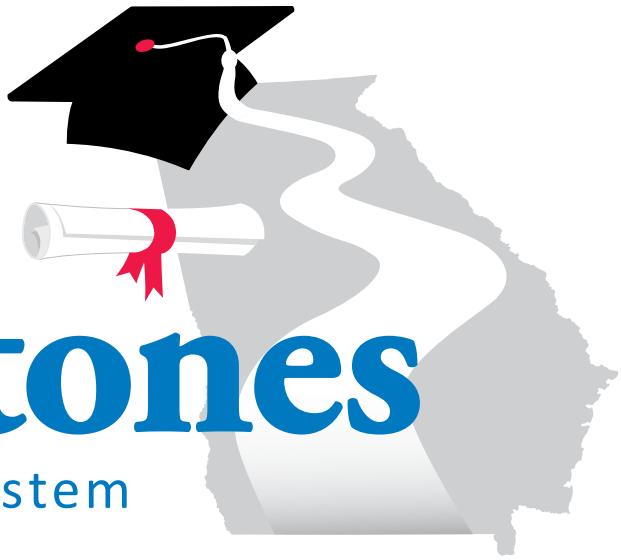
Georgia Milestones Assessment System



Study/Resource Guide for Students and Parents Science Grade 8

Study/Resource Guide

The Study/Resource Guides are intended to serve as a resource for parents and students. They contain practice questions and learning activities for each content area. The standards identified in the Study/Resource Guides address a sampling of the state-mandated content standards.

For the purposes of day-to-day classroom instruction, teachers should consult the wide array of resources that can be found at www.georgiastandards.org.

Table of Contents

INTRODUCTION

Please see the *Study/Resource Guide for Students and Parents: Introduction and Overview* document for valuable information about how to use this guide.

DEPTH OF KNOWLEDGE (DOK) EXAMPLE ITEMS

Example items that represent the applicable DOK levels across various Grade 8 Science content domains are provided.

All example and sample items contained in this guide are the property of the Georgia Department of Education.

Example Item 1

Selected-Response

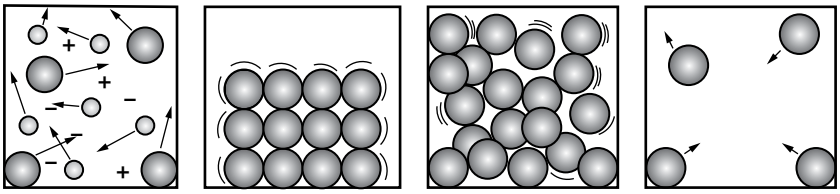
DOK Level 1: This is a DOK level 1 item because the question requires the student to recall information concerning a known relationship between scientific quantities.

Science Grade 8 Content Domain: Matter

Standard: S8P1. Obtain, evaluate, and communicate information about the structure and properties of matter.

b. Develop and use models to describe the movement of particles in solids, liquids, gases, and plasma states when thermal energy is added or removed.

Look at the illustrations.



Which model shows the structure and movement of particles in a solid?

A. model 1
B. model 2
C. model 3
D. model 4

Correct Answer: B

Explanation of Correct Answer: The correct answer is choice (B) model 2. Model 2 shows particles that are held in a fixed position. Choice (A) is incorrect because model 1 shows plasma. The particles in plasma move more freely and have electrical charges. Choice (C) is incorrect because model 3 shows a liquid. Particles in a liquid are more randomly distributed and move more freely than those in a solid. Choice (D) is incorrect because model 4 shows a gas. Particles in a gas are spread far apart and move randomly.

Example Item 2

Selected-Response

DOK Level 2: This is a DOK level 2 item because the question requires the student to apply learned information to abstract and real-life situations.

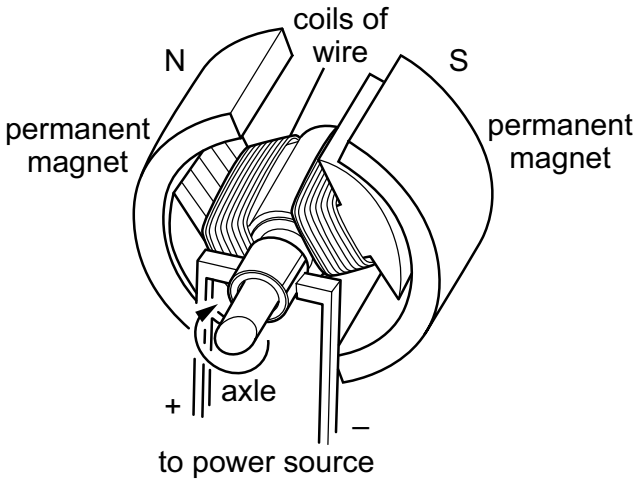
Science Grade 8 Content Domain: Force

Standard: S8P5. Obtain, evaluate, and communicate information about gravity, electricity, and magnetism as major forces acting in nature.

a. Plan and carry out investigations to identify the factors (e.g., distance between objects, magnetic force produced by an electromagnet with varying number of wire turns, varying number or size of drycells, and varying size of iron core) that affect the strength of electric and magnetic forces. (*Clarification statement*: Including, but not limited to, generators or motors.)

A group of students is investigating the different factors that affect the strength of an electric motor. A diagram of the motor is shown.

Inner Workings of an Electric Motor



What step should the students take next in the investigation to increase the strength of the motor?

A. Reduce the size of the axle running through the center of the motor.
B. Increase the number of coils of wire within the two sections of the motor.
C. Decrease the voltage of the power source being used to operate the motor.
D. Place the permanent magnets and coils of wire farther apart inside the motor.

Correct Answer: B

Explanation of Correct Answer: The correct answer is choice (B) Increase the number of coils of wire within the two sections of the motor. Increasing the number of coils of wire makes each loop of the coil closer to the other coils. This makes the magnetic fields from each coil overlap more, so their strengths add up. This makes the total magnetic field of both parts of the motor stronger, which makes the motor stronger. Choice (A) is incorrect because reducing the size of the axle might allow the motor to spin faster, but it will not increase the strength of the motor. Choice (C) is incorrect because a decrease in the battery voltage will cause less current and result in less strength for the motor. Choice (D) is incorrect because moving the magnets and coils farther apart will reduce the magnetic field strength and strength for the motor.

Example Item 3

Selected-Response

DOK Level 3: This is a DOK level 3 item because the question requires the student to construct arguments supported by evidence, to analyze and interpret data, to construct explanations and design solutions, and to plan and carry out investigations.

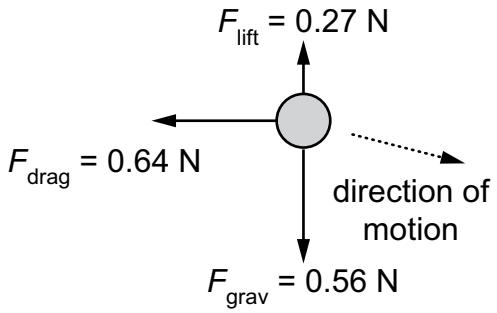
Science Grade 8 Content Domain: Motion

Standard: S8P3. Obtain, evaluate, and communicate information about cause and effect relationships between force, mass, and the motion of objects.

b. Construct an explanation using Newton's Laws of Motion to describe the effects of balanced and unbalanced forces on the motion of an object.

A force diagram of a tennis ball flying through the air toward the right is shown in the diagram below. The arrows show the direction of the gravitational force (F_{grav}), the drag force (F_{drag}), the lift force (F_{lift}), and the direction of movement of the tennis ball.

Force Diagram for a Flying Tennis Ball



Which pair of statements is a valid description and explanation of the motion of the ball based on evidence from the diagram?

A. **description:** The ball slows down as it moves to the right because the horizontal forces are unbalanced, with the larger force acting to the left.
explanation: The ball speeds up as it moves downward because the vertical forces are unbalanced, with the larger force acting downward.

B. **description:** The ball speeds up as it moves to the right because the horizontal forces are unbalanced, with the larger force acting to the right.
explanation: The ball speeds up as it moves downward because the vertical forces are unbalanced, with the larger force acting downward.

C. **description:** The ball moves at a constant speed to the right because the horizontal forces are unbalanced, with the larger force acting to the left.
explanation: The ball slows down as it moves downward because the vertical forces are unbalanced, with the larger force acting upward.

D. **description:** The ball slows down as it moves to the right because the horizontal forces are unbalanced, with the larger force acting to the right.
explanation: The ball moves at a constant speed downward because the vertical forces are unbalanced, with the larger force acting upward.

Example Item 3. *Continued*.

Correct Answer: A

Explanation of Correct Answer: The correct answer is choice (A)
description: The ball slows down as it moves to the right because the horizontal forces are unbalanced, with the larger force acting to the left.
explanation: The ball speeds up as it moves downward because the vertical forces are unbalanced, with the larger force acting downward.
Choice (B) is incorrect because, while the horizontal force is unbalanced, the net force is to the left, not to the right, so the ball slows down as it moves to the right. Choice (C) is incorrect because the ball speeds up while moving downward because the unbalanced vertical forces produce a large downward force. Choice (D) is incorrect because the net horizontal force is to the left, and the ball is speeding up as it moves downward.

CONTENT DESCRIPTION AND ADDITIONAL SAMPLE ITEMS

In this section, you will find information about what to study in order to prepare for the Grade 8 Science EOG assessment. This includes main ideas and important concepts. This section also contains practice questions with an explanation of the correct answers that you can use to prepare for the test.

All example and sample items contained in this guide are the property of the Georgia Department of Education.

Content Description

- Develop an understanding of the structure and properties of matter.
- Investigate the law of conservation of energy.
- Investigate the cause-and-effect relationships between force, mass, and the motion of objects.
- Compare and contrast the energy and behavior of electromagnetic (light) waves and mechanical (sound waves).
- Investigate the major forces acting in nature of gravity, electricity, and magnetism.

Force

This section will focus on developing a conceptual understanding of the relationship between force, mass, and the motion of objects; and energy transformations. You will develop an understanding that all objects and substances in the natural world are composed of matter that is influenced by forces. You will explore the relationship between velocity and acceleration through graphical representations of the motion of objects. You will gain a qualitative understanding of the universal laws of motion through scenarios in which forces act through direct physical contact between objects as well as examples in which forces act on objects at a distance (via gravitational force).

KEY CONCEPTS

Displacement is the length and direction of a straight line between two locations, or positions. Since displacement considers only the length and direction of a straight line, it doesn't depend on the actual path of a moving object. If Town A is 10 miles east of Town B, the displacement of Town A is 10 miles east relative to Town B. For a moving object, displacement can be defined as the change between the initial and final position of the object. (S8P3a)

Distance is a measure of the length of a path that a moving object travels. If the only road between the two towns has to wind through hills, the distance traveled between the two towns is longer than 10 miles, even though the displacement between the two towns is 10 miles east. (S8P3a)

Velocity is a quantity that measures the rate at which the position of an object changes in time. Velocity always describes a distance and a direction. Since velocity has direction, one way to show this numerically is to assume that travelling in a certain direction is symbolized with positive numbers while traveling opposite that direction is shown using negative numbers. (S8P3a)

Speed measures the rate at which an object moves along a path. Unlike velocity, speed is not considered to have a direction. (S8P3a)

Acceleration is a quantity that measures the rate at which an object changes its velocity. People often talk about an object decelerating when the object slows down. An object that slows down is actually experiencing a negative acceleration. This means the rate of change is a negative value. An object can have a velocity but not acceleration if it is moving at a constant velocity. For example, a car takes one hour to make a trip of 80 kilometers on a straight road pointing due east. In the middle of the trip, the car accelerated to 100 kilometers per hour (kph) and operated at that speed for 10 minutes and then accelerated to 60 kph and operated at that speed for 10 minutes. After the first acceleration the speed of the car was 100 kph, and during that time, the velocity of the car was 100 kph eastward. After the second acceleration the speed of the car was 60 kph and the velocity of the car during that time was 60 kph eastward. Finally, the car accelerated again back to 80 kph. The average velocity of the car over the whole trip was 80 kph eastward, and the average speed was 80 kph. (S8P3a)

A **force** is a push or pull on an object. Force can be the result of contact, such as when you push a book across your desk. Forces between objects that are not in contact with each other can be explained by the presence of force fields, like the magnetic field and the gravitational field. When one magnet repels another magnet, there is a push force that acts on the magnets even though the magnets are not in contact. (S8P3b)

When two or more forces act on an object but the object's velocity does not change, the object is being acted on by **balanced forces**. A book on your desk that is not moving is said to be **stationary**. The book is said to be at **rest** in relation to the desk. Gravity is acting to pull the book down. The desk pushes up against the book, and the book is at rest in relation to the desk. (S8P3b)

An accelerating object is being acted on by **unbalanced forces**. When you push your book across your desk, you are applying force to one side of the book. The force of friction acts on the book in the opposite direction that the book is moving, reducing the speed at which the book moves. Because the book begins to move in the direction you are pushing it, these forces are unbalanced. (S8P3b)

Friction is the force that resists motion between two surfaces. (S8P3b)

Inertia is the resistance to any change in the state of motion of any physical object. All matter has inertia, and the inertia of matter does not change until the matter is acted on by unbalanced forces that cause a change in motion. (S8P3b)

Mass is the total amount of matter of an object. Mass is a numerical measure of the object's inertia. The mass of an object does not change, regardless of where the object is located. (S8P3c)

Gravity is the force of attraction that exists between any two or more masses. Gravity can refer to the force that Earth exerts on everything. (S8P3b, S8P5a)

Important Tip

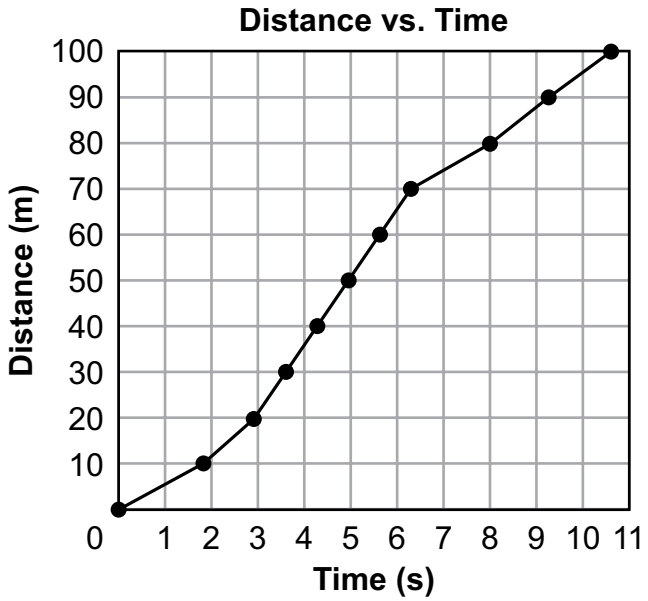
✍ Gravity also refers to the **gravitational force** every object exerts on every other object. (S8P3b)

SAMPLE ITEMS

Item 1

Selected-Response

A coach at a track meet measured the time of a runner every 10 meters (m) during a 100 m dash. The data for the runner are shown.



