examinee will demonstrate understanding that digital information involves coding information by using only “ones and zeros.”</p> <p>The examinee will demonstrate understanding that words, numbers, and audio and visual information can be coded digitally.</p> <p>The examinee will demonstrate understanding that computers and digital devices operate by using digital information.</p> <p>The examinee will demonstrate understanding of the basic advantages and disadvantages of digital information.</p>
Assessment Limits/Content Constraints	<p><u>Beyond Scope</u></p> <ul style="list-style-type: none"> • Binary code • Hexadecimal code • Details of fiber optic transmission
DOK(s)	1
Stimulus	Items may include diagrams, data tables, or graphs.
Tools	Scientific calculator provided
Sample Item Stem(s)	What is <u>one</u> advantage of storing information digitally?

4) Other TASC Science Test Specifications

a) Scoring Rules and Rubrics

Multiple-Choice (MC) Items

MC items have four answer options with a single correct response. These items are worth 1 point each. An examinee receives 1 point for a correct response and 0 points for an incorrect response.

Autoscored Items

Autoscored item types that are offered on both print and online forms are included in the TASC subtest in Science. These item types include Multiple-Selected Response (MSR), Two-Part Multiple Choice, and Technology Enhanced items such as Drag and Drop (DND), Interactive Matching, and Dropdown List items. Autoscored items worth 1 point and autoscored items worth 2 points are included in both online and print forms. Technology Enhanced items (which appear only online) have companion items on the print forms. These companion items are presented as MSR or two-part multiple choice items such that the companion item assesses the same skill at the same level of rigor as the TE item. (A sample online item and its print companion are shown for LS2-1 on pages 60 and 61 of this document.) An examinee can receive partial credit for each of these item types as described below.

MSR

Multiple-Selected Response (MSR) items may ask examinees to identify two or three correct responses. When responding to items that have three correct answers, examinees will earn 2 points for identifying all three correct responses and 1 point for identifying two correct responses. An examinee will receive 0 points for identifying 0 or 1 correct responses. When responding to items that have two correct answers, examinees will receive 1 point for identifying both correct responses and 0 points for identifying 0 or 1 correct responses. Each MSR item in the Science subtest has six answer options. An examinee responds by selecting (filling in a bubble in the answer document or the online testing environment) up to the specified number of answer options, and each item indicates how many correct responses should be selected. MSR items appear in both print and online forms.

Two-Part Multiple Choice or Two-Part Multiple Select

A Two-Part Multiple Choice or Two-Part Multiple Select item is typically used as the print companion of a technology-enhanced item. As such, it may be worth 1 or 2 points, depending on the point value of the accompanying online item. If the item is worth 2 points, the scoring of the two parts is independent, and examinees may receive one point for each part.

DND

Drag and Drop (DND) items ask examinees to drag responses to two or more drop areas, or response areas. These items may be worth 1 or 2 points, depending on the number of responses that are expected. If a DND item is worth 2 points, an examinee will receive 2 points for a completely correct response and 1 point for a response that is at least 50% correct (e.g., if an examinee is asked to label a diagram by dragging each of four labels into the diagram, the examinee would receive 2 points for all four labels correctly placed, 1 point for 2-3 labels correctly placed, and 0 points for 0-1 labels correctly placed).

Interactive Matching

Interactive Matching items ask examinees to correctly classify each of a list of two or more examples (rows in a table) as one of two or more categories (columns in the table). These items may be worth 1 or 2 points, depending on the number of responses that are expected. If an Interactive Matching item is worth 2 points, an examinee will receive 2 points for a completely correct response and 1 point for a response that is at least 50% correct (e.g., if an examinee is asked to identify each of four organisms as a consumer, producer, or decomposer, the examinee would receive 2 points for correctly identifying all 4 organisms, 1 point for correctly labeling 2 or 3 organisms, and 0 points for correctly labeling 0 or 1 organisms).

Dropdown List

Dropdown List items ask examinees to drag responses to two or more drop areas, or response areas. These items may be worth 1 or 2 points, depending on the number of responses that are expected. If a Dropdown List item is worth 2 points, an examinee will receive 2 points for a completely correct response and 1 point for a partially correct response (e.g., if an examinee is asked to complete two sentences by selecting from dropdown lists within each sentence, the examinee would receive 2 points for correctly completing both sentences, 1 point for correctly completing one sentence, and 0 points for not correctly completing either sentence).

Constructed-Response (CR) Items

Constructed-Response (CR) items are worth 2 points. An examinee can receive either 2 points for fulfilling all the requirements for a correct response, 1 point for a partially correct response, or 0 points for a response that is completely irrelevant or completely incorrect. If no response is present, a condition code is assigned. Scoring rubrics are included in this document in the section following the specification tables.

