Item #	Rationale	
1	Option A is correct	Table A correctly describes divergent plate boundaries as moving away from each other and forming ridges and rifts and convergent plate boundaries as moving toward each other and forming trenches and mountains. Volcanic activity is present in both.
	Option B is incorrect	Table B incorrectly describes divergent plate boundaries as moving toward each other and having no volcanic activity and convergent plate boundaries as moving away from each other.
	Option C is incorrect	Table C incorrectly identifies divergent plate boundaries as forming trenches and mountains and having no volcanic activity and convergent plate boundaries as forming ridges and rifts and having no volcanic activity.
	Option D is incorrect	Table D incorrectly describes divergent plate boundaries as moving toward each other and forming trenches and mountains and convergent plate boundaries as moving away from each other, forming ridges and rifts, and having no volcanic activity.

Item #	Rationale	
2	Option D is correct	According to Newton's first law, an object in motion tends to keep moving at a constant speed in a straight line unless it is acted on by an unbalanced force. The sphere will go first to the location indicated in Diagram D.
	Option A is incorrect	Diagram A does not follow the path predicted by Newton's first law.
	Option B is incorrect	Diagram B does not follow the path predicted by Newton's first law.
	Option C is incorrect	Diagram C does not follow the path predicted by Newton's first law.

Item #	Rationale	
3	2 pts.	The student's response includes: The three elements represented in the formula are sodium (Na), sulfur (S), and oxygen (O). There are 2 atoms of sodium, 1 atom of sulfur, and 4 atoms of oxygen represented.
	1 pt.	The student answered half of the question correctly.
	0 pts.	The response is incorrect or irrelevant.

Item #	Rationale	
4	Option C is correct	The Northern Hemisphere is tilted toward the sun, which indicates summer in Texas.
	Option A is incorrect	The Northern Hemisphere is tilted away from the sun, which indicates winter in Texas.
	Option B is incorrect	This diagram indicates fall in Texas.
	Option D is incorrect	This diagram indicates spring in Texas.

Item #	Rationale	
5	Option B is correct	Growing taller than nearby plants would help a plant in a rain forest compete for sunlight.
	Option A is incorrect	Producing thick stems may provide resistance to wind but will not necessarily lead to the increased growth needed to reach the sunlight.
	Option C is incorrect	Producing small purple flowers may assist in attracting pollinators, but it is not associated with the ability to find sunlight.
	Option D is incorrect	Conservation of water is unrelated to adaptations that allow a plant to grow toward sunlight.

Item #	Rationale	
6	Option D is correct	Ocean temperatures are higher in the Gulf of Mexico in August than in January. Warm ocean waters provide energy to storm systems such as hurricanes.
	Option A is incorrect	Ocean temperature is the determining factor for hurricane formation, not wind speed.
	Option B is incorrect	Wave height varies each month. Large waves may occur during hurricanes, but they do not contribute to their formation.
	Option C is incorrect	While it is true that, in Texas, there is less rainfall in August than in January, hurricane formation is more dependent on ocean temperature than on the amount of rainfall.

Item #	Rationale	
7	Option D is correct	Eroded soil will collect at Area Z because it is a depression at the bottom of a hill.
	Option A is incorrect	Area W is on a slope, so soil will continue to move downward and will not collect at this location.
	Option B is incorrect	Area X is 10 meters above the bottom of the hill, so soil can continue to move downhill without collecting at this location.
	Option C is incorrect	Area Y is at the top of the hill, so soil will erode downhill from this location.

Item #	Rationale	
8	Option C is correct	This diagram shows the sun, moon, and Earth alignment during the third-quarter phase of the lunar cycle.
	Option A is incorrect	This diagram shows the sun, moon, and Earth alignment during the new-moon phase of the lunar cycle.
	Option B is incorrect	This diagram shows the sun, moon, and Earth alignment during the full-moon phase of the lunar cycle.
	Option D is incorrect	This diagram shows the sun, moon, and Earth alignment during the first-quarter phase of the lunar cycle.

Item #	Rationale	
9	Option D is correct	The mass of a proton is approximately 1 amu. The mass of an electron is so little that it is often ignored and represented as 0 amu.
	Option A is incorrect	The mass of a proton is approximately 1 amu, while the mass of an electron is roughly 0 amu.
	Option B is incorrect	The mass of a neutron is approximately 1 amu, while the mass of an electron is roughly 0 amu.
	Option C is incorrect	Protons and neutrons both have a mass of approximately 1 amu.

Item #	Rationale	
10	Option A is correct	Primary succession is the process of ecological succession that starts in an environment lacking soil and any living things.
	Option B is incorrect	An ecosystem beginning primary succession would have no animals present.
	Option C is incorrect	An ecosystem beginning primary succession would have no hardwood trees or other plants present.
	Option D is incorrect	Forest fires are disturbances that leave some of the ecosystem intact. Secondary succession, not primary succession, typically occurs after a forest fire.