Which statement is the BEST analysis of the data for the runner?

A. The runner covers the first 80 m running at a constant speed and then slows down, reaching a minimum speed during the final 20 m.

B. The runner starts slower and speeds up, reaching a constant speed between 20 and 80 m, and then speeds up again during the final 20 m.

C. The runner covers the first 70 m running at a constant speed and then speeds up, reaching a maximum speed during the final 30 m.

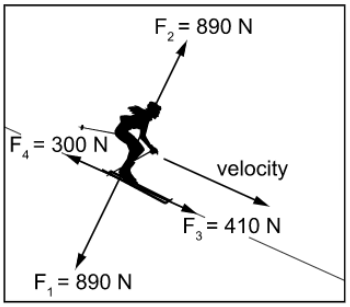
D. The runner starts slower and speeds up, reaching a maximum speed between 50 and 70 m, and then slows down during the final 30 m.

Item 2

Drop-Down Technology-Enhanced

A force diagram for a downhill skier is shown.

Force Diagram for Downhill Skier



Use the diagram, Newton's laws of motion, and the drop-down menus to complete the statement explaining the skier's speed.

The skier's speed increases going down the hill because forces [ ] are [ ] and acting [ ] the direction of the velocity, which causes the speed to change.

Use a mouse, touchpad, or touchscreen to click the arrow beside each of the three blank boxes. When you click the arrow, a drop-down menu will appear showing you all the possible options for that blank. Each drop-down menu with its options is shown below.

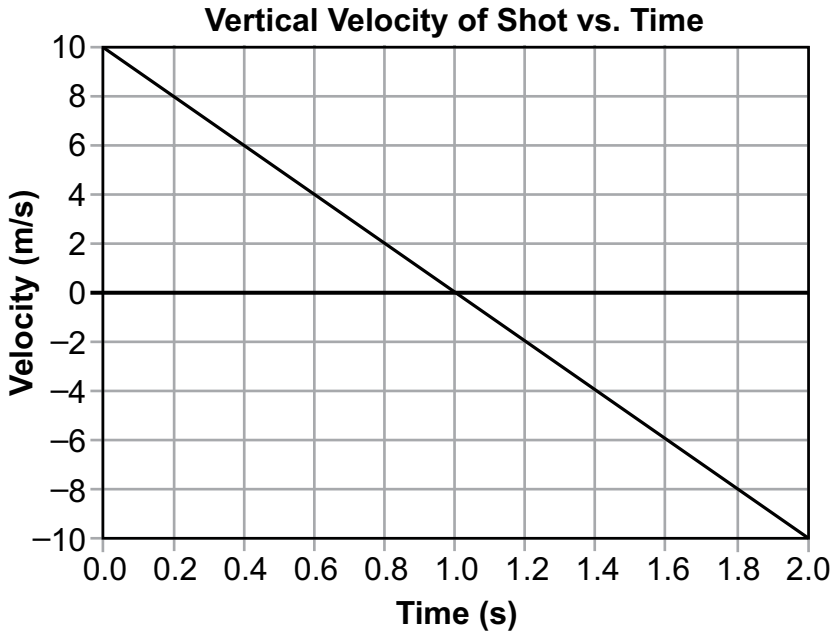
The skier's speed increases going down the hill because forces [ ] are [ ] and acting [ ] the direction of the velocity, which [ ]eed t

perpendicular to	F_1 and F_2	balanced
in the same direction as	F_3 and F_4	unbalanced

Item 3

Selected-Response

During a shot put event, athletes throw a very heavy round ball, called a shot, as far as possible. The graph shows the vertical velocity of a shot that was thrown by an athlete.



Which statement is an accurate analysis of the vertical motion of the shot?

A. The direction of the velocity is upward for both the first second and the last second, and the acceleration remains constant for the entire period.

B. The direction of the velocity is downward for both the first second and the last second, and the acceleration decreases during the entire period.

C. The direction of the velocity is upward for the first second and then downward for the last second, and the acceleration decreases during the entire period.

D. The direction of the velocity is upward for the first second and then downward for the last second, and the acceleration remains constant for the entire period.

SAMPLE ITEM KEYS

Item	Standard/ Element	DOK Level	Correct Answer	Explanation
1	S8P3a	2	D	The correct answer is choice (D) The runner starts slower and speeds up, reaching a maximum speed between 50 and 70 m, and then slows down during the final 30 m. Choice (A) is incorrect because the runner's speed is not constant during the first 80 m because the slope is not the same, and the minimum speed occurs during the first 10 m. Choice (B) is incorrect because the runner's speed is not constant between 20 and 80 m because the slope is not the same, and the runner is slowing down during the final 20 m. Choice (C) is incorrect because the runner actually speeds up during the first 70 m, reaching a maximum constant speed between 50 and 70 m, and then slows down during the last 30 m.
2	S8P3b	3	N/A	See scoring rubric and exemplar response on page 16.
3	S8P3a	3	D	The correct answer is choice (D) The direction of the velocity is upward for the first second and then downward for the last second, and the acceleration remains constant for the entire period. Because the velocity is positive between time 0 and 1 second the shot is traveling upward during this time period. Because the velocity is negative between 1 second and 2 seconds, the shot is traveling downwards during this time period. Choice (A) is incorrect because the velocity of the shot is actually negative for the last second so the direction of the velocity is downward for that period. Choice (B) is incorrect because the velocity of the shot is positive for the first second so the direction is upward. The slope is constant, so the acceleration is constant. Choice (C) is incorrect because although the line drops down to the right and the slope is negative, the change in the slope is constant, so the acceleration is constant.

EXAMPLE SCORING RUBRIC AND EXEMPLAR RESPONSE

Item 2

Scoring Rubric

Points	Description
1	The student correctly selects all three drop-down menu options.
0	The student does not correctly select all three drop-down menu options.

Exemplar Response

The correct response is shown below.

The skier's speed increases going down the hill because forces [F_3 and F_4] are [unbalanced] and acting [in the same direction as] the direction of the velocity, which causes the speed to change.

"F_3 and F_4" is the correct response for the first menu because the F_1 and F_2 forces are equal, and therefore are balanced, so these two forces will have no net effect. "Unbalanced" is the correct response for the second drop-down menu because balanced forces do not result in a change in speed. "In the same direction as" is the correct response for the third drop-down menu because again, the F_3 and F_4 forces are the forces that will affect the velocity down the hill.

Structure and Properties of Matter

In this section, you will develop a conceptual understanding of the nature of matter. You will understand that, in a chemical reaction, matter can be neither created nor destroyed, only transformed. You will learn about the characteristics of matter (i.e., physical and chemical properties) that are useful to classify and differentiate substances.

KEY CONCEPTS

Atoms are the smallest unit of matter that defines the chemical element. **Elements** are pure chemical substances that are made up of one type of atom. A **molecule** is made of two or more atoms joined together chemically. Molecules can be made of the same element or more than one element. Water molecules are made up of two atoms of hydrogen and one atom of oxygen. (S8P1a, e)

The **Periodic Table of Elements** is a table arranging all the known elements into groups with common properties. This arrangement also demonstrates trends based on those properties. (S8P1e)

The next page shows the Periodic Table of the Elements that can be used during the state assessment.

PERIODIC TABLE OF THE ELEMENTS

KEY

79 — Atomic Number Au — Element Symbol Gold — Element Name 196.97 — Average Atomic Mass

	1 IA	2 IIA	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8	9 VIIIB	10	11 IB	12 IIB	13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA
1	1 **H** Hydrogen 1.01																	2 **He** Helium 4.00
2	3 **Li** Lithium 6.94	4 **Be** Beryllium 9.01											5 **B** Boron 10.81	6 **C** Carbon 12.01	7 **N** Nitrogen 14.01	8 **O** Oxygen 16.00	9 **F** Fluorine 19.00	10 **Ne** Neon 20.18
3	11 **Na** Sodium 22.99	12 **Mg** Magnesium 24.31											13 **Al** Aluminum 26.98	14 **Si** Silicon 28.09	15 **P** Phosphorus 30.97	16 **S** Sulfur 32.07	17 **Cl** Chlorine 35.45	18 **Ar** Argon 39.95
4	19 **K** Potassium 39.10	20 **Ca** Calcium 40.08	21 **Sc** Scandium 44.96	22 **Ti** Titanium 47.87	23 **V** Vanadium 50.94	24 **Cr** Chromium 52.00	25 **Mn** Manganese 54.94	26 **Fe** Iron 55.85	27 **Co** Cobalt 58.93	28 **Ni** Nickel 58.69	29 **Cu** Copper 63.55	30 **Zn** Zinc 65.41	31 **Ga** Gallium 69.72	32 **Ge** Germanium 72.64	33 **As** Arsenic 74.92	34 **Se** Selenium 78.96	35 **Br** Bromine 79.90	36 **Kr** Krypton 83.80
5	37 **Rb** Rubidium 85.47	38 **Sr** Strontium 87.62	39 **Y** Yttrium 88.91	40 **Zr** Zirconium 91.22	41 **Nb** Niobium 92.91	42 **Mo** Molybdenum 95.94	43 **Tc** Technetium (98)	44 **Ru** Ruthenium 101.07	45 **Rh** Rhodium 102.91	46 **Pd** Palladium 106.42	47 **Ag** Silver 107.87	48 **Cd** Cadmium 112.41	49 **In** Indium 114.82	50 **Sn** Tin 118.71	51 **Sb** Antimony 121.76	52 **Te** Tellurium 127.60	53 **I** Iodine 126.90	54 **Xe** Xenon 131.29
6	55 **Cs** Cesium 132.91	56 **Ba** Barium 137.33	57 **La** Lanthanum 138.91	72 **Hf** Hafnium 178.49	73 **Ta** Tantalum 180.95	74 **W** Tungsten 183.84	75 **Re** Rhenium 186.21	76 **Os** Osmium 190.23	77 **Ir** Iridium 192.22	78 **Pt** Platinum 195.08	79 **Au** Gold 196.97	80 **Hg** Mercury 200.59	81 **Tl** Thallium 204.38	82 **Pb** Lead 207.2	83 **Bi** Bismuth 208.98	84 **Po** Polonium (209)	85 **At** Astatine (210)	86 **Rn** Radon (222)
7	87 **Fr** Francium (223)	88 **Ra** Radium (226)	89 **Ac** Actinium (227)															

58 **Ce** Cerium 140.12	59 **Pr** Praseodymium 140.91	60 **Nd** Neodymium 144.24	61 **Pm** Promethium (145)	62 **Sm** Samarium 150.36	63 **Eu** Europium 151.96	64 **Gd** Gadolinium 157.25	65 **Tb** Terbium 158.93	66 **Dy** Dysprosium 162.50	67 **Ho** Holmium 164.93	68 **Er** Erbium 167.26	69 **Tm** Thulium 168.93	70 **Yb** Ytterbium 173.04	71 **Lu** Lutetium 174.97
90 **Th** Thorium 232.04	91 **Pa** Protactinium 231.04	92 **U** Uranium 238.03	93 **Np** Neptunium (237)	94 **Pu** Plutonium (244)	95 **Am** Americium (243)	96 **Cm** Curium (247)	97 **Bk** Berkelium (247)	98 **Cf** Californium (251)	99 **Es** Einsteinium (252)	100 **Fm** Fermium (257)	101 **Md** Mendelevium (258)	102 **No** Nobelium (259)	103 **Lr** Lawrencium (262)

Substance is matter of any form that cannot be broken down into separate elements by physical means but can be broken down using chemical changes. (S8P1a)

A **compound** is a pure chemical substance that is made up of two or more different elements. Salt is a compound whose molecules are made up of one atom of sodium and one atom of chlorine. (S8P1a)

A **mixture** is made of two or more substances that are not combined chemically. Salted popcorn is an example of a mixture. (S8P1a)

Matter is anything that has mass and occupies space. Matter can be found in several states (e.g., solid, liquid, gas, plasma). (S8P1b, c)

Physical properties are any properties that are measurable and can be observed. Physical properties can be determined without changing the chemical properties of an object. Color, hardness, area, length, strength, temperature, and state of matter are some examples of physical properties. (S8P1c)

The **states of matter** are the different forms that matter can be found in. Water is a **liquid**, the state of matter that has a definite volume but no fixed shape. When water is ice, it is a **solid**. Solids have a definite shape and volume. Their shape and volume cannot be easily changed. When water is steam, or water vapor, it is a **gas**. Gases have no definite shape and take the shape of their container. **Plasma** is gas that is charged. Plasma conducts electricity easily. Stars and neon lights are examples of plasma. Plasma is different from the other states of matter in that it is a high-energy state of matter. (S8P1b)

Mass is the total amount of matter of an object. Mass is a numerical measure of the object's inertia. The mass of an object does not change regardless of where the object is located. (S8P3c)

Volume is the amount of space that an object or substance occupies. Volume is a physical property. (S8P1b)

Density is the physical property that describes how tightly matter is put together. A pure element, such as gold, will have a characteristic density and mass. (S8P1c)

Boiling point is the physical property that describes the temperature at which a substance will change from a liquid to a gas. Water boils at 100°C (212°F). (S8P1c)

Melting point is the physical property that describes the temperature at which a solid will become a liquid. Ice, a solid, will change into liquid water at 0°C (32°F). This is the melting point of water. (S8P1c)

Chemical properties are any properties that can be measured only by chemically changing an object. Paper starts to burn at around 249°C (480°F). At this temperature the paper combines with oxygen in the air and new substances are formed. (S8P1c)

Combustibility is the chemical property of how easily a substance will set on fire. For example, paper's heat of combustion is around 249 degrees Celsius. (S8P1c)

Reactivity is the chemical property of the capacity of an atom or molecule to go through a chemical reaction with another atom or molecule. Sodium is a very reactive metal. Sodium reacts rapidly and energetically with other substances. Gold is a metal that is not very reactive. It won't tarnish from oxygen or water. (S8P1c)

A **physical change** happens when matter has a change in its physical properties but not its chemical properties. For example, salt can be dissolved in water, but if the water evaporates, the salt is still there. (S8P1d)

A **chemical change** happens when matter breaks down into two or more substances or when more than one substance is combined to form a new substance. Hydrogen peroxide forming bubbles on its own is an example of matter breaking down into two substances. Vinegar and baking soda turning into bubbling foam is an example of two substances combining to create other substances. (S8P1d)

A **chemical reaction** is a process where two or more substances combine chemically in some way to form one or more other substances. When iron is combined with air and water, the iron is slowly converted into rust. (S8P1f)

A **precipitate** is a solid that is formed by a chemical reaction. Precipitates can form in a solution or inside another solid. (S8P1d)

The **law of conservation of matter** states that the total amount of matter in a system cannot be created or destroyed. When a piece of paper burns, it becomes ash, water vapor, and carbon dioxide. If the mass of the ash, water vapor, and carbon dioxide were found, it would be the same as the mass of the paper before the paper was burnt. (S8P1f)

Important Tip

- The movement of particles within the different states of matter can vary greatly. Particles in solids are packed together very tightly, and they do not move around easily. This is why solids tend to be hard. Particles in a liquid move around and are packed loosely. Particles in gases move in all sorts of directions, and the particles are spread very far apart. (S8P1b)

SAMPLE ITEMS

Item 4

Selected-Response

A student is planning an investigation to explore different properties of matter.

