

# Ohio's State Tests

## ANSWER KEY & SCORING GUIDELINES

SPRING 2015

### PHYSICAL SCIENCE

#### PART 2

## Table of Contents

Questions 1 – 16: Content Summary and Answer Key .....	1
Question 1: Question and Scoring Guidelines .....	3
Question 1: Sample Response .....	6
Question 2: Question and Scoring Guidelines .....	7
Question 2: Sample Response .....	10
Question 3: Question and Scoring Guidelines .....	11
Question 3: Sample Response .....	14
Question 4: Question and Scoring Guidelines .....	15
Question 4: Sample Response .....	19
Question 5: Question and Scoring Guidelines .....	21
Question 5: Sample Responses .....	25
Question 6: Question and Scoring Guidelines .....	29
Question 6: Sample Response .....	32
Question 7: Question and Scoring Guidelines .....	33
Question 7: Sample Responses .....	37
Question 8: Question and Scoring Guidelines .....	41
Question 8: Sample Responses .....	45
Question 9: Question and Scoring Guidelines .....	49
Question 9: Sample Response .....	52
Question 10: Question and Scoring Guidelines .....	53
Question 10: Sample Responses .....	57
Question 11: Question and Scoring Guidelines .....	65
Question 11: Sample Response .....	68
Question 12: Question and Scoring Guidelines .....	69
Question 12: Sample Responses .....	73
Question 13: Question and Scoring Guidelines .....	81
Question 13: Sample Responses .....	85

Question 14: Question and Scoring Guidelines .....	89
Question 14: Sample Responses .....	93
Question 15: Question and Scoring Guidelines .....	97
Question 15: Sample Response .....	100
Question 16: Question and Scoring Guidelines .....	101
Question 16: Sample Response .....	104

Physical Science  
EOY Practice Test  
Content Summary and Answer Key

Question No.	Item Type	Topic	Subtopic	Answer Key	Points
1	Multiple Choice	Study of Matter	Bonding and Compounds	A	1 point
2	Multiple Choice	Forces and Motion	Dynamics	B	1 point
3	Multiple Choice	Energy and Waves	Electricity	B	1 point
4	Evidence-Based Selected Response	The Universe	History of the Universe	B; C; D	1 point
5	Graphic Response	Forces and Motion	Dynamics	---	1 point
6	Multiple Choice	Study of Matter	Classification of Matter	B	1 point
7	Matching	Energy and Waves	Waves	---	1 point
8	Short Answer	The Universe	Galaxy formation	---	1 point
9	Multiple Choice	Study of Matter	Reactions of Matter	D	1 point
10	Graphic Response	Study of Matter	Bonding and Compounds	---	1 point
11	Multi-Select	Energy and Waves	Thermal Energy	A; C; F	1 point
12	Graphic Response	Energy and Waves	Conservation of Energy	---	1 point
13	Table	The Universe	History of the Universe	---	1 point
14	Equation Editor	Forces and Motion	Motion	---	1 point
15	Multiple Choice	Study of Matter	Bonding and Compounds	C	1 point
16	Multiple Choice	Forces and Motion	Dynamics	B	1 point

1

### Question 1

A compound is formed between barium (Ba) in group 2, and oxygen (O) in group 16. These elements form a compound with the formula BaO.

What is the name of this compound?

- Ⓐ barium oxide
- Ⓑ barium oxygen
- Ⓒ barium dioxide
- Ⓓ barium monoxide

## Physical Science EOY Practice Test

### Question 1

#### Question and Scoring Guidelines

Points Possible: 1

See [Alignment](#) for more detail.

#### Scoring Guidelines

**Rationale for Option A; Key** – Since barium is a metal and oxygen is a nonmetal, the compound is most likely ionic and the name will not contain prefixes. The name of an ionic compound is generally the name of the metal followed by the name of the nonmetal that is given an “-ide” suffix. Therefore, the name of the compound between barium and oxygen would be “barium oxide.”

**Rationale for Option B;** This is incorrect. Since barium is a metal and oxygen is a nonmetal, the compound is most likely ionic and the name will not contain prefixes. The name of an ionic compound is generally the name of the metal followed by the name of the nonmetal that is given an “-ide” suffix. Therefore, the name of the compound between barium and oxygen would be “barium oxide,” not “barium oxygen.”

Rationale for Option C: This is incorrect. Since barium is a metal and oxygen is a nonmetal, the compound is most likely ionic and the name will not contain prefixes. The name of an ionic compound is generally the name of the metal followed by the name of the nonmetal that is given an "-ide" suffix. Therefore, the name of the compound between barium and oxygen would be "barium oxide," not "barium dioxide."

Rationale for Option D: This is incorrect. Since barium is a metal and oxygen is a nonmetal, the compound is most likely ionic and the name will not contain prefixes. The name of an ionic compound is generally the name of the metal followed by the name of the nonmetal that is given an "-ide" suffix. Therefore, the name of the compound between barium and oxygen would be "barium oxide," not "barium monoxide."

## Alignment

### Topic

Study of Matter

### Subtopic

Bonding and Compounds

### Content Elaboration

"Using the periodic table to determine ionic charge, formulas of ionic compounds containing elements from groups 1, 2, 17, hydrogen and oxygen can be predicted. Given a chemical formula, a compound can be named using conventional systems that include Greek prefixes where appropriate. Prefixes will be limited to represent values from one to 10. Given the name of an ionic or covalent substance, formulas can be written. Naming organic molecules is beyond this grade level and is reserved for an advanced chemistry course. Prediction of bond types from electronegativity values, polar covalent bonds, writing formulas and naming compounds that contain polyatomic ions or transition metals will be addressed in the chemistry syllabus."

### Cognitive Demand

Recalling Accurate Science (R)

Requires students to provide accurate statements about scientifically valid facts, concepts and relationships. Recall only requires students to provide a rote response, declarative knowledge or perform routine mathematical tasks. This cognitive demand refers to students' knowledge of science fact, information, concepts, tools, procedures and basic principles.

5

### Explanation of the Item

This one-point multiple choice item requires the student to identify the correct name of the compound formed between barium and oxygen. Looking at the placement of the elements on the periodic table, it can be observed that barium is a metal since it is on the left of the zig-zagged line, and oxygen is a nonmetal since it is on the right of the zig-zagged line. Generally, ionic compounds are formed between a metal and a nonmetal. Naming of an ionic compound does not involve using prefixes. The name of an ionic compound is generally the name of the metal followed by the name of the nonmetal that is given an "-ide" suffix. Therefore, the name of the compound between barium and oxygen would be "barium oxide."

Sample Response: 1 point

A compound is formed between barium (Ba) in group 2, and oxygen (O) in group 16. These elements form a compound with the formula BaO.

What is the name of this compound?

- A barium oxide
- B barium oxygen
- C barium dioxide
- D barium monoxide

6

## Question 2

Which statement describes an interacting force pair?

- A The force exerted by a cyclist equals the combined forces of friction and air resistance.
- B A car exerts a force on a bug as they collide, and the bug exerts an equal force on the car.
- C Gravity exerts a downward force on a refrigerator, and the normal force pushes up on the refrigerator.
- D Two people pull on opposite ends of a rope, but the rope does not move because the people pull with equal forces.

Points Possible: 1

See Alignment for more detail.

## Physical Science EOY Practice Test

### Question 2

### Question and Scoring Guidelines

7

### Scoring Guidelines

Rationale for Option A: This is incorrect. These forces may represent balanced forces if they cancel each other out. However, they are different types of forces and act on the same object (the bicycle) so they cannot be interactive force pairs. Also, the description does not follow the format "Object A acts on Object B so Object B acts on Object A." The statement does not describe an interactive force pair.

Rationale for Option B: Key – The two forces act on different objects (one on the bug and one on the car) and are equal and opposite. The description of the forces follows the format "Object A acts on Object B so Object B acts on Object A." This statement describes an interactive force pair.

Rationale for Option C: This is incorrect. These forces may represent balanced forces if they cancel each other out. However, they are different types of forces and act on the same object (the refrigerator) so they cannot be interactive force pairs. Also, the description does not follow the format "Object A acts on Object B so Object B acts on Object A." The statement does not describe an interactive force pair.

8

Rationale for Option D: This is incorrect. These forces may represent balanced forces if they cancel each other out. However, they act on the same object (the rope) so they cannot be interactive force pairs. Also, the description does not follow the format "Object A acts on Object B so Object B acts on Object A." The statement does not describe an interactive force pair.