Item #	Rationale	
11	Option B is correct	The constant slope on the initial distance-time graph indicates that the velocity of the cart is constant. On a velocity-time graph, a constant velocity is shown as a straight line with a slope of zero, which is represented in Graph B.
	Option A is incorrect	Graph A shows the velocity increasing and then leveling off; this does not reflect the data from the initial graph.
	Option C is incorrect	Graph C shows the velocity increasing at a constant rate; this does not reflect the data from the initial graph.
	Option D is incorrect	Graph D shows the velocity increasing; this does not reflect the data from the initial graph.

Item #	Rationale	
12	Option B is correct	The texture of peas is determined by genes found within chromosomes in the nucleus of each cell.
	Option A is incorrect	Genetic information is not located in the plasma membrane.
	Option C is incorrect	Genetic information that determines traits is not found in proteins in the cytoplasm.
	Option D is incorrect	The mitochondria provide energy for cells, they do not determine the traits of peas.

Item #	Rationale	
13	Top Left – Hot, bright Top Right – Cool, bright Bottom Left – Hot, dim Bottom Right – Cool, dim	On the H-R diagram, temperature decreases from left to right. This means that stars on the left side are hotter than stars on the right side. The luminosity increases from the bottom to the top. This means that stars near the bottom are dimmer than stars near the top.

Item #	Rationale	
14	Option C is correct	A grasshopper converts chemical energy stored in food into mechanical energy used for movement.
	Option A is incorrect	A microwave oven converts electrical energy into thermal energy.
	Option B is incorrect	A stove converts electrical or chemical energy into thermal energy.
	Option D is incorrect	Sunlight melting an icicle is an example of thermal energy causing a phase change.

Item #	Rationale	
15	Part A	
	Option C is correct	Element X is more reactive than Element Y. Element Y is likely nonreactive because of its full shell of valence electrons. Element X is likely very reactive because of its incomplete shell of valence electrons.
	Option A is incorrect	Element Y has a full shell of valence electrons and is unreactive.
	Option B is incorrect	Element X has only 7 valence electrons; this incomplete valence shell makes it very reactive.
	Option D is incorrect	Element X is more reactive than Element Y because of Element X's incomplete shell of valence electrons.
	Part B	
	Option C is correct	Element X has 7 valence electrons; therefore, this atom will react with other atoms to fill its valence shell.
	Option A is incorrect	It is unlikely that two atoms having the same number of electron shells will determine the atoms' reactivity.
	Option B is incorrect	Having ten neutrons in the nucleus contributes to the atom's mass, not to the atom's chemical reactivity.
	Option D is incorrect	Having an even number of protons and neutrons does not contribute to an atom's reactivity.

Item #	Rationale	
16	metals, valence electrons	All the elements in Group 2 of the periodic table are classified as **metals**. Each element in Group 2 has fewer **valence electrons** than any of the elements in Group 17.

Item #	Rationale	
17	Option A is correct	Location A describes an area near a transform plate boundary because earthquakes, not volcanoes, are characteristic of transform plates moving past each other.
	Option B is incorrect	Volcanic activity is not characteristic of transform plate boundaries.
	Option C is incorrect	No evidence of seismic activity in the last 10,000 years is an indication that Location C is not near a plate boundary.
	Option D is incorrect	Location D has characteristics of convergent or divergent plate boundaries because volcanic rocks are present.

Item #	Rationale	
18	Option C is correct	Insects that have traits such as thick exoskeletons are better equipped to resist insecticides. These insects are more likely to survive, reproduce, and pass on these helpful traits.
	Option A is incorrect	Insecticides do not change a plant's DNA to make it naturally resistance to insects.
	Option B is incorrect	Spraying insecticides does not affect whether plants are resistant to insects.
	Option D is incorrect	Insects that are not resistant to insecticides will die and not reproduce.

Item #	Rationale	
19	4.0 and any equivalent values are correct.	Solution: 32 N/8.0 kg = 4.0 m/s every second This is an efficient way to solve the problem; however, other methods could be used to solve the problem correctly.

Item #	Rationale	
20	Option B is correct	The law of conservation of mass can be used to determine that the total mass of the reactants is equal to the total mass of the products. Therefore, 74 g + 98 g = 136 g + 36 g; 172 g of reactants = 172 g of products.
	Option A is incorrect	This violates the law of conservation of mass; 74 g + 62 g does not equal 172 g.
	Option C is incorrect	This violates the law of conservation of mass; 74 g + 36 g does not equal 172 g.
	Option D is incorrect	This violates the law of conservation of mass; 74 g + 100 g does not equal 172 g.