Which investigation will help the student explore a physical property of matter?

A. **investigation:** Place a solid in a beaker and add a small amount of liquid.
observation: The beaker becomes warm to the touch.

B. **investigation:** Add a small amount of solid to a liquid in a beaker.
observation: The solid dissolves in the liquid.

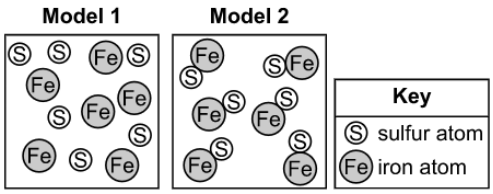
C. **investigation:** Add a small amount of solid to a liquid in a beaker.
observation: The solution starts to fizz and overflows the container.

D. **investigation:** Place a solid in a beaker and add a small amount of liquid.
observation: Bubbles form on the top of the solid.

Item 5

Drag-and-Drop Technology-Enhanced

Iron can be found as a gray powder, and sulfur can be found as a yellow powder. The diagram shows atomic models of two substances made of iron (Fe) and sulfur (S).



Move the correct classification and description text into the boxes in the table to classify and describe the appearances of the substances. One classification will not be used.

Model	Classification	Appearance
1		
2		

Classification

- pure substance
- homogeneous mixture
- heterogeneous mixture

Appearance

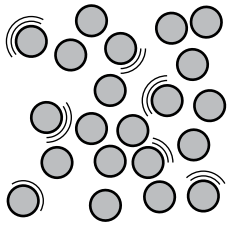
- uniform color
- gray and yellow particles visible

Use a mouse, touchpad, or touchscreen to move the classification and description text into the boxes in the table. Each option can be used once. One classification will not be used.

Item 6

Multi-Part Technology-Enhanced

A student is shown a simple model of particles that make up a liquid, as shown.



Part A

How should the model be changed to show the particles of a solid?

A. Increase the velocities of the particles, and increase the space between the particles.
B. Increase the velocities of the particles, and decrease the space between the particles.
C. Decrease the velocities of the particles, and increase the space between the particles.
D. Decrease the velocities of the particles, and decrease the space between the particles.

Part B

How should the model be changed to show the particles of a liquid at a higher temperature?

A. Separate the particles into positive and negative charges, and increase the space between the particles.
B. Separate the particles into positive and negative charges, but maintain the same space between the particles.
C. Decrease the velocities of the particles, and decrease the space between the particles.
D. Increase the velocities of the particles, but maintain the same space between the particles.

Item 7

Multi-Part Technology-Enhanced

A student is asked to conduct an investigation that will determine a physical property of a cube-shaped solid block of salt sample.

Part A

Which procedure BEST measures a physical property of the sample?

A. 1. Measure 10 mL of vinegar (acetic acid) in a graduated cylinder.
2. Pour the acetic acid into a beaker.
3. Drop the sample into the beaker of acetic acid to determine what happens to the sample.
4. Record your observations.

B. 1. Gently break the solid sample into smaller pieces using a hammer.
2. Use long-handled forceps to pick up one of the small sample pieces.
3. Hold the small sample piece in the flame of a Bunsen burner for a few seconds to determine what happens to the sample.
4. Record your observations.

C. 1. Use a ruler to measure the length of one side of the sample.
2. Record this value to the nearest millimeter.
3. Cube the value in step 2.
4. Place the cubed sample on the digital balance.
5. Record this value to the nearest tenth of a gram.
6. Divide the value in step 5 by the value in step 3.

D. 1. Cut away two different-sized pieces of the sample and place into a container on a hot plate.
2. Place two thermometers in the containers, one touching each sample.
3. Record the time it takes the temperature of the smaller sample to increase 1°C.
4. Continue to heat the sample.
5. Record the time it takes the temperature of the larger sample to increase 1°C.
6. Subtract the value in step 3 from the value in step 5.

Go on to the next page to finish item 7.

Item 7. *Continued*.

Part B

Which statement supports the answer to Part A?

A. The physical property being tested is density; the procedure selected measures the mass and the volume of the sample.

B. The physical property being tested is reactivity; the procedure selected determines whether the sample will change to a different substance due to mixing with acetic acid.

C. The physical property being tested is melting point; the procedure selected measures the temperature at which the sample changes to a liquid.

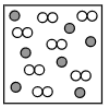
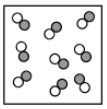
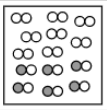
D. The physical property being tested is combustibility; the procedure selected determines whether the sample will begin to burn due to exposure to a flame.

Item 8

Drag-and-Drop Technology-Enhanced

A student draws four models to represent the different types of pure substances and mixtures.

Move the descriptions into the table to correctly identify each model. Descriptions may be used more than once.

Models	Descriptions
	• •
	• •
	• •
	• •

Key
○ type X particle
● type Y particle

pure substance
heterogeneous mixture
homogeneous mixture

could be separated physically
could be separated chemically
cannot be separated

Use a mouse, touchpad, or touchscreen to move the descriptions below the table into the boxes in the table. Each description can be used more than once.

SAMPLE ITEM KEYS

Item	Standard/ Element	DOK Level	Correct Answer	Explanation
4	S8P1c	2	B	The correct answer is choice (B) **investigation:** Add a small amount of solid to a liquid in a beaker. **observation:** The solid dissolves into the liquid. This is correct because the investigation tests the solubility of the solid substance, and solubility is a physical property. Choices (A), (C) and (D) are incorrect because reactivity is a chemical property.
5	S8P1a	2	N/A	See scoring rubric and exemplar response on page 29.
6	S8P1b	3	D, D	The correct answer for Part A is choice (D) Decrease the velocities of the particles, and decrease the space between the particles. Choice (A) is incorrect because it would increase the temperature and not produce a solid. Choice (B) is incorrect because it would increase the temperature and density but would not produce a solid. Choice (C) is incorrect because the space between the particles would decrease. The correct answer for Part B is choice (D) Increase the velocities of the particles, but maintain the same space between the particles. Choices (A) and (B) are incorrect because they would show a change of state to a plasma. Choice (C) is incorrect because would show a lower temperature.

Item	Standard/ Element	DOK Level	Correct Answer	Explanation
7	S8P1c	3	C, A	The correct answer for Part A is choice (C) 1. Use a ruler to measure the length of one side of the sample. 2. Record this value to the nearest millimeter. 3. Cube the value in step 2. 4. Place the cubed sample on the digital balance. 5. Record this value to the nearest tenth of a gram. 6. Divide the value in step 5 by the value in step 3. This choice is correct because this process allows the student to measure the density of the block of salt, which is a physical property. Choices (A) and (B) are incorrect because this is testing a chemical property. Choice (D) is incorrect because the time it takes the sample to increase in temperature is not a physical property. The correct answer for Part B is choice (A) The physical property being tested is density; the procedure selected measures the mass and the volume of the sample. Choice (B) is incorrect because reactivity is a chemical property. Choice (C) is incorrect because none of the options in Part A actually tests the melting point of a sample. Choice (D) is incorrect because combustibility is a chemical property.
8	S8P1a	3	N/A	See scoring rubric and exemplar response beginning on page 30.

EXAMPLE SCORING RUBRICS AND EXEMPLAR RESPONSES

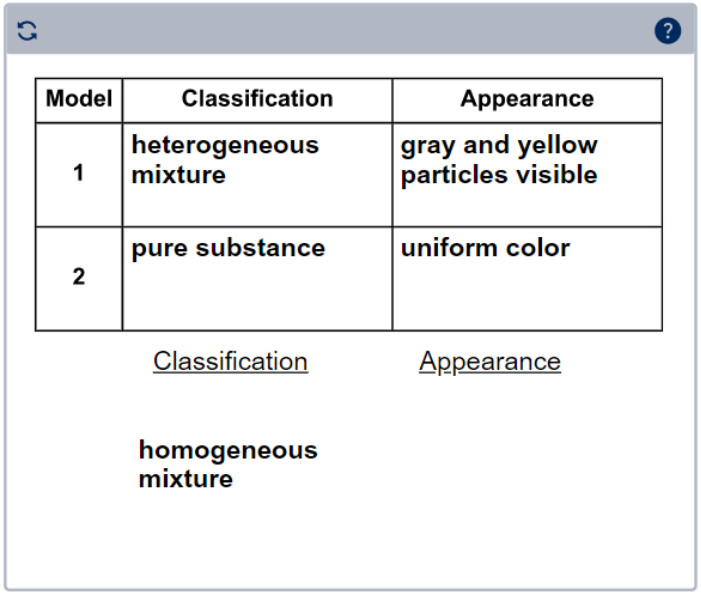
Item 5

Scoring Rubric

Points	Description
1	The student correctly fills in all four boxes.
0	The student does not correctly fill in all four boxes.

Exemplar Response

The correct response is shown below.



This is the correct response because Model 1 shows a heterogeneous mixture where the particles retain their individual identities, so their different colors show. Model 2 is a pure substance because the pictures indicate the particles are combined to form a compound. A pure substance will have a uniform color throughout.

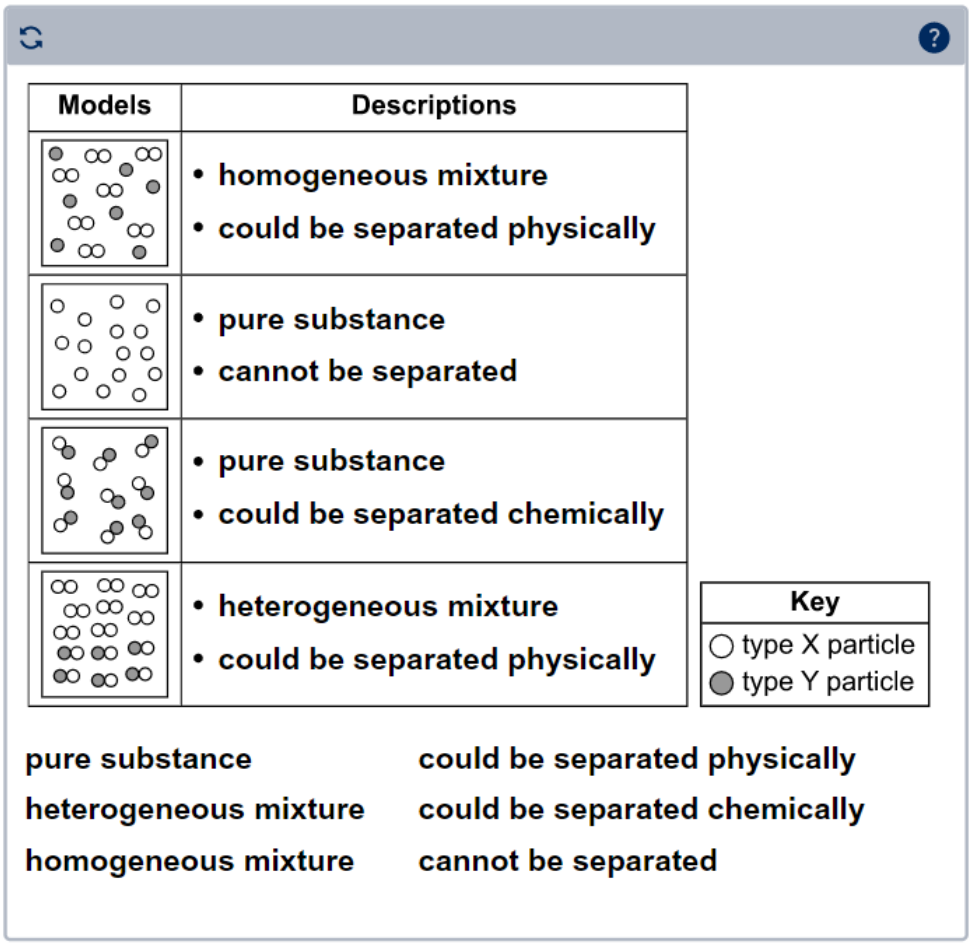
Item 8

Scoring Rubric

Points	Description
2	The student correctly fills in all four boxes (order within each box does not matter).
1	The student correctly fills in two or three boxes (order within each box does not matter).
0	The student does not correctly fill in at least two boxes.

Exemplar Response

The correct response is shown below.



This is a correct response because the first model, at the top, is a homogenous mixture. The two different types of particles in the mixture are distributed equally. Homogeneous mixtures can be separated by physical processes. NOTE: The order in which descriptions are placed within any box does not matter as long as correct descriptions are assigned in each box.

Go on to the next page to finish item 8.

Item 8

The second model is also correctly described. It contains only one kind of particle, which is a pure substance, and the particles are a single type of atom so must be an element, which cannot be separated.

The third model is also correctly described. It contains two types of particles, which are all attached to each other, so these form a compound. Compounds are pure substances because all the particles of the compound are the same, and cannot be separated physically but can be separated by chemical processes.

The fourth model is also correctly described. The type X and type Y particles are combined either together (two type X) or with each other (one type X and one type Y). While these particles are together in the box, they are separated from each other, so this is a heterogeneous mixture. Heterogeneous mixtures can be separated by physical processes.