## Alignment

### Topic

Forces and Motion

### Subtopic

Dynamics

### Content Elaboration

"A force is an interaction between two objects. Both objects in the interaction experience an equal amount of force, but in opposite directions. Interacting force pairs are often confused with balanced forces. Interacting force pairs can never cancel each other out because they always act on different objects. Naming the force (e.g., gravity, friction) does not identify the two objects involved in the interacting force pair. Objects involved in an interacting force pair can be easily identified by using the format "A acts on B so B acts on A." For example, the truck hits the sign, therefore, the sign hits the truck with an equal force in the opposite direction. Earth pulls the book down, so the book pulls Earth up with an equal force. The focus of the content is to develop a conceptual understanding of the laws of motion to explain and predict changes in motion, not to name or recite a memorized definition. In the physics syllabus, all laws will be applied to systems of many objects."

### Cognitive Demand

Recalling Accurate Science (R)

Requires students to provide accurate statements about scientifically valid facts, concepts and relationships. Recall only requires students to provide a rote response, declarative knowledge or perform routine mathematical tasks. This cognitive demand refers to students' knowledge of science fact, information, concepts, tools, procedures and basic principles.

9

## Explanation of the Item

This one-point multiple choice item requires the student to identify an example of an interacting force pair. Forces always occur in pairs that act on different objects in equal and opposite directions. When someone pushes against a wall with their fingertips, the wall pushes back on their fingertips and bends them backward. The two forces in the pair are always the same type of force (e.g., friction, gravitational force, electrical force) and act on different objects so they cannot cancel each other out. Interactive force pairs are often confused with balanced forces because they can both involve equal and opposite forces. Balanced forces apply when two or more objects exert a force on a third object in such a way that the forces cancel each other out. An example of balanced forces is a tug of war contest where two teams exert equal and opposite forces on a rope, so the rope has a net force of zero acting on it and remains at rest.

A good "rule of thumb" for determining if forces indicate an interactive force pair is to identify which objects act on which. If the forces are interacting force pairs, they can be described in the following format: "Object A acts on Object B so Object B acts on Object A." The only multiple choice selection that follows this format is "A car exerts a force on a bug as they collide, and the bug exerts an equal force on the car."

## Sample Response: 1 point

Which statement describes an interacting force pair?

- A The force exerted by a cyclist equals the combined forces of friction and air resistance.
- B A car exerts a force on a bug as they collide, and the bug exerts an equal force on the car.
- C Gravity exerts a downward force on a refrigerator, and the normal force pushes up on the refrigerator.
- D Two people pull on opposite ends of a rope, but the rope does not move because the people pull with equal forces.

10

## Physical Science EOY Practice Test

### Question 3

#### Question and Scoring Guidelines

## Question 3

What is the function of a power source in an electrical circuit?

- A to create electrons
- B to provide an electric potential difference
- C to increase the speed of electron movement
- D to promote current flow by reducing resistance

Points Possible: 1

See Alignment for more detail.

## Scoring Guidelines

Rationale for Option A: This is incorrect. Power sources do not create electrons. Power sources transfer electric potential energy to existing electrons.

Rationale for Option B; Key – Power sources transfer electric potential energy to electrons in a circuit, thereby establishing an electric potential difference in the circuit.

Rationale for Option C: This is incorrect. Electrons travel roughly the same range of speeds with and without an electric potential difference. The difference is without an electric potential difference, the electrons travel randomly. Even with a power source, the electrons travel mostly at random. However, the electric potential difference produces an electric field that causes a very small net movement of electrons through the circuit. It is the electric field that travels instantaneously through the circuit, not the electrons.

Rationale for Option D: This is incorrect. A power source transfers more electric potential energy to the circuit so it is better able to overcome any electrical resistance. It does not actually reduce resistance.

11

12

## Alignment

### Topic

Energy and Waves

### Subtopic

Electricity

### Content Elaboration

"By convention, electric current is the rate at which positive charge flows in a circuit. In reality, it is the negatively charged electrons that are actually moving. Current is measured in amperes (A), which is equal to one coulomb of charge per second (C/s). In an electric circuit, the power source supplies the electrons already in the circuit with electric potential energy by doing work to separate opposite charges. For a battery, the energy is provided by a chemical reaction that separates charges on the positive and negative sides of the battery. This separation of charge is what causes the electrons to flow in the circuit. These electrons then transfer energy to other objects and transform electrical energy into other forms (e.g., light, sound, heat) in the resistors. Current continues to flow, even after the electrons transfer their energy. Resistors oppose the rate of charge flow in the circuit. The potential difference or voltage across an energy source is a measure of potential energy in Joules supplied to each coulomb of charge. The volt (V) is the unit of potential difference and is equal to one Joule of energy per coulomb of charge (J/C). Potential difference across the circuit is a property of the energy source and does not depend upon the devices in the circuit. These concepts can be used to explain why current will increase as the potential difference increases and as the resistance decreases. Experiments, investigations and testing (3-D or virtual) must be used to construct a variety of circuits, and measure and compare the potential difference (voltage) and current. Electricity concepts are dealt with conceptually in this course. Calculations with circuits will be addressed in the physics syllabus."

### Cognitive Demand

Recalling Accurate Science (R)

Requires students to provide accurate statements about scientifically valid facts, concepts and relationships. Recall only requires students to provide a rote response, declarative knowledge or perform routine mathematical tasks. This cognitive demand refers to students' knowledge of science fact, information, concepts, tools, procedures and basic principles.

### Explanation of the Item

This one-point multiple choice item requires the student to recognize that a power source in a circuit is a source of electric potential difference. The source of energy in a circuit, whether it is a battery or a DC power supply, is what provides an electric potential difference in a circuit. Electric potential difference (voltage) is a measure of the potential energy supplied to each unit of charge. This energy allows the current to flow within the circuit.

13

## Sample Response: 1 point

What is the function of a power source in an electrical circuit?

- A. to create electrons
- B. to provide an electric potential difference
- C. to increase the speed of electron movement
- D. to promote current flow by reducing resistance

14

## Physical Science EOY Practice Test

### Question 4

#### Question and Scoring Guidelines


15

## Question 4

The following question has two parts. First, answer part A. Then, answer part B.


**Part A**  
A scientist is trying to construct a model of the universe as it will appear several billion years from now. The scientist has observed several galaxies and the distribution of galaxies. The current distribution of galaxies is shown in the diagram.

**Current Distribution of Galaxies**




Which diagram represents how the current distribution of galaxies would need to change to represent the future distribution of galaxies several billion years from now?


A




B



C



D



**Part B**  
Select all of the choices that give observations that support the future distribution of galaxies several billion years from now.

- I. Ivernia
- II. Quarity
- III. Fud Flat
- IV. Hubble's law for galaxies
- V. Hertzprung-Russell Diagram

16

Points Possible: 1

See [Alignment](#) for more detail.

## Scoring Guidelines

### Part A

**Rationale for Option A:** This is incorrect. According to the Big Bang theory, the galaxies would move farther apart in the future, not closer together.

**Rationale for Option B; Key** – According to the Big Bang theory, the galaxies would move farther apart in the future.

**Rationale for Option C:** This is incorrect. According to the Big Bang theory, the galaxies would move farther apart in the future, not revolve around some point.

**Rationale for Option D:** This is incorrect. According to the Big Bang theory, the galaxies would move farther apart in the future, not remain in fixed positions.

### Part B

**First Rationale:** This is incorrect. Inertia is a property of an object's resistance to changing its state of motion. Inertia is an explanation of behavior, not an observation.

**Second Rationale:** This is incorrect. Gravity is an attractive force between two objects with mass. Gravity actually acts against the expansion of the universe. However, the expansion continues, even with this opposing force.

**Third Rationale; Key** – Red-shift is an apparent shift in a galaxy's spectrum toward longer wavelengths because of the galaxy's motion away from the observer. Therefore, the fact that red-shift is observed from distant galaxies is an observation that supports an expanding universe.

**Fourth Rationale; Key** – Hubble's Law states that galaxies that are farther away from an observer have a greater red shift because the speed at which an object moves away from an observer is greater the farther away it is. Therefore, the fact that a greater red-shift is observed from more distant galaxies is an observation that supports an expanding universe.

**Fifth Rationale:** A Hertzsprung-Russell diagram gives information about the type, mass and life cycle of a star. It does not address universe expansion or the movement of galaxies.

17

## Alignment

### Topic

The Universe

### Subtopic

History of the Universe

### Content Elaboration

According to the "big bang" theory, the contents of the known universe expanded explosively into existence from a hot, dense state 13.7 billion years ago (NAEP 2009). After the big bang, the universe expanded quickly (and continues to expand) and then cooled down enough for atoms to form. Gravity pulled the atoms together into gas clouds that eventually became stars, which comprise young galaxies. Foundations for the big bang model can be included to introduce the supporting evidence for the expansion of the known universe (e.g., Hubble's law and red-shift or cosmic microwave background radiation).