Item #	Rationale	
21	Option C is correct	An electron has a negative charge, a neutron has no charge, and a proton has a positive charge.
	Option A is incorrect	A neutron is not positively charged, but a proton is.
	Option B is incorrect	An electron is negatively charged, not positively charged. A proton is positively charged, not negatively charged.
	Option D is incorrect	An electron has a negative charge, and a neutron has no charge.

Item #	Rationale	
22	Option B is correct	Offspring produced through sexual reproduction are genetically different from either parent, and offspring produced through asexual reproduction are identical to the parent.
	Option A is incorrect	Offspring size is not related to whether they were produced through sexual or asexual reproduction.
	Option C is incorrect	Offspring produced through sexual reproduction have genetic information from two parents, while offspring produced through asexual reproduction have genetic information from one parent. However, this does not mean that offspring produced through sexual reproduction have twice as much genetic information.
	Option D is incorrect	Offspring produced through sexual reproduction are genetically different from one another, while offspring produced through asexual reproduction are genetically identical to one another.

Item #	Rationale	
23	Option C is correct	The object has a mass of 33.0 grams and a volume of 43.68 cm^3 (length × width × height). The density can be found by dividing the mass by the volume. The density of the wood is 0.76 g/cm^3, which falls within the range of the density of plum wood.
	Option A is incorrect	The calculated density (0.76 g/cm^3) is too high to be bamboo wood.
	Option B is incorrect	The calculated density (0.76 g/cm^3) is too high to be English elm wood.
	Option D is incorrect	The calculated density (0.76 g/cm^3) is too low to be boxwood.

Item #	Rationale	
24	Sample 1 is a metalloid. Sample 2 is a nonmetal. Sample 3 is a metal. Sample 4 is a metal. Sample 5 is a metal.	Sample 1: Metalloids are shiny and brittle and can conduct electricity under certain conditions. Sample 2: Nonmetals are dull, are poor conductors of heat and electricity, and shatter when hit with a hammer. Sample 3: Metals are shiny, are good-to-excellent conductors of heat and electricity, can be stretched into wires, and will bend when hit with a hammer. Sample 4: Metals are shiny, are good-to-excellent conductors of heat and electricity, can be stretched into wires, and will bend when hit with a hammer. Sample 5: Metals are shiny, are good-to-excellent conductors of heat and electricity, can be stretched into wires, and will bend when hit with a hammer.

Item #	Rationale	
25	Part A	
	Option D is correct	Ecosystem Plan 4 contains the greatest diversity of species, so it will likely be the most sustainable.
	Option A is incorrect	Ecosystem Plan 1 does not contain as many species as another ecosystem option.
	Option B is incorrect	Ecosystem Plan 2 contains only one type of plant and one type of fish; there are more diverse ecosystems that would be more sustainable.
	Option C is incorrect	Ecosystem Plan 3 contains only plants and therefore does not have the most diverse species.
	Part B	
	Option C is correct	Ecosystems with more species are more sustainable, because there are both producers and consumers to produce carbon dioxide and oxygen for each other to utilize.
	Option A is incorrect	While plants are important sources of energy for organisms, having many different types of species makes an ecosystem sustainable.
	Option B is incorrect	While water quality is important, it is not a factor that directly relates to how sustainable the ecosystem is.
	Option D is incorrect	Ecosystems with fewer species are prone to imbalance if one species dies off, and such ecosystems are therefore less sustainable.

Item #	Rationale	
26	Option C is correct	The sun is located on an arm of the spiral-shaped Milky Way galaxy.
	Option A is incorrect	The sun is not in the center of the Milky Way galaxy. A black hole is located at the center of the galaxy.
	Option B is incorrect	The Milky Way galaxy is a spiral-shaped galaxy, not an elliptical-shaped galaxy.
	Option D is incorrect	The Milky Way galaxy is a spiral-shaped galaxy, not an elliptical-shaped galaxy.

Item #	Rationale	
27	Option B is correct	Speed is independent of direction, while velocity is dependent on direction. Position 1 is moving to the left, while Position 4 is moving upward.
	Option A is incorrect	The velocities at Positions 1 and 3 are different due to the difference in direction (position 1 is moving to the left and Position 3 is moving to the right), while the acceleration is zero at both positions.
	Option C is incorrect	Position 3 has an acceleration of zero, while Position 2 is accelerating due to the change in direction along the curved path.
	Option D is incorrect	The velocities at Positions 2 and 4 are different due to the difference in direction, while the speed at both positions is constant.

Item #	Rationale	
28	Option C is correct	The snowboarder has the most gravitational potential energy when highest above the ground. As the snowboarder moves down the hill, the potential energy decreases and the kinetic energy increases until they are equal at Position 2. Position 3 is the lowest point, and most of the potential energy has been converted into kinetic energy.
	Option A is incorrect	The snowboarder at Position 1 has more potential energy than kinetic energy. At Position 3 the snowboarder has more kinetic energy than potential energy.
	Option B is incorrect	The snowboarder has the most potential energy when at the top of the hill, and the least when at the bottom of the hill. Since potential energy is converted into kinetic energy as the snowboarder goes down the hill, kinetic energy is lowest at the top of the hill and greatest at the bottom.
	Option D is incorrect	The snowboarder has equal amounts of potential and kinetic energy at Position 2.