Energy and Force

In this section, you will develop an understanding that energy exists in many forms. You will learn that in a closed system, energy can be transferred and transformed, but the total amount of energy available is always the same—it is conserved. You will also learn about two of the four main forces in the universe: gravitational and electromagnetic forces. You'll determine how these forces influence the motion of objects and are responsible for the work that a system does or for the work that is done on a system.

KEY CONCEPTS

The **law of conservation of energy** states that the total amount of energy in a system cannot change unless energy enters or leaves that system by some form and that energy cannot be created or destroyed. Energy can only change forms. An **energy transformation** refers to the changing of energy from one form to another. (S8P2b, c)

Gravitational potential energy is the energy stored in an object due to its position. The energy stored in a ball sitting at the top of a ramp is all potential energy. In the case of the ball, gravity is pulling down on the ball. Although the ball is not rolling down the hill, it has potential energy due to the pull of gravity. (S8P2a, b)

Kinetic energy is the energy of **motion**. As the ball starts to roll down the ramp, the potential energy of the ball transforms into kinetic energy. The energy in the system is converted from potential energy to kinetic energy. (S8P2a, b)

Mechanical energy is the total of all the potential energy and kinetic energy in an object. (S8P2b)

Thermal energy is the random motion of particles (whether vibrations in solids or molecules in free motion in a gas). This energy is distributed among all the particles in a system through collisions and interactions at a distance. Thermal energy flows from an object that has a higher temperature to one that has a lower temperature. (S8P2c, d)

Conduction is the movement of heat through an object or from one object to another when they are touching. In conduction, thermal energy is transferred between atoms when they collide with each other. Thermal energy moves from warmer areas, those with higher energy, to cooler areas, those with less energy. This is why ice in a glass of water melts on a warm day. Warm air molecules collide with the molecules of the glass container and transfer thermal energy to them. The molecules in the container then pass the thermal energy between themselves by direct contact. Finally, the energy is transferred to the water and ice by the water molecules coming in contact with both. The thermal energy flows toward the ice and the energy turns the ice into water. (S8P2d)

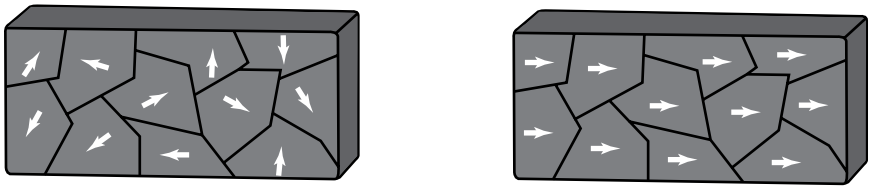
Convection is the movement of heat through fluids and gases. In convection, thermal energy is transferred due to differences in density caused by temperature variations. When you heat a pot of soup, the liquid becomes warm through convection. As the liquid at the bottom of the pot becomes warmer, its density decreases. The increased thermal energy causes the molecules to move faster, which spaces them farther apart, increasing the volume and thus decreasing the density. The change in density causes the warm liquid to rise to the top of the soup and the colder liquid to sink. It is this motion of the warm and cold masses that is called convection. (S8P2d)

Heat can also move by means of **radiation**. Thermal radiation does not require any form of matter to move through, as conduction and convection require. Thermal radiation energy moves via electromagnetic waves. Because of this, thermal radiation moves very fast. (S8P2d)

Electric energy is the energy of electrons moving through a conductor. Electricity is the name for the motion of electrons along the path formed by a conductor. (S8P2c)

Magnetic energy is produced when magnetic fields are generated. (S8P2c)

Magnetic materials have what are known as magnetic domains—they are sort of like pieces of a big puzzle, as shown in the illustration of magnetized material below. The two poles of a magnet result when these magnetic domains align in such a way that they point in the same direction. If you cut a magnet in half, the domains of each half will still line up so that the two new magnets each have a north pole and a south pole. In an object that is not magnetized, the domains lie in many different directions (as shown in the illustration below) and mostly cancel each other out. (S8P5a, c)



Not Magnetized **Magnetized**

An **electromagnet** is created when a wire is coiled and an electric current flows through it. Generally, electromagnets have a metal core that helps to increase the strength of the electromagnet. Magnetic force is created by the movement of electrical charges through a wire. A magnetic field is created around the wire, and this magnetic field lines up the domains in the core, turning the core into a temporary magnet. When the electric current is turned off, the magnetic field quickly fades. An electromagnet can be made using a circuit with a battery, a switch, and wire wrapped around a nail. (S8P5c)

Important Tip

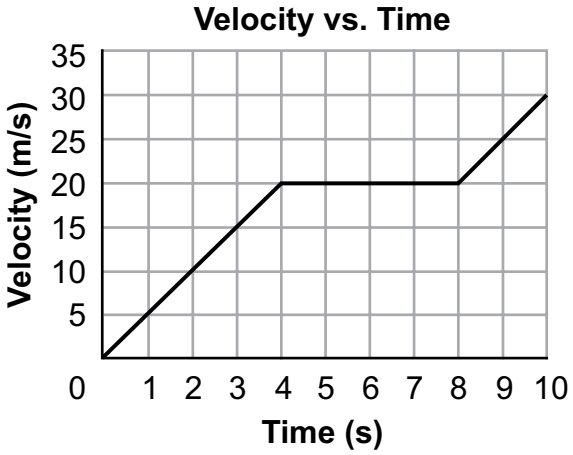
- When thinking of energy transforming from one form to another, remember that, in most cases, it is not a matter of one form of energy being transformed into only one other form of energy. When you rub your hands together, the kinetic energy of your hands is transformed by friction into heat energy. You can also hear your hands rubbing together, which is the result of the friction converting some of the kinetic energy into sound energy. (S8P2c)

SAMPLE ITEMS

Item 9

Selected-Response

A physics student used radar to measure the velocity of a vehicle over a 10-second period. The student presented the data in the graph shown.

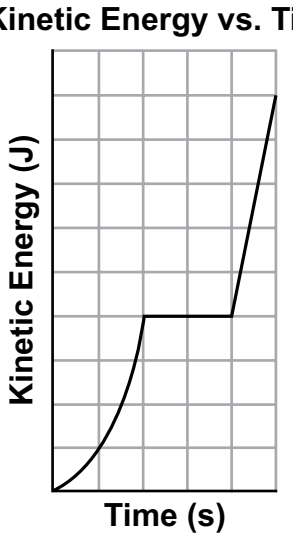


Go on to the next page to finish item 9.

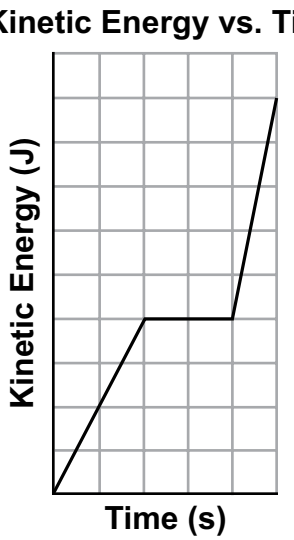
Item 9. *Continued*.

Which graph of the kinetic energy of the vehicle versus time corresponds to the velocity versus time graph?

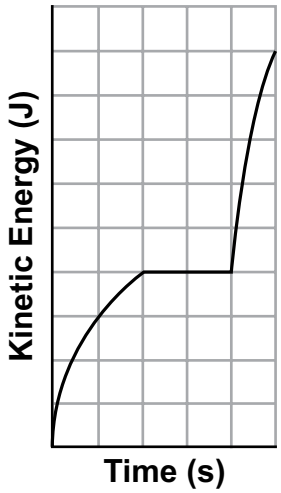
A.



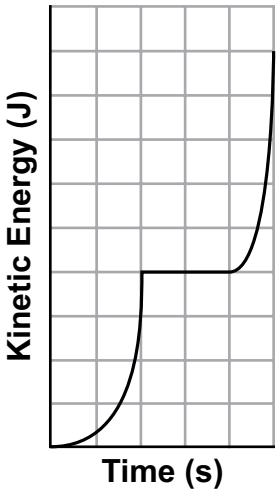
B.



C.



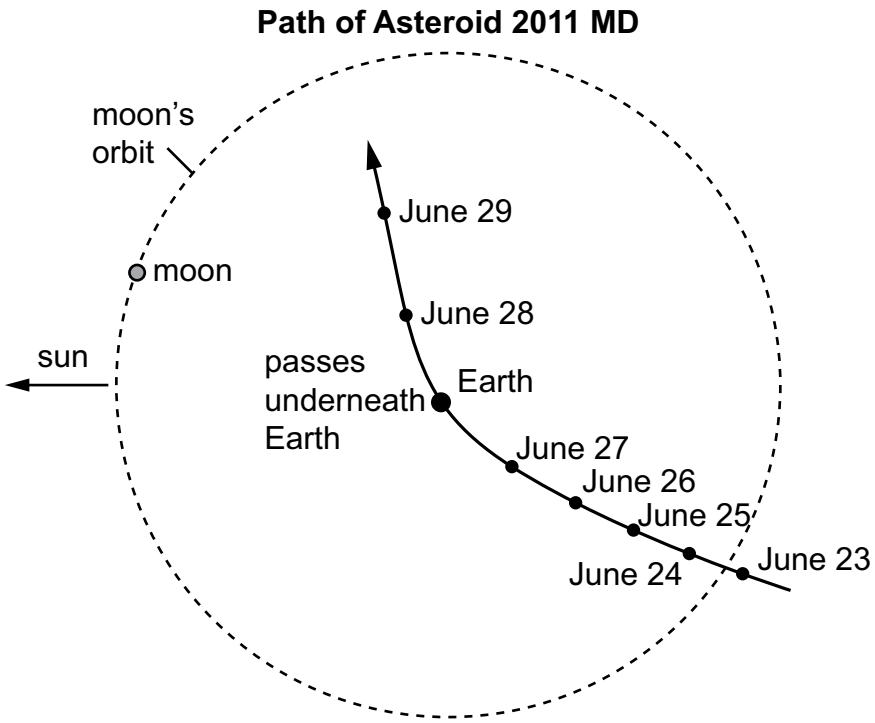
D.



Item 10

Selected-Response

A space agency tracked the path of an asteroid named 2011 MD, which passed within 12,300 kilometers of Earth's surface. The path of the asteroid is projected onto the plane of the moon's orbit around Earth in the diagram.



Space scientists claimed that Earth's strong gravitational field was responsible for the path of asteroid 2011 MD. Which argument BEST supports this claim?

A. The velocity of the asteroid changed as evidenced by the changing direction of the asteroid.

B. The velocity of the asteroid changed as evidenced by the straight line path after it passes Earth.

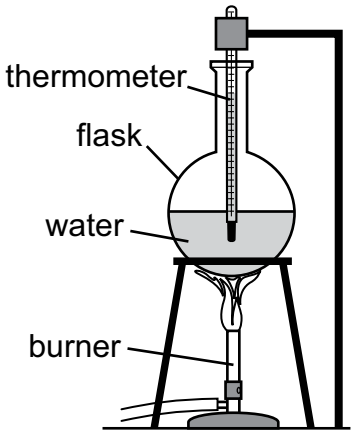
C. The position of the asteroid bends slightly away from Earth as evidenced by the different locations relative to Earth.

D. The position of the asteroid bends slightly toward the sun as evidenced by the different locations relative to the sun.

Item 11

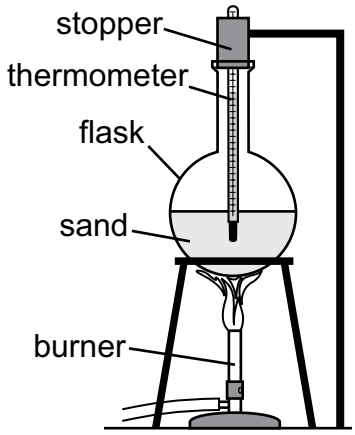
Selected-Response

A student is planning an investigation in which different modes of heat transfer will be used to heat a thermometer. The diagram shows the setup used to conduct the first part of the investigation.

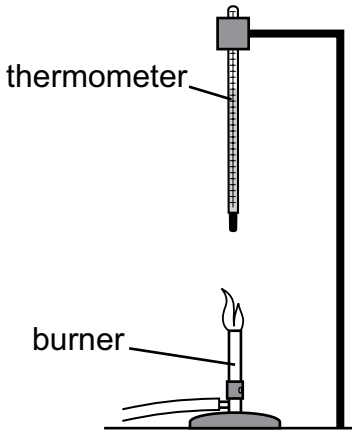


In this setup, the thermometer is being heated by conduction and convection. How should the student change the setup to heat the thermometer by using only radiation?

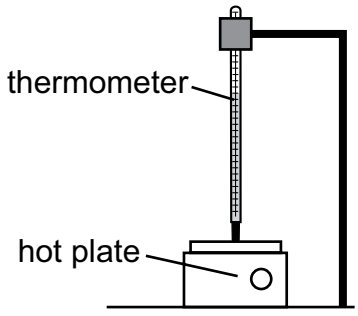
A.



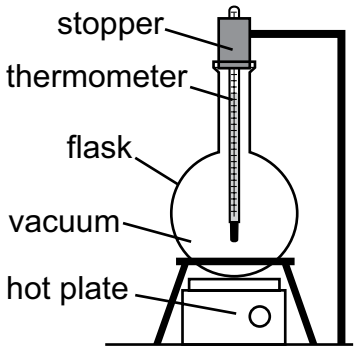
B.



C.



D.

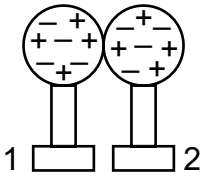


Item 12

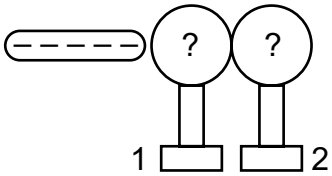
Selected-Response

A student is investigating how a negatively charged rubber rod affects how charges are distributed on two stainless steel spheres that are touching each other. A diagram that shows two steps of the investigation is shown.

Investigation of the Process of Induction



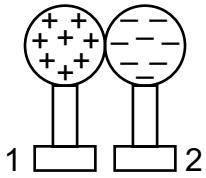
Step 1
Place two stainless steel spheres, both on hard rubber stands, in contact with each other.