### Cognitive Demand

Recalling Accurate Science (R)

Requires students to provide accurate statements about scientifically valid facts, concepts and relationships. Recall only requires students to provide a rote response, declarative knowledge or perform routine mathematical tasks. This cognitive demand refers to students' knowledge of science fact, information, concepts, tools, procedures and basic principles.

### Explanation of the Item

This one-point evidence-based selected response item requires the student to make a choice in Part A, which is similar to a multiple choice question. Then the student must identify reasons for the selection in Part B. This item requires the student to identify a diagram of the positions of galaxies several billion years from now and select reasons to support this identification. According to the Big Bang theory, the universe is expanding and therefore galaxies are moving farther apart. The only selection in Part A that shows this expansion is Option B. Red-shift is an apparent shift in a galaxy's spectrum toward longer wavelengths because of the galaxy's motion away from the observer. Hubble's Law states that galaxies that are farther away from an observer have a greater red-shift because the speed at which an object moves away from an observer is greater the farther away it is. Therefore, for Part B, Options C and D are observations that support that expansion of the universe.

18


## Sample Response: 1 point

The following question has four parts, Part A, and three parts B, then, circle your best answer.


**Part A**


A student is using the general model of the universe as it will appear several billion years from now. The student has determined everything except the distribution of galaxies. The current distribution of galaxies is shown in the diagram.


**Current Distribution of Galaxies**

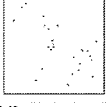


Which diagram represents how the current distribution of galaxies could need to change to represent the future distribution of galaxies several billion years from now?

a. 

b. 

c. 

d. 

**Part B**

Circle all of the circles that give observations that support the future distribution of galaxies several billion years from now.

Inertia

Gravity

Red-shift

Hubble's Law for galaxies

Hertzsprung-Russell Diagram

19

## Physical Science EOY Practice Test

### Question 5

#### Question and Scoring Guidelines

### Question 5

A speed vs. time graph for an object is shown. Three net forces,  $F_1$ ,  $F_2$ , and  $F_3$ , are applied to the object at different times, as shown in the graph. Compare the magnitude of the net forces acting on the object.

Move a force label into each blank box to rank the forces in order of increasing magnitude.

- Move only **one** label into each blank box.

Points Possible: 1

See [Alignment](#) for more detail.

### Scoring Guidelines

For this item, a full-credit response includes

- From left to right: " $F_2$ ", " $F_1$ ", " $F_3$ " (1 point).

21

22

### Alignment

#### Topic

Forces and Motion

#### Subtopic

Dynamics

#### Content Elaboration

An object does not accelerate (remains at rest or maintains a constant speed and direction of motion) unless an unbalanced net force acts on it. The rate at which an object changes its speed or direction (acceleration) is proportional to the vector sum of the applied forces (net force,  $F_{\text{net}}$ ) and inversely proportional to the mass ( $a = F_{\text{net}}/m$ ). When the vector sum of the forces (net force) acting on an object is zero, the object does not accelerate. For an object that is moving, this means the object will remain moving without changing its speed or direction. For an object that is not moving, the object will continue to remain stationary. These laws will be applied to systems consisting of a single object upon which multiple forces act. Vector addition will be limited to one dimension (positive and negative). While both horizontal and vertical forces can be acting on an object simultaneously, one of the dimensions must have a net force of zero.

#### Cognitive Demand

Interpreting and Communicating Science Concepts (C)

Requires students to use subject-specific conceptual knowledge to interpret and explain events, phenomena, concepts and experiences using grade-appropriate scientific terminology, technological knowledge and mathematical knowledge. Communicate with clarity, focus and organization using rich, investigative scenarios, real-world data and valid scientific information.

#### Explanation of the Item

This one-point graphic response item requires the student to interpret a speed vs. time graph and determine the relative magnitudes of the forces producing the motion in different parts of the graph. For a speed vs. time graph, the slope represents acceleration. The section with the greatest slope has the greatest magnitude of acceleration. In the graph shown, this means  $F_3$  has the greatest magnitude of acceleration and  $F_2$  has the least magnitude of acceleration. Since, for any given object, greater net forces are needed to produce greater accelerations, the correct rank of forces in order of increasing magnitude is  $F_2$ ,  $F_1$  and then  $F_3$ .

# Physical Science EOY Practice Test

## Question 5

### Sample Responses

### Sample Response: 1 point

A speed vs. time graph for an object is shown. Three net forces,  $F_1$ ,  $F_2$ , and  $F_3$ , are applied to the object at different times, as shown in the graph. Compare the magnitude of the net forces acting on the object.

Move a force label into each blank box to rank the forces in order of increasing magnitude.

- Move only one label into each blank box.

#### Notes on Scoring

This response earns full credit (1 point). It correctly indicates the rank of forces in order of increasing magnitude as  $F_2$ ,  $F_1$  and then  $F_3$ .

25

26

### Sample Response: 0 points

A speed vs. time graph for an object is shown. Three net forces,  $F_1$ ,  $F_2$ , and  $F_3$ , are applied to the object at different times, as shown in the graph. Compare the magnitude of the net forces acting on the object.

Move a force label into each blank box to rank the forces in order of increasing magnitude.

- Move only one label into each blank box.

#### Notes on Scoring

This response earns no credit (0 points). It incorrectly indicates the rank of forces in order of increasing magnitude as  $F_1$ ,  $F_2$  and then  $F_3$ , not as  $F_2$ ,  $F_1$  and then  $F_3$ .

27

### Sample Response: 0 points

A speed vs. time graph for an object is shown. Three net forces,  $F_1$ ,  $F_2$ , and  $F_3$ , are applied to the object at different times, as shown in the graph. Compare the magnitude of the net forces acting on the object.

Move a force label into each blank box to rank the forces in order of increasing magnitude.

- Move only one label into each blank box.

#### Notes on Scoring

This response earns no credit (0 points). It incorrectly indicates the rank of forces in order of increasing magnitude as  $F_3$ ,  $F_2$  and then  $F_1$ , not as  $F_2$ ,  $F_1$  and then  $F_3$ .

28



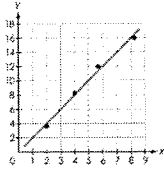
## Physical Science EOY Practice Test

### Question 6

#### Question and Scoring Guidelines

### Question 6

The density of an unknown material can be determined graphically from the experimental results shown.



Which statement describes how to label the axes and determine the density of the material?

- The  $x$ -axis is mass and the  $y$ -axis is volume. Density is the slope of the line.
- The  $x$ -axis is volume and the  $y$ -axis is mass. Density is the slope of the line.
- The  $x$ -axis is volume and the  $y$ -axis is mass. Density is the average  $y$ -value.
- The  $x$ -axis is mass and the  $y$ -axis is volume. Density is the maximum  $y$ -value.

Points Possible: 1

See [Alignment](#) for more detail.

### Scoring Guidelines

**Rationale for Option A:** This is incorrect. If mass is plotted on the  $x$ -axis and volume is plotted in the  $y$ -axis, the slope would give  $(\text{change in volume})/(\text{change in mass})$ , which gives the inverse or reciprocal of density. For the slope to give density, a graph must plot mass on the  $y$ -axis and volume on the  $x$ -axis.

**Rationale for Option B:** **Key** – Density is mass per unit volume, which is given by the slope of a graph when mass is plotted on the  $y$ -axis and volume is plotted on the  $x$ -axis.

29

30

**Rationale for Option C:** This is incorrect. If volume is plotted on the  $x$ -axis and mass is plotted on the  $y$ -axis, the average  $y$ -value would give the average of the masses used in the experiment. To determine the density from this graph, one would have to calculate the slope of the graph.

**Rationale for Option D:** This is incorrect. If mass is plotted on the  $x$ -axis and volume is plotted on the  $y$ -axis, the maximum  $y$ -value would give the greatest volume measured in the experiment. To determine the density from this graph, one would have to find the reciprocal or inverse of the slope.

### Alignment

#### Topic

Study of Matter

#### Subtopic

Classification of Matter

#### Content Elaboration

"When thermal energy is added to a solid, liquid or gas, most substances increase in volume because the increased kinetic energy of the particles causes an increased distance between the particles. This results in a change in density of the material. Generally, solids have greater density than liquids, which have greater density than gases due to the spacing between the particles. The density of a substance can be calculated from the slope of a mass vs. volume graph. Differences in densities can be determined by interpreting mass vs. volume graphs of the substances."

#### Cognitive Demand

Recalling Accurate Science (R)

Requires students to provide accurate statements about scientifically valid facts, concepts and relationships. Recall only requires students to provide a rote response, declarative knowledge or perform routine mathematical tasks. This cognitive demand refers to students' knowledge of science fact, information, concepts, tools, procedures and basic principles.