A CR item can ask a question (e.g., How ...) or can prompt with a directive (e.g., Explain how...). A CR item may have more than one question or prompt, if necessary. A lead-in will typically have one paragraph of text (or less) and may have one or two graphics.

Analytic Scoring Rubrics

TASC Science subtests use analytic rubrics that describe the type(s) of acceptable response(s) for each key element being scored. Typically, a CR item will require a separate key element for each score point. The rubric must be designed in such a way to allow each key element to be identified accurately, consistently, efficiently, and fairly across the full range of possible responses.

Each score point level should represent a distinct level of performance (i.e., a response awarded a score of 2 demonstrates additional knowledge and skills distinct from those demonstrated in a response awarded a score of 1, etc.). The question and rubric should avoid dependencies that create a “domino effect” where a response either gets everything correct or nothing correct. Partially correct responses (such as scoring 1 out of 2 points) must be possible to attain.

- Ensure that the CR item is eliciting responses that provide rich information about performance.
- If an actual response states the same idea in slightly different (but still accurate) wording, it will receive credit. The response does not necessarily have to match the exact wording in the rubric.
- For bulleted lists, indicate what quantity of responses (“any one”, “any two”, etc.) are needed to receive full credit.
- If necessary, include scoring note(s) to help clarify what responses are acceptable and/or how to award the key elements.
- The analytical scoring rubrics for the sample CR items aligned with standard **LS1-1** and standard **LS1-2** (sample 2) are included below.

TASC Science 2-Point Analytic Scoring Rubric Samples

Sample LS1-1

See page 43 for Sample LS1-1

Score: 2

Rationale: Two key elements

Exemplar:

Part 1. Any one of the following:

- Protein
- Peptide
- Polypeptide
- Other valid response

Part 2. Any response indicating that the order of the DNA codon/code determines the specific amino acid OR protein OR peptide OR polypeptide that is built

Score: 1

Rationale: One key element

Exemplar: N/A

Score: 0

Rationale: Other

Exemplar: N/A

Sample LS1-2

See page 47 for Sample LS1-2

Score: 2

Rationale: Two key elements

Exemplar:

Part 1. Common to Plant and Animal Cells

Any one of the following:

- Cell membrane
- Nucleus
- Chromosomes/Genes/DNA
- Mitochondria
- Cytoplasm
- Ribosomes
- Endoplasmic reticulum
- Golgi bodies
- Vacuoles
- Other valid part of a cell that can be found in both a plant cell and an animal cell

Part 2. Difference in Plant and Animal Cells

Any one of the following:

- A plant cell has a cell wall, but an animal cell does not.
- A plant cell has chloroplasts, but an animal cell does not.
- A plant cell (typically) has one large vacuole, but an animal cell (typically) has many small vacuoles.
- An animal cell has centrioles, but a plant cell does not.

Scoring Note: The response describing a difference must specify (or imply) which type of cell possesses or lacks the particular part. For example, “chloroplasts” is insufficient because it does not specify which type of cell possesses chloroplasts, but “Plant cells have chloroplasts” is acceptable because it is specific (and it implies that animal cells do not have chloroplasts.)

Score: 1

Rationale: One key element

Exemplar: N/A

Score: 0

Rationale: Other

Exemplar: N/A

b) Item/Stimuli Graphic Guidelines

Any art used should be necessary in order to answer the question. All the following are considered graphics: tables, charts, graphs, diagrams, pictures, etc.

Graphics used in stimuli or items must take into consideration the size limitations associated with the TASC art specifications. If a stimulus or item has one graphic, the maximum allowed size of the graphic is approximately 4.5 inches wide by 4.5 inches high. Each graphic is allowed half of the maximum space, whether they are presented vertically or horizontally. Graphic stimuli should be used only when they are necessary to answer the question.

c) Item Accessibility

In general, vocabulary within an item should be at or below the grade level being tested. The concept is being tested, not the examinee's ability to decipher the question. For TASC tests, vocabulary should be at the 9th-grade level.

Additional considerations include the following:

- Use plain, common language
- Avoid extraneous phrases and clauses
- Avoid including excessive data in stimuli
- Include clear titles and labels with all graphic stimuli
- Avoid using idioms (e.g., long time, leading edge, dry run, kitty-corner)
- Use simple, describable graphic stimuli (tables, graphs, charts, and diagrams)
- Avoid certain English word choices or phrases that may cause linguistic issues in translation and interpretation (e.g., billion, library, fabric, ton, deck of cards)