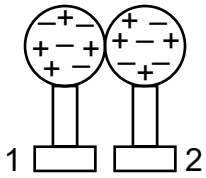
Step 2
Bring a negatively charged rubber rod near sphere 1.

Which diagram for step 2 correctly predicts the distribution of charges on the stainless steel spheres?

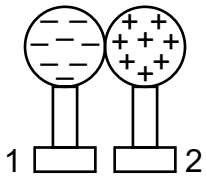
A.



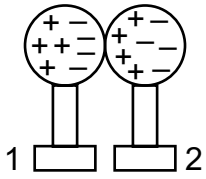
B.



C.



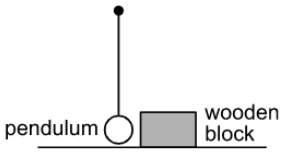
D.



Item 13

Drop-Down Technology-Enhanced

A student wishes to use the pendulum and wooden block shown to investigate the relationship between kinetic energy and potential energy.



The boxes show two possible procedures the student can use in the investigation.

Procedure W

step 1. Release the pendulum from a measured height and allow it to swing down and collide with the wooden block at the bottom of the swing.
step 2. Allow the wooden block to come to rest, then measure the distance the block slid.
step 3. Repeat steps 1 and 2 using different starting heights for the pendulum. Compare the data for the different starting heights.

Procedure X

step 1. Pull the pendulum back and throw it downward, allowing it to swing down and collide with the wooden block at the bottom of the swing.
step 2. Allow the wooden block to come to rest, then measure the distance the block slid.
step 3. Repeat steps 1 and 2, throwing the pendulum with different amounts of force. Compare the data for the different throws.

Use the drop-down menus to explain the procedure that will BEST allow the student to complete measurements for the investigation.

Procedure [ ] should be used. In this procedure, the moving pendulum will demonstrate transforming [ ] energy.

Use a mouse, touchpad, or touchscreen to click the arrow beside each of the two blank boxes. When you click the arrow, a drop-down menu will appear showing you all the possible options for that blank. Each drop-down menu with its options is shown below.

Procedure [ ] should be used. In this procedure, ving pendulum will demonstrat forming [ ] energy.

- W
- X

Procedure [ ] should be used. In this procedure, the moving pendulum will demonstrate transforming [ ] energy.

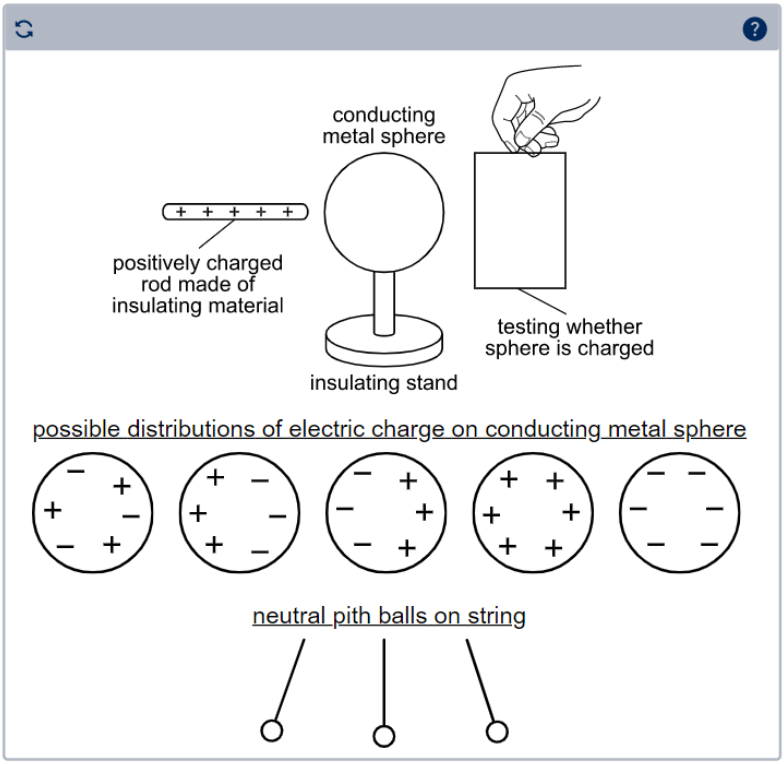
- kinetic energy into potential
- potential energy into kinetic

Item 14

Drag-and-Drop Technology-Enhanced

A student wants to investigate how to apply an electric charge to a conducting metal sphere by using an electrically charged rod made of insulating material. Pith is a light material that easily picks up an electrical charge. The student will then show that the charge remains on the sphere after the charged rod is removed by holding a neutral pith ball hanging from a string near the sphere and observing its behavior.

Move a circle showing the distribution of electric charge onto the conducting metal sphere to show how electric charge will be distributed on the metal sphere after the positively charged rod is touched to the sphere and then removed. Next, move the correct image of the pith ball hanging from a string into the box labeled "testing whether sphere is charged" to show how the pith ball and string will behave if the charge remains on the sphere.



➔ Use a mouse, touchpad, or touchscreen to move a circle with the correct distribution of electric charge onto the conducting metal sphere picture and move a neutral pith ball on string picture into the "testing whether sphere is charged" box in the diagram.

Item 15

Selected-Response

A student reads that a number of electrical devices utilize electromagnets. Some of these devices require strong magnetic fields. The student decides to investigate how to increase the strength of a basic electromagnet.

How can the student test whether the magnetic field produced by an electromagnet is increasing in strength?

A. A stronger magnet will require less wire for the coils.
B. A stronger magnet will have more widely spaced coils.
C. A stronger magnet will have a reduced measurable current.
D. A stronger magnet will attract a greater number of metallic items.

SAMPLE ITEM KEYS

Item	Standard/ Element	DOK Level	Correct Answer	Explanation
9	S8P2a	3	D	The correct answer is choice (D). Choice D is correct because the graph shows the kinetic energy increasing as the square of the velocity during the two time periods when the object is increasing in speed. Choice (A) is incorrect because the last section is linear rather than proportional to the square of the velocity. Choice (B) is incorrect because the relationship to the velocity is linear between these values instead of proportional to the square of the velocity. Choice (C) is incorrect because the curvature of the line indicates that the vehicle's kinetic energy increases less as its velocity continues to linearly increase.
10	S8P5a	3	A	The correct answer is choice (A) The velocity of the asteroid changed as evidenced by the changing direction of the asteroid. Choice (B) is incorrect because a straight line path does not necessarily indicate a change in velocity and not enough points are shown for this latter stage of the asteroid's path to make that determination. Choice (C) is incorrect because the path of the asteroid bends toward Earth, not away from it. Choice (D) is incorrect because the asteroid's positions indicate that the asteroid is not bending toward the sun.
11	S8P2d	2	D	The correct answer is choice (D). Choice (D) shows the thermometer surrounded by a vacuum; therefore, conduction and convection cannot transfer thermal energy to the thermometer since they require the movement of energy through matter. Radiation, however, can transfer through a vacuum. Choice (A) is incorrect because this would eliminate heat transfer by convection, which does not occur in solids or masses of granular solids like sand, but not conduction and would not add radiation. Choice (B) is incorrect because convection is still occurring to transfer thermal energy from the flame to the thermometer and conduction still occurs to transfer thermal energy from the air to the thermometer itself. Choice (C) is incorrect because a hot plate touching the thermometer would heat the thermometer by conduction.

Item	Standard/ Element	DOK Level	Correct Answer	Explanation
12	S8P5b	2	A	The correct answer is choice (A). Choice (A) is correct because the negatively charged rod will repel negative charges from the nearer (left) sphere, so that they will flow into the more distant sphere. Similarly, positive charges in the more distant (right) sphere will be attracted to the negatively charged rod, so will flow into the left sphere. Choice (B) is incorrect because the charges on the two spheres don't simply mix to form a uniform distribution of charges on both spheres, but rather the positive charges should accumulate on the left sphere and negative charges on the right sphere. Choice (C) is incorrect because the negatively charged rod attracts opposite charges, not like charges, thus the positive charges should accumulate on the left sphere and negative charges on the right sphere. Choice (D) is incorrect because this would be the distribution of charges if the two spheres were located close together but not touching when the negatively charged rod is brought near the left sphere.
13	S8P2b	2	N/A	See scoring rubric and exemplar response on page 44.
14	S8P5b	3	N/A	See scoring rubric and exemplar response on page 45.
15	S8P5c	1	D	The correct answer is choice (D) A stronger magnet will attract a greater number of metallic items. Choices (A), (B), and (C) are incorrect because none of these changes are tests of increasing the strength of an electromagnet. In addition, choices (A), (B), and (C) would all reduce the strength of an electromagnet.

EXAMPLE SCORING RUBRICS AND EXEMPLAR RESPONSES

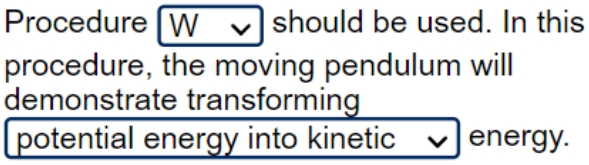
Item 13

Scoring Rubric

Points	Description
1	The student correctly selects both drop-down menu options.
0	The student does not correctly select both drop-down menu options.

Exemplar Response

The correct response is shown below.



“W” is the correct response for the first drop-down menu because this is a fair test that does not risk varying starting forces. “Potential energy into kinetic” (energy) is the correct response for the second drop-down menu because raising a weight such as a pendulum to a height gives it potential energy, which is then transformed into kinetic energy as the pendulum falls. Pushing a pendulum would just give it kinetic energy to start with, which would not demonstrate a relationship between potential and kinetic energy.

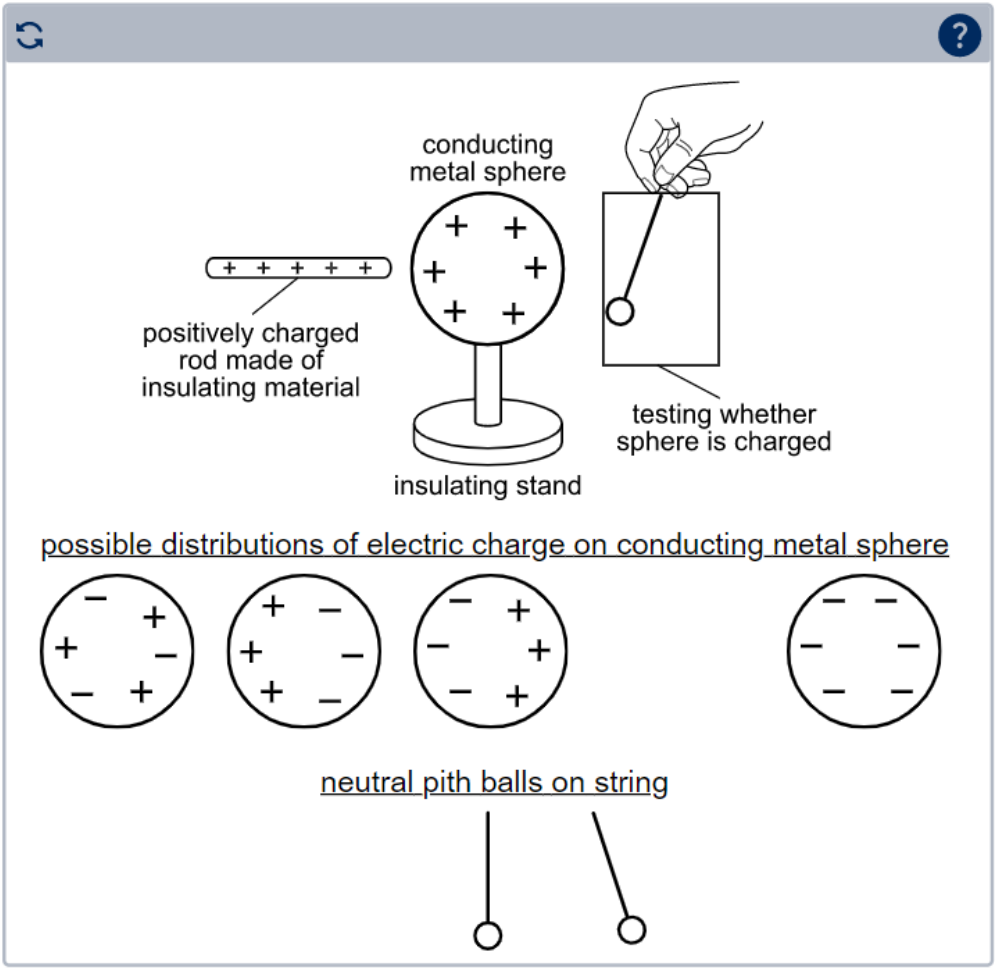
Item 14

Scoring Rubric

Points	Description
2	The student fills in the correct charge distribution and the correct neutral pith ball picture.
1	The student fills in the correct charge distribution OR the correct neutral pith ball picture.
0	The student fills in neither the correct charge distribution nor the correct neutral pith ball picture.

Exemplar Response

The correct response is shown below.



This is the correct response because touching the positively charged rod to the conducting metal sphere will transfer some of the positive charge to the sphere. In addition, because the sphere is conducting, the positive charge will remain on the sphere and become evenly distributed on the surface of the sphere. The other options are incorrect because they show either no net charge on the sphere, charges that accumulate on one side or the other side of the sphere instead of being distributed evenly, or the sphere having an evenly distributed negative charge. The neutral pith ball will be attracted to the charged sphere and move toward the sphere (regardless of whether the sphere is positively or negatively charged).

Waves

In this section, you will acquire a conceptual understanding of the nature of sound and electromagnetic radiation. You will study how sound behaves in the presence of different obstacles and how light is manipulated by positioning mirrors and lenses in its path.