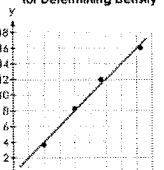
#### Explanation of the Item

This one-point multiple choice item requires the student to recall how density is determined graphically. When mass is plotted on the  $y$ -axis and volume is plotted on the  $x$ -axis, the slope gives  $(\text{change in mass})/(\text{change in volume})$  which gives the density of the material. Therefore, B is the correct response.

31

### Sample Response: 1 point

The density of an unknown material can be determined graphically from the experimental results shown.



Which statement describes how to label the axes and determine the density of the material?

- The  $x$ -axis is mass and the  $y$ -axis is volume. Density is the slope of the line.
- The  $x$ -axis is volume and the  $y$ -axis is mass. Density is the slope of the line.
- The  $x$ -axis is volume and the  $y$ -axis is mass. Density is the average  $y$ -value.
- The  $x$ -axis is mass and the  $y$ -axis is volume. Density is the maximum  $y$ -value.

32

## Question 7

A student observes the interaction of sound waves coming from two identical speakers. The student has an arrangement of three different points, as shown in the diagram, and needs to be able to describe the volume of the sound. The diagram represents the sound in the second half of the speakers.

Select the boxes to identify the relative volume at each point.

	Very Low Volume	Medium Volume	Very High Volume
Point A	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Point B	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Point C	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

## Physical Science EOY Practice Test

### Question 7

#### Question and Scoring Guidelines

Points Possible: 1

See [Alignment](#) for more detail.

#### Scoring Guidelines

For this item, a full-credit response includes

- Only "Very High Volume" selected for "Point B" and "Point C"
- AND
- Only "Very Low Volume" selected for "Point A." (1 point).

33

34

### Alignment

#### Topic

Energy and Waves

#### Subtopic

Waves

#### Content Elaboration

"In elementary and middle school, reflection and refraction of light were introduced, as was absorption of radiant energy by transformation into thermal energy. In this course, these processes are addressed from the perspective of waves and expanded to include other types of energy that travel in waves. When a wave encounters a new material, the new material may absorb the energy of the wave by transforming it to another form of energy, usually thermal energy. Waves can be reflected off solid barriers or refracted when a wave travels from one medium into another medium. Waves may undergo diffraction around small obstacles or openings. When two waves traveling through the same medium meet, they pass through each other then continue traveling through the medium as before. When the waves meet, they undergo superposition, demonstrating constructive and destructive interference. Sound travels in waves and undergoes reflection, refraction, interference and diffraction. In the physics syllabus, many of these wave phenomena will be studied further and quantified."

#### Cognitive Demand

Interpreting and Communicating Science Concepts (C)

Requires students to use subject-specific conceptual knowledge to interpret and explain events, phenomena, concepts and experiences using grade-appropriate scientific terminology, technological knowledge and mathematical knowledge. Communicate with clarity, focus and organization using rich, investigative scenarios, real-world data and valid scientific information.

#### Explanation of the Item

This one-point matching item requires the student to select matches between the column and row descriptions. This item requires the student to use the concept of superposition in waves to determine the relative loudness of sounds in locations between two speakers placed near each other. The curved lines show the highest point of the wave (the crest), so the lowest point of the wave (the trough) would occur midway between two adjacent lines. The loudest sounds will occur when two crests or two troughs intersect. Points B and C occur at the intersection of two crests. Therefore, Points B and C should be matched with "Very High Volume." The lowest volume would occur when a crest meets a trough, as in Point A. At this point, the crest and trough would cancel each other out and give a flat resultant wave with no amplitude. Therefore, Point A should be matched with "Very Low Volume."

\*While this item only features one selection per row, matching items may require the student to select multiple descriptions per row to earn full credit. See the matching item on the Practice Test for Grade 8 Science to see an example of such an item.

35

# Physical Science EOY Practice Test

## Question 7

### Sample Responses

### Sample Response: 1 point

A student observes the interference of sound waves coming from two identical speakers. The student takes measurements at three different points, as seen in the diagram, and records the relative volume of the sound. The lines in the diagram represent the peaks in the sound waves coming from the speakers.

Select the boxes to identify the relative volume of each point.

	Very Low Volume	Medium Volume	Very High Volume
Point A	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Point B	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Point C	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

#### Notes on Scoring

This response earns full credit (1 point). It correctly matches Point A with "Very Low Volume" and Points B and C with "Very High Volume."

37

38

### Sample Response: 0 points

A student observes the interference of sound waves coming from two identical speakers. The student takes measurements at three different points, as seen in the diagram, and records the relative volume of the sound. The lines in the diagram represent the peaks in the sound waves coming from the speakers.

Select the boxes to identify the relative volume of each point.

	Very Low Volume	Medium Volume	Very High Volume
Point A	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Point B	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Point C	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

#### Notes on Scoring

This response earns no credit (0 points). It correctly matches Points B and C with "Very High Volume." However, it incorrectly matches Point A to "Very High Volume."

### Sample Response: 0 points

A student observes the interference of sound waves coming from two identical speakers. The student takes measurements at three different points, as seen in the diagram, and records the relative volume of the sound. The lines in the diagram represent the peaks in the sound waves coming from the speakers.

Select the boxes to identify the relative volume of each point.

	Very Low Volume	Medium Volume	Very High Volume
Point A	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Point B	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Point C	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

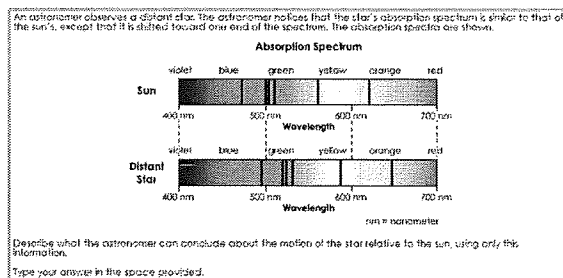
#### Notes on Scoring

This response earns no credit (0 points). It correctly matches Point A with "Very Low Volume" and Point C with "Very High Volume." However, it incorrectly matches Point B with "Medium Volume."

39

40

## Question 8



## Physical Science EOY Practice Test

### Question 8

#### Question and Scoring Guidelines

Points Possible: 1

See [Alignment](#) for more detail.

#### Scoring Guidelines

Score Point	Description
1 point	Response includes at least one of the following: <ul style="list-style-type: none"> <li>The {distant} star is <b>moving/going/traveling away from the sun</b>.</li> <li>They (the star and the sun) are <b>moving/going/traveling away from each other</b>.</li> <li>The <b>distance between the star and the sun is increasing</b>.</li> <li>It is <b>increasing its distance from the star</b>.</li> </ul>

41

42

0 points The response does not meet the criteria required to earn one point. The response indicates inadequate or no understanding of the task and/or the idea or concept needed to answer the item. It may only repeat information given in the test item. The response may provide an incorrect solution/response and the provided supportive information may be irrelevant to the item, or possibly, no other information is shown. The student may have written on a different topic or written, "I don't know."

#### Alignment

Topic  
The Universe

Subtopic  
Galaxy formation

Content Elaboration  
"Hubble's law states that galaxies that are farther away have a greater red shift, so the speed at which a galaxy is moving away is proportional to its distance from the Earth. Red shift is a phenomenon due to Doppler shifting, so the shift of light from a galaxy to the red end of the spectrum indicates that the galaxy and the observer are moving farther away from one another. Doppler shifting also is found in the Energy and Waves section of this course."

Cognitive Demand  
Interpreting and Communicating Science Concepts (C)

Requires students to use subject-specific conceptual knowledge to interpret and explain events, phenomena, concepts and experiences using grade-appropriate scientific terminology, technological knowledge and mathematical knowledge. Communicate with clarity, focus and organization using rich, investigative scenarios, real-world data and valid scientific information.

Explanation of the Item  
This one-point short answer item requires the student to construct a short written response that will be scored by a computer. The item requires the student to determine how a star and the sun are moving relative to each other based on their observed absorption spectra. When the lines on an absorption spectrum from a distant star are shifted toward higher wavelengths, closer to the red end of the spectrum, it shows the star is moving away from the observer. When the lines on an absorption spectrum from a distant star are shifted toward lower wavelengths, closer to the blue end of the spectrum, it shows the star is moving toward the observer. In the diagram, the absorption spectrum of the distant star shows a shift of the spectral lines to higher wavelengths, toward the red end of the spectrum. This means the distant star is moving away from Earth.

43

## Physical Science EOY Practice Test

### Question 8

#### Sample Responses

#### Sample Responses: 1 point

The astronomer can conclude that the distant star is moving away from the sun.

##### Notes on Scoring

This response earns full credit (1 point) for "the distant star is moving away from the sun."