Item #	Rationale	
29	Left – Provides energy for cell functions Top – Animal cell Right – Storage and transport of molecules	Left – This part of the diagram shows the mitochondria, which provide energy for the cell's functions. Top – This is the title of the cell. It is an animal cell because there is no cell wall. Right – This shows the vacuoles, which function as storage and transport of molecules.

Item #	Rationale	
30	Option C is correct	Carts 2 and 3 both experience a net force of 5 N (newtons).
	Option A is incorrect	Cart 1 experiences a net force of 4 N, and Cart 2 experiences a net force of 5 N.
	Option B is incorrect	Cart 1 experiences a net force of 4 N, and Cart 3 experiences a net force of 5 N.
	Option D is incorrect	Cart 2 experiences a net force of 5 N, and Cart 4 experiences a net force of 8 N.

Item #	Rationale	
31	Option B is correct	Waning gibbous is the moon phase between a full moon and third quarter moon.
	Option A is incorrect	The waning-crescent phase occurs after the third quarter moon phase, not before it.
	Option C is incorrect	The new moon phase does not occur 4 days after a full moon.
	Option D is incorrect	The first quarter moon occurs before the waxing-gibbous phase and after the waxing-crescent phase.

Item #	Rationale	
32	2 pts.	The student describes both the student's push and friction as the forces affecting the block's motion before release. The student also identifies that these forces affect the block's acceleration (or change in velocity).
	1 pt.	The student answers half of the question correctly.
	0 pts.	The response is incorrect or irrelevant.

Item #	Rationale	
33	Option B is correct	A precipitate forming is evidence that a chemical reaction has occurred because it indicates that a new substance has formed.
	Option A is incorrect	Water boiling is a physical change from liquid to gas. This is not a chemical reaction because no new substances are formed.
	Option C is incorrect	Spraying a liquid into the air is a physical change from liquid to gas.
	Option D is incorrect	Blowing air through a bubble wand to produce bubbles is a physical change in the size and shape of the soapy water and air.

Item #	Rationale	
34	Option A is correct	Point A is facing toward the sun and experiencing day, while Point B is facing away from the sun and experiencing night.
	Option B is incorrect	Point A is not experiencing night because it is facing the sun, and Point B is not experiencing day because it is facing away from the sun.
	Option C is incorrect	The Northern Hemisphere is tilted away from the sun, so both Points A and B are experiencing winter.
	Option D is incorrect	The Northern Hemisphere is tilted away from the sun, so both Points A and B are experiencing winter.

Item #	Rationale	
35	Option C is correct	The image shows the brain and nerves. The function of the nervous system is to send signals back and forth from the brain to the body.
	Option A is incorrect	The endocrine system excretes hormones throughout the body. This system does not involve the brain and nerves.
	Option B is incorrect	The integumentary system helps prevent infections from entering the body. This system does not involve the brain and nerves.
	Option D is incorrect	The circulatory system moves blood, nutrients, and gases throughout the body. This system does not include the brain or nerves.

Item #	Rationale	
36	Option A is correct	The number of protons is unique for each element and determines an element's identity.
	Option B is incorrect	If the number of neutrons changed, the mass of the atom would change, not the element.
	Option C is incorrect	The number of energy levels within an atom can change without changing the element. Many different elements have the same number of energy levels.
	Option D is incorrect	The number of valence electrons within an atom can change when the atom reacts with other atoms; however, this does not change the identity of the element.

Item #	Rationale	
37	Option A is correct	Speed is the ratio of distance and time. Object 1 has an average speed of 20 m/s, while Object 2 has an average speed of 5 m/s.
	Option B is incorrect	Speed is a calculated variable that is dependent on both distance and time.
	Option C is incorrect	Object 1 has a greater average speed because speed is a calculated variable that is dependent on both distance and time.
	Option D is incorrect	Object 1 has a greater average speed since traveling a shorter distance per unit time would mean the speed of the object was slower.

Item #	Rationale	
38	Option B is correct	Snakes prey on frogs; therefore, if the snake population increases, the frog population is likely to decrease.
	Option A is incorrect	An increase in the ladybird population does not directly affect the frog population.
	Option C is incorrect	Frogs eat butterflies; therefore, if the butterfly population increases, the frogs will have more prey, and the population is more likely to increase.
	Option D is incorrect	An increase in the number of producers will likely increase the population of primary consumers. This will likely increase the population of secondary consumers, such as frogs.