KEY CONCEPTS

Waves are constant fluctuations that travel through space (either in the vacuum of outer space or through matter), transferring energy. When you throw a rock in a puddle, the water forms waves that move outward from the place where the rock hit the water. Waves can move through solids, liquids, gases, and empty space (i.e., a vacuum, a volume containing no matter). (S8P4a)

Frequency is the number of vibrations a wave makes per a unit of time, commonly measured in Hertz, which is waves per second. If you counted the number of wave peaks that occurred in a minute after throwing a rock in a puddle, you could determine the frequency of that wave. (S8P4f)

Wavelength is the distance from one peak of a wave to the next peak of the wave. (S8P4f)

Amplitude is the property of a wave that describes half the distance between the height of the peak of the wave and the trough (the bottom) of the wave, or the maximum distance from the resting position. In a surf wave, the amplitude represents the amount of water displaced, which can be very large. (S8P4f)

Electromagnetic radiation is a form of energy that is produced by oscillating electric and magnetic disturbances, or by the movement of electrically charged particles traveling through a vacuum or matter. It is used to describe radio waves, microwaves, infrared radiation, visible light, ultraviolet radiation, X-rays, and gamma rays. The **electromagnetic spectrum** consists of all the different kinds of electromagnetic radiation. Radio waves have the smallest frequency and longest wavelength in the electromagnetic (EM) spectrum (the complete set of electromagnetic radiation) and therefore contain the least energy. Gamma rays have the largest frequency and shortest wavelength in the EM spectrum and therefore contain the most energy. (S8P4a)

Electromagnetic waves do not require a medium to move through. Electromagnetic waves transport energy that is stored in the electric and magnetic fields. (S8P4a)

Mechanical waves are caused by a disturbance or vibration that causes the molecules in matter to bump into each other and transfer the energy from one molecule to the next in a set direction. Mechanical waves require matter to provide a **medium** for the waves to move through, so mechanical waves cannot occur in the vacuum of space. (S8P4a, e)

Sound is a mechanical wave that can be heard as it moves through a medium, such as air, and temporarily displaces the particles of the medium, either by rarefaction (the particles temporarily move farther apart, creating lower pressure) or compression (the particles temporarily move closer together, creating higher pressure). When fireworks go off on the Fourth of July, you can hear the sound. With some of the larger fireworks, you can also feel the air as the pressure from the firework exploding pushes the air away from the firework. (S8P4d)

When people refer to **light**, they are usually referring to the visible light they can see. Light is not considered matter and has no mass. The behavior of light can be explained by the introduction of a massless particle called a photon or by studying the way that electromagnetic waves interact with matter. (S8P4d)

There are several processes that light can go through as it encounters matter. **Reflection** occurs when light bounces off a medium. When light is reflected, not all the light is reflected. **Refraction** occurs when light moves from one medium to a new medium and bends as the medium changes the speed of the light as it moves through the new medium. When you look through a glass of water and an object behind the glass appears to change shape, the light reflected by that object has been refracted by the glass. **Diffraction** occurs when light encounters an obstacle and slightly bends as it passes around the object. If you hold a CD and see the colors of the rainbow, this is the light being diffracted by the surface of the CD.

Absorption occurs when light strikes a surface and the energy of the photon is taken up by the matter. An object lying in the sun will warm up as the sunlight transforms into heat energy. (S8P4d)

When the human eye sees **colors**, it is seeing the parts of the spectrum of light that are reflected from an object. A blue object reflects the wavelengths of light that we see as blue. (S8P4d)

Important Tip

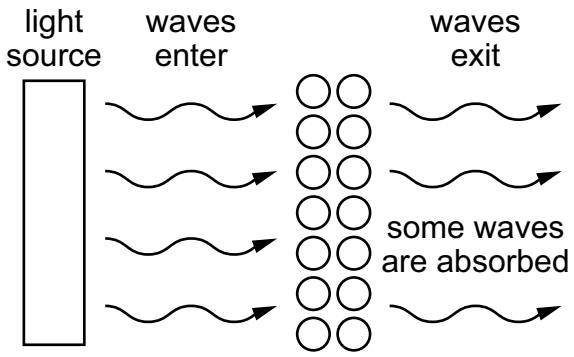
- The ways waves travel is known as wave propagation. As waves propagate, some of the energy is transferred. When light travels through a glass of water, it slows down and is refracted. Some of the energy that is lost from the wave—and that causes the light to slow down—is transferred into the water and glass as thermal energy. (S8P4b, d)

SAMPLE ITEMS

Item 16

Selected-Response

The model shows how light waves are transmitted through a transparent substance.



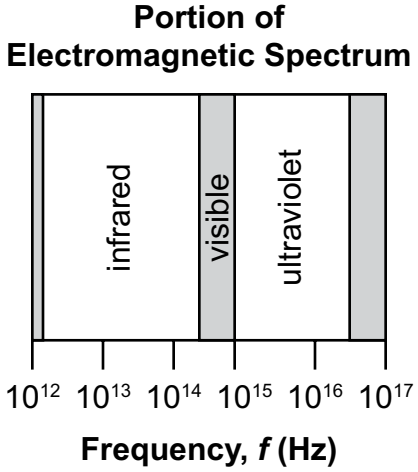
How would the model be different for a sound wave that is being transmitted through the same substance?

A. The wavy arrows representing sound waves would have a smaller wavelength.
B. The wavy arrows representing sound waves would go in the opposite direction.
C. The atoms in the model would move parallel to the direction of the incoming wave.
D. The atoms in the model would move perpendicular to the direction of the incoming wave.

Item 17

Selected-Response

The diagram shows three types of electromagnetic radiation and their range of frequencies.



Which explanation correctly uses the data in the diagram to show how infrared radiation and ultraviolet radiation are related in terms of energy?

A. Ultraviolet radiation has less energy than infrared radiation because energy is inversely proportional to frequency and the frequency of ultraviolet radiation is higher.

B. Ultraviolet radiation has more energy than infrared radiation because energy is inversely proportional to frequency and the frequency of ultraviolet radiation is lower.

C. Ultraviolet radiation has less energy than infrared radiation because energy is proportional to frequency and the frequency of ultraviolet radiation is lower.

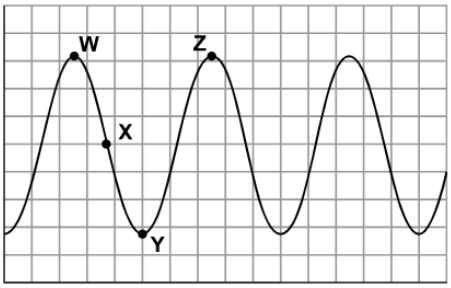
D. Ultraviolet radiation has more energy than infrared radiation because energy is proportional to frequency and the frequency of ultraviolet radiation is higher.

Item 18

Drop-Down Technology-Enhanced

A student drew the diagram shown to model an electromagnetic wave from the sun.

Model of Electromagnetic Wave from Sun



Scientists have shown that ultraviolet light from the sun that has a wavelength of 315 to 400 nanometers can damage the retina.

Use the drop-down menus to create the BEST question for the student to ask to determine whether the electromagnetic wave modeled will cause damage to the retina.

What is the [ ] distance between point [ ] on the model?

Use a mouse, touchpad, or touchscreen to click the arrow beside each of the two blank boxes. When you click the arrow, a drop-down menu will appear showing you all the possible options for that blank. Each drop-down menu with its options is shown below.

What is the [ ] distance between point [ ] on the model?

First drop-down menu:
- vertical
- horizontal

Second drop-down menu:
- Y and point Z
- X and point Y
- W and point Z
- W and point Y

Item 19

Selected-Response

The densities of four different materials at the same temperature are shown in the table.

Densities of Four Materials

Material	Density (g/cm^3)
W	0.000178
X	0.00138
Y	1.00
Z	8.90

Based on the densities shown in the table, in which material will a sound wave MOST LIKELY travel at the GREATEST speed?

A. Material W
B. Material X
C. Material Y
D. Material Z

Item 20

Multi-Select Technology-Enhanced

A student questioned how the properties of different materials affect the speed of sound waves traveling through them. The student found the following data in a chemistry handbook for the speed of sound in gases, liquids, and solids.

Speed of Sound in Different Materials at Room Temperature

State	Material	Density (kg/m^3)	Speed of Sound (m/s)
gas	carbon dioxide	1.842	267
	helium	0.166	1,007
	methane	0.668	446
liquid	benzene	874	1,310
	ethanol	789	1,162
	water	1,000	1,497
solid	aluminum	2,700	6,420
	copper	8,790	5,010
	gold	19,290	3,240

The student analyzed the data to make predictions about the speed of sound through materials with various densities and states of matter. Which TWO predictions can be made based on the data shown in the table?

A. The speed of sound generally increases as it moves from gases to liquids to solids.
B. The speed of sound generally increases as it moves from liquids to gases to solids.
C. The speed of sound generally increases as it moves from solids to gases to liquids.
D. As the density of liquids and solids increases, the speed of sound generally increases.
E. As the density of gases and liquids increases, the speed of sound generally decreases.
F. As the density of solids and gases increases, the speed of sound generally decreases.

Item 21

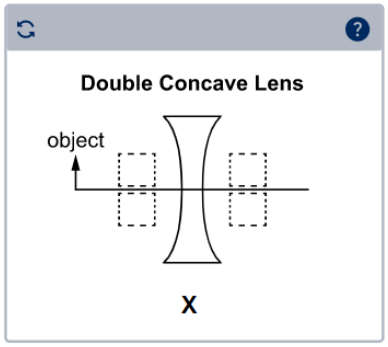
Drag-and-Drop Multi-Part Technology-Enhanced

Part A

A student is modeling the image that will be produced by a double concave lens as shown.

Part A

Move the X into the box that shows the location of the image that will be produced.



Use a mouse, touchpad, or touchscreen to move the X into the correct box. After the response is entered and the OK button is clicked, Part B will appear on the screen.

Go on to the next page to finish item 21.

Item 21. *Continued*.

Part B

A student is modeling the image that will be produced by a double concave lens as shown.

Part B

Move the correct words into the table to describe the image.

Image from a Double Concave Lens

Characteristic	Description
real or virtual?	
upright or inverted?	
size compared to object?	

real **upright** **same size**
virtual **inverted** **larger size**
smaller size

Use a mouse, touchpad, or touchscreen to move the correct words into the boxes in the table.

Item 22

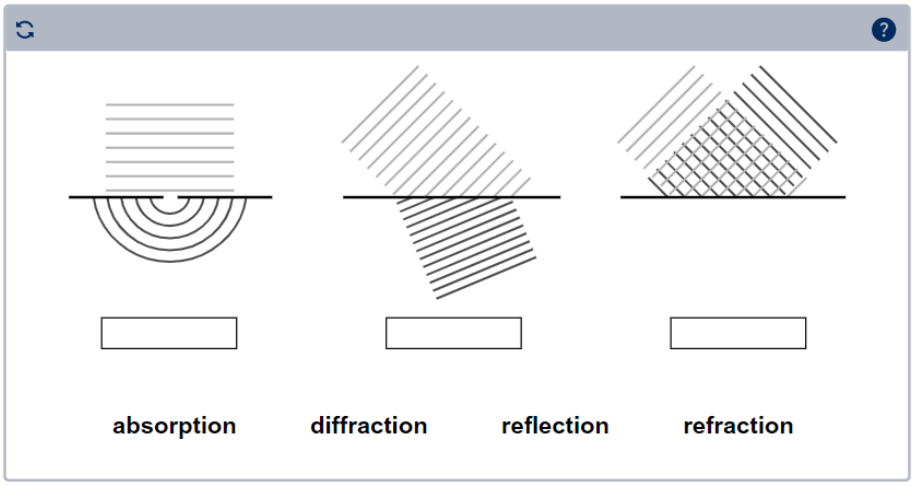
Drag-and-Drop Multi-Part Technology-Enhanced

Part A

A student is making models of incoming sound waves' interactions with a surface.

Part A

Move one interaction term into each box to correctly identify each model. Not all of the interaction terms will be used.



Use a mouse, touchpad, or touchscreen to move the correct words into the boxes. After the response is entered and the OK button is clicked, Part B will appear on the screen.

Go on to the next page to finish item 22.

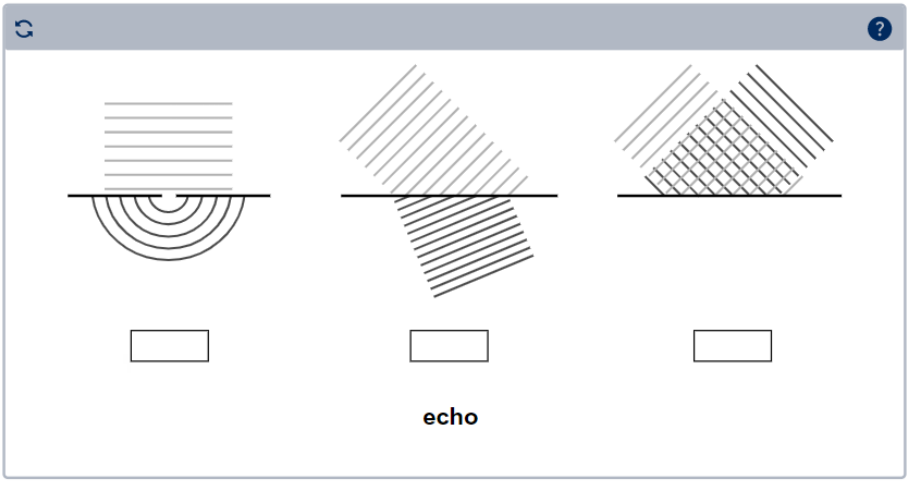
Item 22. *Continued*.

Part B

A student is making models of incoming sound waves' interactions with a surface.

Part B

Move the word "echo" into the box under the interaction that shows an echo.



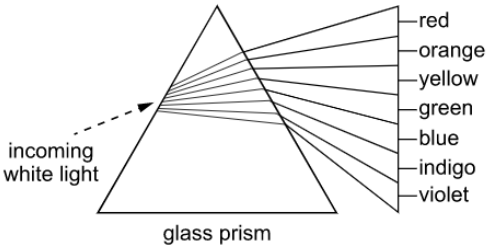
Use a mouse, touchpad, or touchscreen to move the word "echo" into the correct box.

Item 23

Drop-Down Multi-Part Technology-Enhanced

The diagram is a model of a narrow beam of white light encountering a prism.

White Light Encountering a Prism



Part A Use the drop-down menu to BEST complete the statement about how light interacts with the prism.

When white light enters and leaves the prism, its path is changed because the light is [ ] at the boundary between the glass and the air.

Part B Use the drop-down menu to BEST complete the statement describing how color is seen by the human eye.

Different colors are seen because each color of light that emerges from the prism has a different [ ].

Use a mouse, touchpad, or touchscreen to click the arrow beside each of the two blank boxes. When you click the arrow, a drop-down menu will appear showing you all the possible options for that blank. Each drop-down menu with its options is shown below.

Part A Use the drop-down menu to BEST complete the statement about how light interacts with the prism.

When white light enters and leaves the prism, its path is changed because the light is [ ] at the boundary between the glass and the air.