The distant star is moving away from earth.

##### Notes on Scoring

This response earns full credit (1 point) for "the distant star is moving away from earth."

The astronomer can conclude that the star relative to the sun is moving away from us because it is shifted towards the red side of the spectrum.

##### Notes on Scoring

This response earns full credit (1 point) for "the star . . . is moving away from us."

45

46

#### Sample Responses: 0 points

A star takes longer to form it's color and has shorter time in this stage

##### Notes on Scoring

This response earns no credit (0 points). The statement "a star takes longer to form it's color and has a shorter time in this stage" is incorrect and does not give a conclusion about the motion of the star.

The astronomer can conclude that the distant star has a longer wavelength from looking at the spectrum. They can also conclude that the distant star is larger than the sun because its wavelength is longer.

##### Notes on Scoring

This response earns no credit (0 points). The statement "The astronomer can conclude that the distant star has a longer wavelength from looking at the spectrum" does not give a conclusion about the motion of the star. The statement "They can also conclude that the distant star is larger than the sun because its wavelength is longer" is an incorrect statement.

The distant star absorbs more on the left than the sun which absorbs more spectra on the right.

##### Notes on Scoring

This response earns no credit (0 points). The statement "The distant star absorbs more on the left than the sun which absorbs more spectra on the right" is vague and is not a conclusion that can be formed about the distant star's motion.

47

## Physical Science EOY Practice Test

### Question 9

#### Question and Scoring Guidelines

49

#### Alignment

##### Topic

Study of Matter

##### Subtopic

Reactions of Matter

##### Content Elaboration

"During chemical reactions, thermal energy is either transferred from the system to the surroundings (exothermic) or transferred from the surroundings to the system (endothermic). Since the environment surrounding the system can be large, temperature changes in the surroundings may not be detectable."

##### Cognitive Demand

Recalling Accurate Science (R)

Requires students to provide accurate statements about scientifically valid facts, concepts and relationships. Recall only requires students to provide a rote response, declarative knowledge or perform routine mathematical tasks. This cognitive demand refers to students' knowledge of science fact, information, concepts, tools, procedures and basic principles.

##### Explanation of the Item

This one-point multiple choice item requires the student to identify the changes in chemical potential energy for a reaction that releases heat. Heat is released in a chemical reaction when chemical potential energy is transformed into thermal energy and released into the surroundings. Chemical potential energy decreases in a reaction when the chemical bonds in the products have less chemical potential energy than the chemical bonds in the reactants. Therefore, Option D is the correct answer.

51

### Question 9

When sulfuric acid ( $\text{H}_2\text{SO}_4$ ) is poured onto limestone ( $\text{CaCO}_3$ ), the following reaction occurs.



Heat energy is released during the reaction because the

- Ⓐ products have less mass than the reactants.
- Ⓑ products have more mass than the reactants.
- Ⓒ chemical bonds in the products have more energy than the chemical bonds in the reactants.
- Ⓓ chemical bonds in the products have less energy than the chemical bonds in the reactants.

Points Possible: 1

See [Alignment](#) for more detail.

#### Scoring Guidelines

**Rationale for Option A:** This is incorrect. Mass is always conserved in a chemical reaction and is neither increased nor decreased.

**Rationale for Option B:** This is incorrect. Mass is always conserved in a chemical reaction and is neither increased nor decreased.

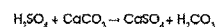
**Rationale for Option C:** This is incorrect. If the chemical bonds in the products have more energy than the chemical bonds in the reactants, the reaction would transform energy, most likely thermal energy, into chemical potential energy. This would result in heat being absorbed by the reaction, not released.

**Rationale for Option D: Key** – Heat is released into the surroundings during a chemical reaction when chemical potential energy is transformed into thermal energy and released into the surroundings. Chemical potential energy decreases in a reaction when the chemical bonds in the products have less chemical potential energy than the chemical bonds in the reactants.

50

#### Sample Response: 1 point

When sulfuric acid ( $\text{H}_2\text{SO}_4$ ) is poured onto limestone ( $\text{CaCO}_3$ ), the following reaction occurs.



Heat energy is released during the reaction because the

- Ⓐ products have less mass than the reactants.
- Ⓑ products have more mass than the reactants.
- Ⓒ chemical bonds in the products have more energy than the chemical bonds in the reactants.
- Ⓓ chemical bonds in the products have less energy than the chemical bonds in the reactants.

52

## Physical Science EOY Practice Test

### Question 10

#### Question and Scoring Guidelines

53

### Question 10

Atoms form chemical bonds by losing, gaining or sharing electrons.

**A. Bond type**

Place the bond type that is formed by sharing electrons in the blank box.

**B. Model**

Place a symbol in each Particle box and any electrons they share in the Shared Electrons box to model the type of bond you chose in part A.

- There may be more than one correct answer.
- You do not need to use all the labels/objects.
- You may use each label/object more than once.

Legend: ● 1 electron

Points Possible: 1

See [Alignment](#) for more detail.

#### Scoring Guidelines

For this item, a full-credit response includes

- Only "Covalent" in the "Bond Type" box
- AND
- Only 2 electrons in the Shared Electrons" box
- AND
- Only one "H" in one "Particle" box and only one "H" in the other "Particle" box
- OR
- Only one "H" in one "Particle" box and only one "Cl" in the other "Particle" box
- OR
- Only one "Cl" in one "Particle" box and only one "Cl" in the other "Particle" box (1 point).

54

#### Alignment

##### Topic

Study of Matter

##### Subtopic

Bonding and Compounds

##### Content Elaboration

"Middle school content included that compounds are composed of atoms of two or more elements joined together chemically. In this course, the chemical joining of atoms is studied in more detail. Atoms may be bonded together by losing, gaining or sharing valence electrons to form molecules or three-dimensional lattices. An ionic bond involves the attraction of two oppositely charged ions, typically a metal cation and a nonmetal anion formed by transferring electrons between the atoms. An ion attracts oppositely charged ions from every direction, resulting in the formation of a three-dimensional lattice. Covalent bonds result from the sharing of electrons between two atoms, usually nonmetals. Covalent bonding can result in the formation of structures ranging from small individual molecules to three-dimensional lattices (e.g., diamond). The bonds in most compounds fall on a continuum between the two extreme models of bonding: ionic and covalent."

##### Cognitive Demand

Interpreting and Communicating Science Concepts (C)

Requires students to use subject-specific conceptual knowledge to interpret and explain events, phenomena, concepts and experiences using grade-appropriate scientific terminology, technological knowledge and mathematical knowledge. Communicate with clarity, focus and organization using rich, investigative scenarios, real-world data and valid scientific information.

##### Explanation of the Item

This one-point graphic response item requires the student to identify the type of bond that forms by sharing electrons and to model a bond formed by sharing two electrons. The type of bond that forms by sharing electrons is a covalent bond. Therefore, "Covalent" must be selected for Part A, and two red dots must appear in the "Shared Electrons" box of Part B. Since electrons are shared, rather than transferred, the particles involved in the bond are electrically neutral atoms, not ions with a charge. Therefore Li<sup>+</sup>, H<sup>+</sup> and Cl<sup>-</sup> are incorrect options to place in the "Particle" box of Part B. Covalent bonds generally form between two nonmetals. Therefore, the metal "Li" is not a correct option to be placed in a "Particle" box of Part B. This leaves three possible combinations to be placed in the "Particle" boxes. The nonmetal "H" can be paired with nonmetal "Cl" to form a covalent bond. Also, chlorine and hydrogen are diatomic elements that exist as two atoms bonded together covalently. This allows "H" to be paired with another "H," or "Cl" to be paired with another "Cl" to correctly represent a covalent bond.

55

# Physical Science EOY Practice Test

## Question 10

### Sample Responses

#### Sample Response: 1 point

Atoms form chemical bonds by losing, gaining or sharing electrons.

A. Place the bond type that is formed by sharing electrons in the blank box.

B. Place a symbol in each Particle box and any electrons they share in the Shared Electrons box to model the type of bond you chose in part A.

- There may be more than one correct answer.
- You do not need to use all the labels/objects.
- You may use each label/object more than once.

**A. Bond Type**  
Covalent

**B. Model**

#### Notes on Scoring

This response earns full credit (1 point). It correctly identifies the bond type as covalent in Part A, Part B shows two electrons in the "Shared Electrons" box and it shows two "H" atoms as the particles involved in the bond.

57

58

#### Sample Responses: 1 point

Atoms form chemical bonds by losing, gaining or sharing electrons.

A. Place the bond type that is formed by sharing electrons in the blank box.

B. Place a symbol in each Particle box and any electrons they share in the Shared Electrons box to model the type of bond you chose in part A.

- There may be more than one correct answer.
- You do not need to use all the labels/objects.
- You may use each label/object more than once.