- absorbed
- diffracted
- reflected
- refracted

Part B Use the dro to BEST complete the statement describing how colo human eye.

Different colors are s each color of light that emerges from the prism has a different [ ].

- amplitude
- intensity
- speed
- wavelength

SAMPLE ITEM KEYS

Item	Standard/ Element	DOK Level	Correct Answer	Explanation
16	S8P4d	2	C	The correct answer is choice (C) The atoms in the model would move parallel to the direction of the incoming wave. Choice (A) is incorrect because sound would not change in wavelength when transmitted. Choice (B) is incorrect because this would show reflection. Choice (D) is incorrect because atoms do not move perpendicular to the direction of sound waves, as sound waves are longitudinal.
17	S8P4b	2	D	The correct answer is choice (D) Ultraviolet radiation has more energy than infrared radiation because energy is proportional to frequency and the frequency of ultraviolet radiation is higher. Choice (A) is incorrect because the energy is inversely proportional to the wavelength of the radiation, not the frequency, so the ultraviolet radiation should have more energy than infrared radiation. Choice (B) is incorrect because the energy is inversely proportional to the wavelength of the radiation, not the frequency, and the frequency of ultraviolet radiation is higher, not lower. Choice (C) is incorrect because the frequency of ultraviolet radiation is higher, not lower; thus it should have more energy, not less energy, than infrared radiation.
18	S8P4b	2	N/A	See scoring rubric and exemplar response on page 60.
19	S8P4e	1	D	The correct answer is choice (D) Material Z. This is the correct choice because according to the table Material Z has the greatest density and the density is very high indicating that the material is most likely a solid. The speed of sound is typically highest in solid materials. The other options are incorrect because they have densities typical of gases in choices (A) and (B) or water in choice (C).
20	S8P4e	3	A, F	The correct answers are choice (A) The speed of sound generally increases as it moves from gases to liquids to solids, and choice (F) As the density of solids and gases increases, the speed of sound generally decreases. Choice (B) is incorrect because the general trend is increasing speed from gases to liquids. Choice (C) is incorrect because the speed of sound generally increases as it moves from gases to liquids to solids, not solids to gases to liquids. Choice (D) is incorrect because this statement is true of liquids, but not solids. Choice (E) is incorrect because this statement is true of gases, but not liquids.

Item	Standard/ Element	DOK Level	Correct Answer	Explanation
21	S8P4g	3	N/A	See scoring rubric and exemplar response beginning on page 61.
22	S8P4d	2	N/A	See scoring rubric and exemplar response beginning on page 63.
23	S8P4d	2	N/A	See scoring rubric and exemplar response on page 65.

EXAMPLE SCORING RUBRICS AND EXEMPLAR RESPONSES

Item 18

Scoring Rubric

Points	Description
1	The student correctly selects both drop-down menu options.
0	The student does not correctly select both drop-down menu options.

Exemplar Response

The correct response is shown below.

What is the horizontal distance between point W and point Z on the model?

"Horizontal" is the correct response for the first drop-down menu because the wavelength is the horizontal "Horizontal" is the correct response for the first drop-down menu because the wavelength is the horizontal distance between the same relative locations on two successive wave oscillations. "W and point Z" is the correct response for the second drop-down menu because these are the same relative locations, the peaks on two successive wave oscillations.

Item 21

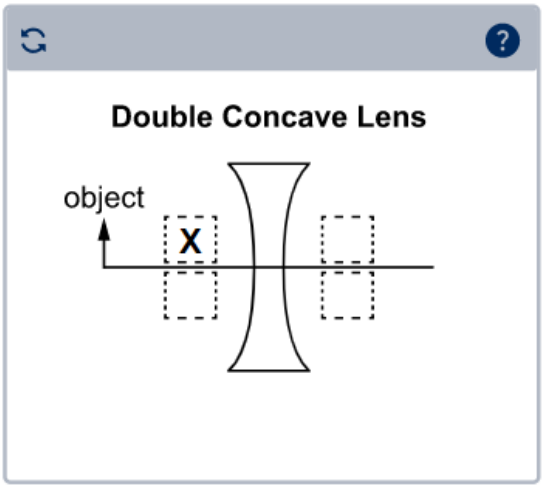
Scoring Rubric

Points	Description
2	The student correctly answers both Part A and Part B.
1	The student correctly answers either Part A OR Part B.
0	The student does not correctly answer either part.

Exemplar Response

Part A

The correct response is shown below.



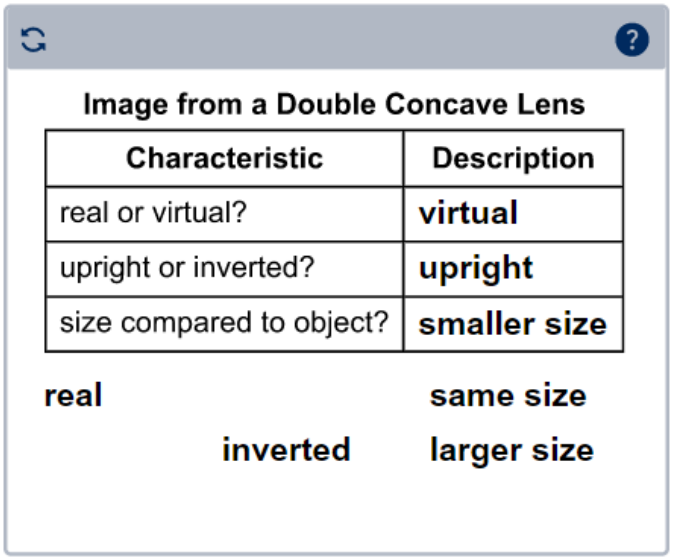
This is the correct response because the image formed by a double concave lens will be on the same side of the lens as the object and will be on the same side relative to a line through the center of the lens.

Go on to the next page to finish item 21.

Item 21

Part B

The correct response is shown below.



This is the correct response because double concave lenses will always produce an upright image at a smaller size than the object. In addition, because the image is on the same side of the lens as the object, the image will be virtual, instead of real.

Part B must be completely correct to receive 1 point, and there are no alternate answers for Part B that would receive 1 point.

Item 22

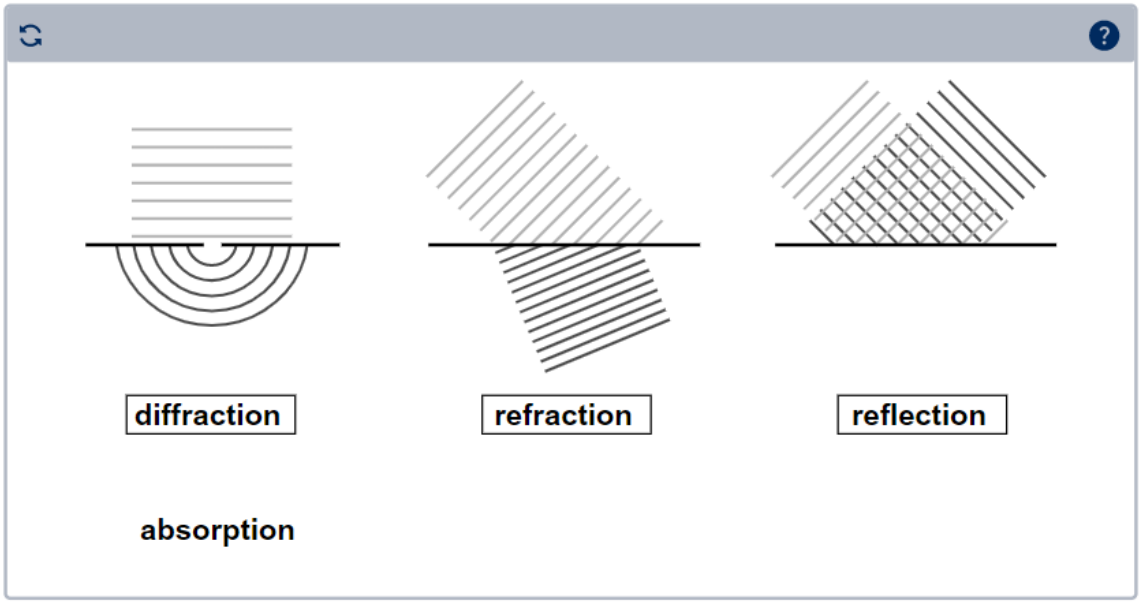
Scoring Rubric

Points	Description
2	The student correctly answers both Part A and Part B.
1	The student correctly answers either Part A OR Part B.
0	The student does not correctly answer either part.

Exemplar Response

Part A

The correct response is shown below.



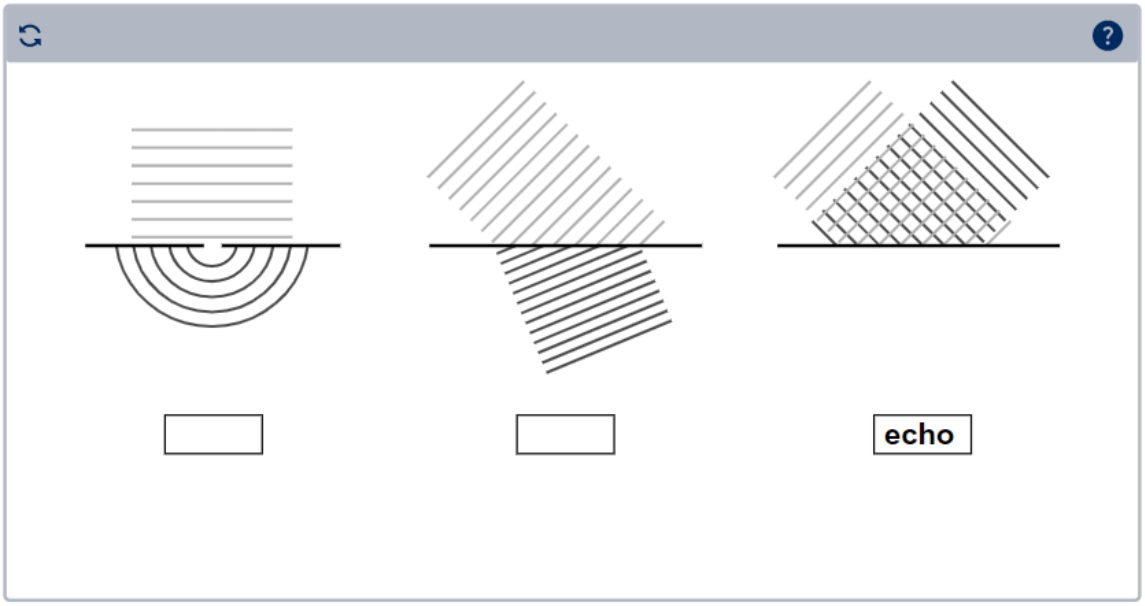
This is the correct response because each model is correctly identified. The model on the left shows diffraction, which occurs when waves spread as they travel after passing through an opening or passing by a corner. The center model shows refraction, which occurs when waves bend as they pass from one medium to another. The model on the right shows reflection, which occurs when waves bounce off a surface. In addition, an echo is a reflection, so echo has been correctly applied to the model on the right.

Go on to the next page to finish item 22.

Item 22

Part B

The correct response is shown below.



An echo is a sound wave reflection, so the response correctly places “echo” in the box on the right.

Item 23

Scoring Rubric

Points	Description
2	The student correctly selects the drop-down menu option for Part A AND Part B.
1	The student correctly selects the drop-down menu option for Part A OR Part B.
0	The student does not correctly select the drop-down menu options for either part.

Exemplar Response

The correct response is shown below.

Part A

When white light enters and leaves the prism, its path is changed because the light is [refracted] at the boundary between the glass and the air.

"Refracted" is the correct response for the first drop-down menu because light waves bend when passing the boundary between two materials that have different speeds of light, and the term for this bending is refraction.

Part B

Different colors are seen because each color of light that emerges from the prism has a different [wavelength].

"Wavelength" is the correct response for the second drop-down menu because the characteristic of visible light that determines the color seen by the human eye is its wavelength.

Motion and Force

In this section, you will focus on acquiring a conceptual understanding of energy conservation; heat transfer processes; and the relationships between force, mass, and acceleration. Throughout this section, you will be expected to analyze scientific data by collecting, using, interpreting, and comparing experimental results.

KEY CONCEPTS

Displacement is the length and direction of a straight line between two locations, or positions. Since displacement considers only the length and direction of a straight line, it doesn't depend on the actual path of a moving object. If Town A is 10 miles east of Town B, the displacement of Town A is 10 miles east relative to Town B. For a moving object, displacement can be defined as the change between the initial and final position of the object. (S8P3a)

Distance is a measure of the length of a path that a moving object travels. If the only road between the two towns has to wind through hills, the distance traveled between the two towns is longer than 10 miles, even though the displacement between the two towns is 10 miles east. (S8P3a)

Velocity is a quantity that measures the rate at which the position of an object changes in time. Velocity always describes a distance and a direction. Since velocity has direction, one way to show this numerically is to assume that travelling in a certain direction is symbolized with positive numbers while traveling opposite that direction is shown using negative numbers. (S8P3a)

Speed measures the rate at which an object moves along a path. Unlike velocity, speed is not considered to have a direction. (S8P3a)

Acceleration is a quantity that measures the rate at which an object changes its velocity. People often talk about an object decelerating when the object slows down. An object that slows down is actually experiencing a negative acceleration. This means the rate of change is a negative value. An object can have a velocity but not acceleration if it is moving at a constant velocity. For example, a car takes one hour to make a trip of 80 kilometers on a straight road pointing due east. In the middle of the trip, the car accelerated to 100 kilometers per hour (kph) and operated at that speed for 10 minutes and then accelerated to 60 kph and operated at that speed for 10 minutes. After the first acceleration the speed of the car was 100 kph, and during that time, the velocity of the car was 100 kph eastward. After the second acceleration the speed of the car was 60 kph and the velocity of the car during that time was 60 kph eastward. Finally, the car accelerated again back to 80 kph. The average velocity of the car over the whole trip was 80 kph eastward, and the average speed was 80 kph. (S8P3a)

A **force** is a push or pull on an object. Force can be the result of contact, such as when you push a book across your desk. Forces between objects that are not in contact with each other can be explained by the presence of force fields, like the magnetic field and the gravitational field. When one magnet repels another magnet, there is a push force that acts on the magnets even though the magnets are not in contact. (S8P3b)

When two or more forces act on an object but the object's velocity does not change, the object is being acted on by **balanced forces**. A book on your desk that is not moving is said to be **stationary**. The book is said to be at **rest** in relation to the desk. Gravity is acting to pull the book down. The desk pushes up against the book, and the book is at rest in relation to the desk. (S8P3b)

An accelerating object is being acted on by **unbalanced forces**. When you push your book across your desk, you are applying force to one side of the book. The force of friction acts on the book in the opposite direction that the book is moving, reducing the speed at which the book moves. Because the book still begins to move in the direction you are pushing it, these forces are unbalanced. (S8P3b)

Friction is the force that resists motion between two surfaces. (S8P3b)

Inertia is the resistance to any change in the state of motion of any physical object. All matter has inertia, and the inertia of matter does not change until the matter is acted on by unbalanced forces that cause a change in motion. (S8P3b)

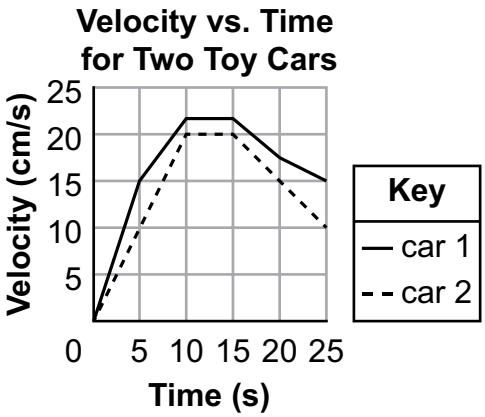
Gravity is the force of attraction that exists between any two or more masses. Gravity can refer to the force that Earth exerts on everything. (S8P3b, S8P5a)

SAMPLE ITEMS

Item 24

Selected-Response

Two toy cars move in the same direction with velocities that are shown in the graph.



Based on the information in the graph, which statement describes the motion of the two toy cars?

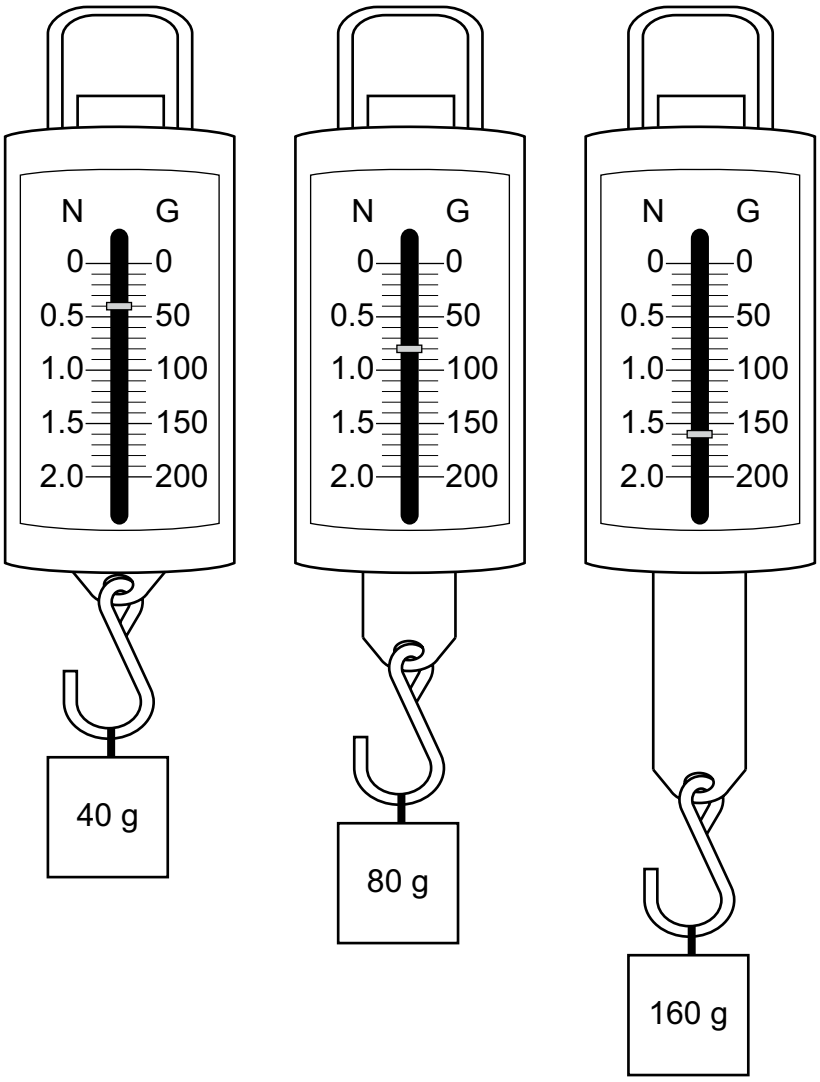
A. Car 1 is traveling faster than car 2.
B. Car 2 is traveling farther than car 1.
C. Car 1 has constant velocity between 0 and 10 seconds.
D. Car 2 is changing direction between 10 and 15 seconds.

Item 25

Selected-Response

A lab group is investigating how Earth's gravitational acceleration affects the force exerted on toy blocks of different masses. The diagram shows the results of their investigation.

Force vs. Mass Investigation



The group claims that the amount of force needed to accelerate a toy block is directly proportional to its inertia.

Go on to the next page to finish item 25.

Item 25. *Continued*.

Which explanation presents the BEST argument for whether the group's claim is true?

A. The claim is false because every time the mass of the metal cube is increased, the pointer on the spring scale moves downward.

B. The claim is true because every time the mass of the metal cube is doubled, the gravitational force doubles.

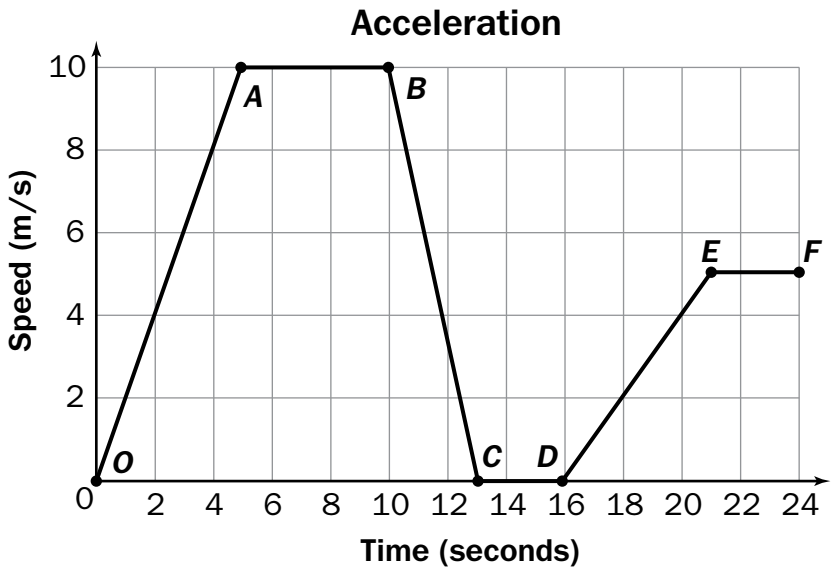
C. The claim is false because every time the volume of the metal cube is increased, the pointer on the spring scale moves downward.

D. The claim is true because every time the volume of the metal cube is doubled, the gravitational force doubles.

Item 26

Selected-Response

Students are exploring the relationship between velocity and acceleration. This graph shows the acceleration of a remote-controlled toy car.



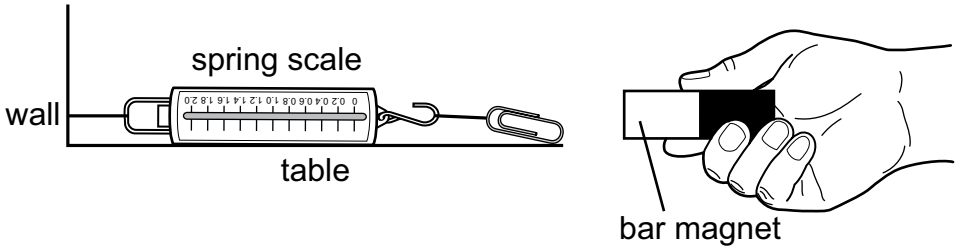
Which statement is TRUE based on the graph?

A. Segment *BC* and segment *EF* show constant speed.
B. Segment *OA* and segment *BC* show constant speed.
C. Segment *AB* and segment *CD* show positive acceleration.
D. Segment *OA* and segment *DE* show positive acceleration.

Item 27

Multi-Select Technology-Enhanced

A magnet is moved toward a paper clip, as shown in the drawing. Students want to investigate how the strength of the force between the paper clip and a magnet changes under different conditions.



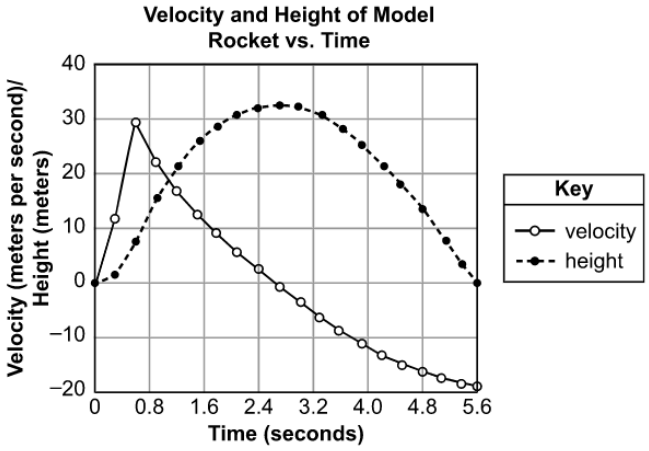
Which TWO factors should the students vary to BEST investigate the strength of the force between the paper clip and a magnet?

A. Attach the spring scale to the table.
B. Move the magnet farther away from the paper clip.
C. Replace the bar magnet with a horseshoe magnet.
D. Replace the spring scale with a larger spring scale.
E. Increase the length of the string attaching the spring scale to the wall.
F. Increase the length of the string attaching the spring scale to the paper clip.

Item 28

Drag-and-Drop Technology-Enhanced

A hobbyist launched a flying model rocket and recorded the motion data shown in the graph. The model rocket is launched at time 0 and lands back on the ground after 5.6 seconds.



Move the words describing the direction of the rocket's acceleration and motion during the flight into the correct boxes in the table. Each word will be used more than once.

Time (s)	Acceleration	Motion
0.0–0.6		
0.6–2.7		
2.7–5.6		

upward downward

Use a mouse, touchpad, or touchscreen to move the correct words into the boxes in the table.

SAMPLE ITEM KEYS

Item	Standard/ Element	DOK Level	Correct Answer	Explanation
24	S8P3a	2	A	The correct answer is choice (A) Car 1 is traveling faster than car 2 since car 1 has a larger velocity than car 2 during the same 25 seconds. Choice (B) is incorrect because car 1 travels farther than car 2. Choice (C) is incorrect because car 1 is moving at a constant acceleration during this time. Choice (D) is incorrect because the graph shows only that the velocity changed in magnitude but not in direction.
25	S8P3c	2	B	The correct answer is choice (B) The claim is true because every time the mass of the metal cube is doubled, the gravitational force doubles. Choice (A) is incorrect because the claim is true. Choice (C) is incorrect because the claim is true and inertia depends on mass, not volume. Choice (D) is incorrect because the mass of the metal cube is a better representation of the inertia than the volume which is not represented quantitatively in the investigation to determine a proportionality with gravitational force.
26	S8P3a	2	D	The correct answer is choice (D) Segment *OA* and segment *DE* show positive acceleration. Choice (A) is incorrect because segment *BC* shows negative acceleration and segment *EF* shows constant speed. Choice (B) is incorrect because segment *OA* shows positive acceleration and segment *BC* shows negative acceleration, not constant speed. Choice (C) is incorrect because segment *AB* shows constant speed as shown by the straight line. Segment *CD* shows speed of zero.
27	S8P5c	3	B, C	The correct answers are choice (B) Move the magnet farther away from the paper clip, and choice (C) Replace the bar magnet with a horseshoe magnet. Each of these changes a characteristic/factor that influences the strength of the magnetic force. Choice (A) is incorrect because changing where the scale is attached does not test the strength of the magnetic force. Choice (D) is incorrect because the size of the scale does not test the strength of the magnetic force. Choice (E) is incorrect because the length of the string attached to the wall does not test the strength of the magnetic force. Choice (F) is incorrect because the length of the string attached to the paper clip does not test the strength of the magnetic force.
28	S8P3a	3	N/A	See scoring rubric and exemplar response on page 75.

EXAMPLE SCORING RUBRIC AND EXEMPLAR RESPONSE

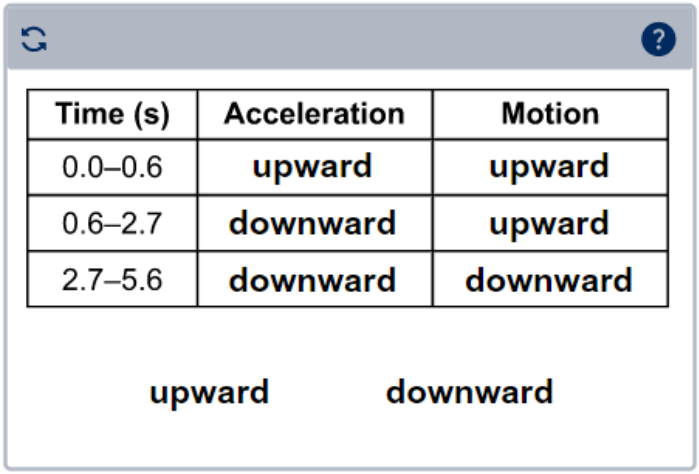
Item 28

Scoring Rubric

Points	Description
2	The student correctly fills in all boxes.
1	The student correctly fills in three, four, or five boxes.
0	The student does not correctly fill in at least three boxes.

Exemplar Response

The correct response is shown below.



This is the correct response because according to the graph the model rocket has an upward acceleration in the first indicated time period, but the acceleration is downward in the next two time periods. (Downward acceleration reflects the pull of gravity. Remember that acceleration can be downward even though motion is upward because negative acceleration represents slowing down). The rocket's motion is upward for the first two time periods because the motor is pushing it at first and because it still travels upward for a while after the motor burns out. However, after the rocket reaches its peak height it begins to fall back toward the ground, so its motion is downward.

Study/Resource Guide
for Students and Parents
Grade 8
Science