**A. Bond type**  
Covalent

**B. Model**

#### Notes on Scoring

This response earns full credit (1 point). It correctly identifies the bond type as covalent in Part A, Part B shows two electrons in the "Shared Electrons" box and it shows one "H" atom and one "Cl" atom as the particles involved in the bond.

59

#### Sample Responses: 1 point

Atoms form chemical bonds by losing, gaining or sharing electrons.

A. Place the bond type that is formed by sharing electrons in the blank box.

B. Place a symbol in each Particle box and any electrons they share in the Shared Electrons box to model the type of bond you chose in part A.

- There may be more than one correct answer.
- You do not need to use all the labels/objects.
- You may use each label/object more than once.

**A. Bond type**  
Covalent

**B. Model**

#### Notes on Scoring

This response earns full credit (1 point). It correctly identifies the bond type as "Covalent" in Part A, Part B shows two electrons in the "Shared Electrons" box, and it shows two "Cl" atoms as the particles involved in the bond.

60



Sample Responses: 0 points

Atoms form chemical bonds by losing, gaining or sharing electrons.

A. Place the bond type that is formed by sharing electrons in the blank box.

B. Place a symbol in each Particle box and any electrons they share in the Shared Electrons box to model the type of bond you chose in part A.

- There may be more than one correct answer.
- You do not need to use all the labels/objects.
- You may use each label/object more than once.

**Notes on Scoring**

This response earns no credit (0 points). While the response correctly shows two electrons in the "Shared Electrons" box in Part B and shows two "H" atoms as the particles involved in the bond, it incorrectly identifies the bond type as "Ionic" in Part A.

Sample Responses: 0 points

Atoms form chemical bonds by losing, gaining or sharing electrons.

A. Place the bond type that is formed by sharing electrons in the blank box.

B. Place a symbol in each Particle box and any electrons they share in the Shared Electrons box to model the type of bond you chose in part A.

- There may be more than one correct answer.
- You do not need to use all the labels/objects.
- You may use each label/object more than once.

**Notes on Scoring**

This response earns no credit (0 points). While the response correctly indicates the bond type as "Covalent" in Part A and correctly shows two electrons in the "Shared Electrons" box in Part B, it incorrectly indicates one of the particles involved is "H" in Part B.

Sample Responses: 0 points

Atoms form chemical bonds by losing, gaining or sharing electrons.

A. Place the bond type that is formed by sharing electrons in the blank box.

B. Place a symbol in each Particle box and any electrons they share in the Shared Electrons box to model the type of bond you chose in part A.

- There may be more than one correct answer.
- You do not need to use all the labels/objects.
- You may use each label/object more than once.

**Notes on Scoring**

This response earns no credit (0 points). While the response correctly indicates the bond type as "Covalent" in Part A and correctly indicates two "Cl" atoms as the particles involved in Part B, it also incorrectly shows four electrons in the "Shared Electrons" box in Part B.

## Physical Science EOY Practice Test

### Question 11

#### Question and Scoring Guidelines

65

**Fifth Rationale:** This is incorrect. In general, when all other variables are held constant, non-reflective materials are able to absorb more thermal energy than reflective materials.

**Sixth Rationale; Key** – In general, when all other variables are held constant, non-reflective materials are able to absorb more thermal energy than reflective materials.

#### Alignment

##### Topic

Energy and Waves

##### Subtopic

Thermal Energy

##### Content Elaboration

"Thermal conductivity depends on the rate at which thermal energy is transferred from one end of a material to another. Thermal conductors have a high rate of thermal energy transfer and thermal insulators have a slow rate of thermal energy transfer. The rate at which thermal radiation is absorbed or emitted by a system depends on its temperature, color, texture and exposed surface area. All other things being equal, in a given amount of time, black rough surfaces absorb more thermal energy than smooth white surfaces. An object or system is continually absorbing and emitting thermal radiation. If the object or system absorbs more thermal energy than it emits and there is no change in phase, the temperature increases. If the object or system emits more thermal energy than is absorbed and there is no change in phase, the temperature decreases. For an object or system in thermal equilibrium, the amount of thermal energy absorbed is equal to the amount of thermal energy emitted; therefore, the temperature remains constant. In chemistry, changes in thermal energy are quantified for substances that change their temperature."

##### Cognitive Demand

Recalling Accurate Science (R)

Requires students to provide accurate statements about scientifically valid facts, concepts and relationships. Recall only requires students to provide a rote response, declarative knowledge or perform routine mathematical tasks. This cognitive demand refers to students' knowledge of science fact, information, concepts, tools, procedures and basic principles.

67

### Question 11

An engineer wants to build a house in a cold climate with little sunlight. The engineer designs a roof that will help keep the house warm.

Select all of the roof characteristics that could be used by the engineer to maximize the amount of thermal energy absorbed by the house.

- rough surface
- smooth surface
- dark-color paint
- light-color paint
- reflective material
- non-reflective material

Points Possible: 1

See Alignment for more detail.

#### Scoring Guidelines

**First Rationale; Key** – In general, when all other variables are held constant, rough surfaces absorb more thermal energy than smooth surfaces.

**Second Rationale:** This is incorrect. In general, when all other variables are held constant, rough surfaces absorb more thermal energy than smooth surfaces.

**Third Rationale; Key** – In general, when all other variables are held constant, dark-colored objects are able to absorb more thermal energy than light-colored objects.

**Fourth Rationale:** This is incorrect. In general, when all other variables are held constant, dark-colored objects are able to absorb more thermal energy than light-colored objects.

66

#### Explanation of the Item

This one-point multi-select item requires the student to identify the ideal elements in roof design to maximize the amount of thermal energy absorbed by the house. The first pair of selections involves a rough surface and a smooth surface. In general, when all other variables are held constant, rough surfaces are able to absorb more thermal energy than smooth surfaces. The next pair of selections involves dark and light-colored paint. In general, when all other variables are held constant, dark-colored objects are able to absorb more thermal energy than light-colored objects. The final pair of selections involves reflective and non-reflective materials. In general, when all other variables are held constant, non-reflective materials are able to absorb more thermal energy than reflective materials. The correct response will indicate that the best roof involves a rough surface, dark-colored paint and a non-reflective material.

#### Sample Response: 1 point

An engineer wants to build a house in a cold climate with little sunlight. The engineer designs a roof that will help keep the house warm.

Select all of the roof characteristics that could be used by the engineer to maximize the amount of thermal energy absorbed by the house.

- rough surface
- smooth surface
- dark-color paint
- light-color paint
- reflective material
- non-reflective material

68

## Question 12

An astronaut on the moon throws a moon rock straight down.

Place variable(s) and/or mathematical operation(s) into the blank box to set up an equation that can be used to solve for the kinetic energy of the rock just before it hits the surface of the moon. Assume there is no air resistance.

• There may be more than one correct answer.  
• You do not need to use all the variables/mathematical operations.

Key	
$E_{k, \text{initial}}$	initial kinetic energy
$E_{g, \text{initial}}$	initial gravitational potential energy
$E_{g, \text{final}}$	final gravitational potential energy
$\Delta E_k$	$E_{k, \text{final}} - E_{k, \text{initial}}$
$\Delta E_g$	$E_{g, \text{final}} - E_{g, \text{initial}}$

## Physical Science EOY Practice Test

### Question 12

#### Question and Scoring Guidelines

Points Possible: 1

See Alignment for more detail.

### Scoring Guidelines

For this item, a full-credit response includes

- $E_{k, \text{initial}} + E_{g, \text{initial}} - E_{g, \text{final}}$  or an equivalent equation, in the blank box  
OR
- $E_{k, \text{initial}} + E_{g, \text{initial}}$  or an equivalent equation, in the blank box  
OR
- $E_{k, \text{initial}} - \Delta E_g$  or an equivalent equation, in the blank box (1 point).

69

70

### Alignment

#### Topic

Energy and Waves

#### Subtopic

Conservation of Energy

#### Content Elaboration

"Energy content learned in middle school, specifically conservation of energy and the basic differences between kinetic and potential energy, is elaborated on and quantified in this course. Energy has no direction and has units of Joules (J). Kinetic energy,  $E_k$ , can be mathematically represented by  $E_k = \frac{1}{2}mv^2$ . Gravitational potential energy,  $E_g$ , can be mathematically represented by  $E_g = mgh$ . The amount of energy of an object is measured relative to a reference that is considered to be a point of zero energy. The reference may be changed to help understand different situations. Only the change in the amount of energy can be measured absolutely. Conservation of energy and equations for kinetic and gravitational potential energy can be used to calculate values associated with energy (i.e., height, mass, speed) for situations involving energy transfer and transformation. Opportunities to quantify energy from data collected in experimental situations (e.g., a swinging pendulum, a car traveling down an incline) must be provided."

#### Cognitive Demand

Interpreting and Communicating Science Concepts (C)

Requires students to use subject-specific conceptual knowledge to interpret and explain events, phenomena, concepts and experiences using grade-appropriate scientific terminology, technological knowledge and mathematical knowledge. Communicate with clarity, focus and organization using rich, investigative scenarios, real-world data and valid scientific information.

#### Explanation of the Item

This one-point graphic response item requires the student to construct an equation to calculate the final kinetic energy of a thrown rock using conservation of energy. The rock initially has kinetic energy  $E_{k, \text{initial}}$ , due to its speed when it is thrown downward. The rock initially also has gravitational potential energy,  $E_{g, \text{initial}}$ , due to its height above Earth. Therefore, the total initial energy of the rock is the sum of the kinetic and potential energy. As the rock falls, the gravitational potential energy decreases as the rock gets closer to Earth and the kinetic energy increases as the rock falls faster. However, due to the conservation of energy, the total energy remains constant. Just before the rock hits the surface, the gravitational potential energy can be considered zero because the height can be considered as zero just before hitting Earth. Therefore, the total energy of the rock is all kinetic energy and the kinetic energy of the rock just before it hits the surface must be equal to the total initial energy of the rock, or  $E_{k, \text{initial}} + E_{g, \text{initial}}$ . In this equation,  $E_{g, \text{final}}$  is not indicated since it can be considered as having no value. However, it would be acceptable to place this term in the equation. Therefore, other acceptable answers are

$$E_{k, \text{initial}} + E_{g, \text{initial}} - E_{g, \text{final}} \text{ and } E_{k, \text{initial}} + \Delta E_g$$

# Physical Science EOY Practice Test

## Question 12

### Sample Responses

### Sample Responses: 1 point

An astronaut on the moon throws a moon rock straight down.

Place variable(s) and/or mathematical operation(s) into the blank box to set up an equation that can be used to solve for the kinetic energy of the rock just before it hits the surface of the moon. Assume there is no air resistance.

- There may be more than one correct answer.
- You do not need to use all the variables/mathematical operations.

$E_{k, \text{initial}}$

$E_{g, \text{initial}}$

$E_{k, \text{final}}$

$E_{g, \text{final}}$

$\Delta E$

+

-

x

+

Initial speed is greater than zero

path of moon rock

Kinetic energy just before rock hits surface

$E_{k, \text{final}} = E_{g, \text{initial}} + E_{g, \text{final}} - E_{g, \text{initial}}$

Key	
$E_{k, \text{initial}}$	initial kinetic energy
$E_{g, \text{initial}}$	initial gravitational potential energy
$E_{k, \text{final}}$	final kinetic energy
$E_{g, \text{final}}$	final gravitational potential energy
$\Delta E$	$E_{k, \text{final}} - E_{g, \text{initial}}$
$\Delta E$	$E_{g, \text{final}} - E_{g, \text{initial}}$

#### Notes on Scoring

This response earns full credit (1 point). It correctly indicates the final kinetic energy of the rock is  $E_{k, \text{initial}} + E_{g, \text{initial}} - E_{g, \text{final}}$ .

73

74

### Sample Responses: 1 point

An astronaut on the moon throws a moon rock straight down.

Place variable(s) and/or mathematical operation(s) into the blank box to set up an equation that can be used to solve for the kinetic energy of the rock just before it hits the surface of the moon. Assume there is no air resistance.

- There may be more than one correct answer.
- You do not need to use all the variables/mathematical operations.

$E_{k, \text{initial}}$

$E_{g, \text{initial}}$

$E_{k, \text{final}}$

$E_{g, \text{final}}$

$\Delta E$

+

-

x

+

Initial speed is greater than zero

path of moon rock

Kinetic energy just before rock hits surface

$E_{k, \text{final}} = E_{k, \text{initial}} + E_{g, \text{initial}}$

Select an object to remove.

Key	
$E_{k, \text{initial}}$	initial kinetic energy
$E_{g, \text{initial}}$	initial gravitational potential energy
$E_{k, \text{final}}$	final kinetic energy
$E_{g, \text{final}}$	final gravitational potential energy
$\Delta E$	$E_{k, \text{final}} - E_{g, \text{initial}}$
$\Delta E$	$E_{g, \text{final}} - E_{g, \text{initial}}$

#### Notes on Scoring

This response earns full credit (1 point). It correctly indicates the final kinetic energy of the rock is  $E_{k, \text{initial}} + E_{g, \text{initial}}$ .

### Sample Responses: 1 point

An astronaut on the moon throws a moon rock straight down.

Place variable(s) and/or mathematical operation(s) into the blank box to set up an equation that can be used to solve for the kinetic energy of the rock just before it hits the surface of the moon. Assume there is no air resistance.

- There may be more than one correct answer.
- You do not need to use all the variables/mathematical operations.

$E_{k, \text{initial}}$

$E_{g, \text{initial}}$

$E_{k, \text{final}}$

$E_{g, \text{final}}$

$\Delta E$

+

-

x

+

Initial speed is greater than zero

path of moon rock

Kinetic energy just before rock hits surface

$E_{k, \text{final}} = E_{k, \text{initial}} - \Delta E$

Key	
$E_{k, \text{initial}}$	initial kinetic energy
$E_{g, \text{initial}}$	initial gravitational potential energy
$E_{k, \text{final}}$	final kinetic energy
$E_{g, \text{final}}$	final gravitational potential energy
$\Delta E$	$E_{k, \text{final}} - E_{g, \text{initial}}$
$\Delta E$	$E_{g, \text{final}} - E_{g, \text{initial}}$

#### Notes on Scoring

This response earns full credit (1 point). It correctly indicates the final kinetic energy of the rock is  $E_{k, \text{initial}} - \Delta E$ .

75

76

Sample Responses: 0 points

An astronaut on the moon throws a moon rock straight down.

Place variable(s) and/or mathematical operation(s) into the blank box to set up an equation that can be used to solve for the kinetic energy of the rock just before it hits the surface of the moon. Assume there is no air resistance.

- There may be more than one correct answer.
- You do not need to use all the variables/mathematical operations.

Key

- $E_{k,initial}$ : initial kinetic energy
- $E_{g,initial}$ : initial gravitational potential energy
- $E_{g,final}$ : final gravitational potential energy
- $E_{k,final}$ : final kinetic energy
- $\Delta E_g$ :  $E_{g,initial} - E_{g,final}$

Equation box:  $E_{k,final} = E_{k,initial} + E_{g,initial}$

Notes on Scoring

This response earns no credit (0 points). It incorrectly indicates the final kinetic energy of the rock is  $E_{k,initial} - E_{g,initial} + E_{g,final}$ . One possible correct response is  $E_{k,initial} + E_{g,initial} - E_{g,final}$ .

Sample Responses: 0 points

An astronaut on the moon throws a moon rock straight down.

Place variable(s) and/or mathematical operation(s) into the blank box to set up an equation that can be used to solve for the kinetic energy of the rock just before it hits the surface of the moon. Assume there is no air resistance.

- There may be more than one correct answer.
- You do not need to use all the variables/mathematical operations.

Key

- $E_{k,initial}$ : initial kinetic energy
- $E_{g,initial}$ : initial gravitational potential energy
- $E_{g,final}$ : final gravitational potential energy
- $E_{k,final}$ : final kinetic energy
- $\Delta E_g$ :  $E_{g,initial} - E_{g,final}$

Equation box:  $E_{k,final} = E_{k,initial} \times E_{g,initial}$

Notes on Scoring

This response earns no credit (0 point). It incorrectly indicates the final kinetic energy of the rock is  $E_{k,initial} \times E_{g,initial}$ . One possible correct response is the sum of these values,  $E_{k,initial} + E_{g,initial}$ , not the product.

Sample Responses: 0 points

An astronaut on the moon throws a moon rock straight down.

Place variable(s) and/or mathematical operation(s) into the blank box to set up an equation that can be used to solve for the kinetic energy of the rock just before it hits the surface of the moon. Assume there is no air resistance.

- There may be more than one correct answer.
- You do not need to use all the variables/mathematical operations.

Key

- $E_{k,initial}$ : initial kinetic energy
- $E_{g,initial}$ : initial gravitational potential energy
- $E_{g,final}$ : final gravitational potential energy
- $E_{k,final}$ : final kinetic energy
- $\Delta E_g$ :  $E_{g,initial} - E_{g,final}$

Equation box:  $E_{k,final} = E_{k,initial} \div \Delta E_g$

Notes on Scoring

This response earns no credit (0 point). It incorrectly indicates the final kinetic energy of the rock is  $E_{k,initial} \div \Delta E_g$ . One possible correct response is the sum of these values,  $E_{k,initial} + \Delta E_g$ , not the quotient.

**Question 13**

Enter numbers in the table to order the events of the Big Bang model as they occurred, with 1 as the earliest and 5 as the most recent.

Event	Order
First stars form	
First atoms form	
First galaxies form	
First gas clouds form	
Rapid expansion of the universe	

**Points Possible:** 1  
See **Alignment** for more detail.

**Physical Science  
EOY Practice Test**

**Question 13**

**Question and Scoring Guidelines**

**Scoring Guidelines**

For this item, a full-credit response includes

- "4" in the "First stars form" box  
AND
- "2" in the "First atoms form" box  
AND
- "5" in the "First galaxies form" box  
AND
- "3" in the "First gas clouds form" box  
AND
- "1" in the "Rapid expansion of the universe" box (1 point).

**Alignment**

Topic

The Universe

Subtopic

History of the Universe

Content Elaboration

"According to the "big bang" theory, the contents of the known universe expanded explosively into existence from a hot, dense state 13.7 billion years ago (NAEP 2009). After the big bang, the universe expanded quickly (and continues to expand) and then cooled down enough for atoms to form. Gravity pulled the atoms together into gas clouds that eventually became stars, which comprise young galaxies. Foundations for the big bang model can be included to introduce the supporting evidence for the expansion of the known universe (e.g., Hubble's law and red shift or cosmic microwave background radiation). A discussion of Hubble's law and red shift is found in the Galaxy formation section."

Cognitive Demand

Recalling Accurate Science (R)

Requires students to provide accurate statements about scientifically valid facts, concepts and relationships. Recall only requires students to provide a rote response, declarative knowledge or perform routine mathematical tasks. This cognitive demand refers to students' knowledge of science fact, information, concepts, tools, procedures and basic principles.

Explanation of the Item

This one-point table item requires the student to sequence the events in the Big Bang model of the formation of the universe by entering the proper values into the table. After the Big Bang, there was a rapid expansion of the universe, followed by cooling to allow the first atoms to form. The atoms were then pulled into gas clouds by their gravitational attraction for each other. Gravity also pulled the gas clouds together into stars and finally pulled the stars together into galaxies. Therefore, the correct order of the events is

- Rapid expansion of the universe
- First atoms form
- First gas clouds form
- First stars form
- First galaxies form.

The numbers entered into the chart should appear in this order: 4, 2, 5, 3 and 1.

Sample Response: 1 point

Enter numbers in the table to order the events of the Big Bang model as they occurred, with 1 as the earliest and 5 as the most recent.

Event	Order
First stars form	4
First atoms form	2
First galaxies form	5
First gas clouds form	3
Rapid expansion of the universe	1

Notes on Scoring

This response earns full credit (1 point). It correctly ranks the events in this order: 4, 2, 5, 3 and 1.

Physical Science  
EOY Practice Test

Question 13

Sample Responses

85

86

Sample Responses: 0 points

Enter numbers in the table to order the events of the Big Bang model as they occurred, with 1 as the earliest and 5 as the most recent.

Event	Order
First stars form	4
First atoms form	3
First galaxies form	5
First gas clouds form	2
Rapid expansion of the universe	1

Notes on Scoring

This response earns no credit (0 points). It incorrectly ranks the events in this order: 4, 3, 5, 2 and 1. The correct order is 4, 2, 5, 3 and 1.

Enter numbers in the table to order the events of the Big Bang model as they occurred, with 1 as the earliest and 5 as the most recent.

Event	Order
First stars form	3
First atoms form	2
First galaxies form	4
First gas clouds form	5
Rapid expansion of the universe	1

Notes on Scoring

This response earns no credit (0 points). It incorrectly ranks the events in this order: 3, 2, 4, 5 and 1. The correct order is 4, 2, 5, 3 and 1.

87

## Physical Science EOY Practice Test

### Question 14

#### Question and Scoring Guidelines

### Question 14

A car starts at rest and speeds up with an average positive acceleration of 4.0 meters per second squared ( $m/s^2$ ), in a straight line. The car travels a distance of 98 meters (m) in 7.0 seconds (s).

Calculate the car's final velocity in meters per second ( $m/s$ ) after 7.0 s. Enter the number in the box.

1	2	3
4	5	6
7	0	9
8	.	/

Points Possible: 1

See Alignment for more detail.

#### Scoring Guidelines

For this item, a full-credit response includes

- "28" entered in the box (1 point).

89

90

#### Alignment

##### Topic

Forces and Motion

##### Subtopic

Motion

##### Content Elaboration

"Acceleration is a vector property that represents the rate at which velocity changes. Average acceleration can be calculated by dividing the change in velocity by elapsed time ( $a_{avg} = (v_f - v_i)/(t_f - t_i)$ ). At this grade level, it should be noted that acceleration can be positive or negative, but specifics about what kind of motions produce positive or negative accelerations will be addressed in the physics syllabus. The word "deceleration" should not be used because students tend to associate a negative sign of acceleration only with slowing down. Objects that have no acceleration can either be standing still or be moving with constant velocity (speed and direction). Constant acceleration occurs when the change in an object's instantaneous velocity is the same for equal successive time intervals."

##### Cognitive Demand

Recalling Accurate Science (R)

Requires students to provide accurate statements about scientifically valid facts, concepts and relationships. Recall only requires students to provide a rote response, declarative knowledge or perform routine mathematical tasks. This cognitive demand refers to students' knowledge of science fact, information, concepts, tools, procedures and basic principles.

##### Explanation of the Item

This one-point equation editor item\* requires the student to calculate the final velocity from average acceleration. Average acceleration can be calculated from the equation  $a_{avg} = (v_f - v_i)/(t_f - t_i)$ . Since the initial velocity,  $v_i$ , and initial time,  $t_i$  are zero, this equation can be simplified to  $a_{avg} = v_f / t_f$ . Multiplying both sides of the equation by  $t_f$  to solve for  $v_f$  gives  $v_f = a_{avg} t_f$ . Substituting given values into the equation gives  $v_f = (4.0 m/s^2) (7.0 s) = 28 m/s$ . The distance is also given in the problem but is not needed to solve for the final velocity.

\*Equation editor items can be used to enter numerical answers, mathematical equations and/or mathematical formulas. The selections to choose from can be any combination of numbers, symbols and/or mathematical operations.

91



# Physical Science EOY Practice Test

## Question 14

### Sample Responses

#### Sample Response: 1 point

A car starts at rest and speeds up with an average positive acceleration of 4.0 meters per second squared ( $m/s^2$ ), in a straight line. The car travels a distance of 98 meters (m) in 7.0 seconds (s).

Calculate the car's final velocity in meters per second (m/s) after 7.0 s. Enter the number in the box.

28

1	2	3
4	5	6
7	8	9
0	.	-

#### Notes on Scoring

This response earns full credit (1 point). The response correctly indicates the final velocity to be 28 m/s [ $v_f = (4.0 m/s^2) (7.0 s) = 28 m/s$ ].

93

94

#### Sample Response: 0 points

A car starts at rest and speeds up with an average positive acceleration of 4.0 meters per second squared ( $m/s^2$ ), in a straight line. The car travels a distance of 98 meters (m) in 7.0 seconds (s).

Calculate the car's final velocity in meters per second (m/s) after 7.0 s. Enter the number in the box.

56

1	2	3
4	5	6
7	8	9
0	.	-

#### Notes on Scoring

This response earns no credit (0 points). The response incorrectly indicates the final velocity to be 56 m/s. The correct final velocity is 28 m/s [ $v_f = (4.0 m/s^2) (7.0 s) = 28 m/s$ ].

A car starts at rest and speeds up with an average positive acceleration of 4.0 meters per second squared ( $m/s^2$ ), in a straight line. The car travels a distance of 98 meters (m) in 7.0 seconds (s).

Calculate the car's final velocity in meters per second (m/s) after 7.0 s. Enter the number in the box.

2.8

1	2	3
4	5	6
7	8	9
0	.	-

#### Notes on Scoring

This response earns no credit (0 points). The response incorrectly indicates the final velocity to be 2.8 m/s. The correct final velocity is 28 m/s [ $v_f = (4.0 m/s^2) (7.0 s) = 28 m/s$ ].

95

## Physical Science EOY Practice Test

### Question 15

#### Question and Scoring Guidelines

97

#### Alignment

##### Topic

Study of Matter

##### Subtopic

Bonding and Compounds

##### Content Elaboration

"Using the periodic table to determine ionic charge, formulas of ionic compounds containing elements from groups 1, 2, 17, hydrogen and oxygen can be predicted. Given a chemical formula, a compound can be named using conventional systems that include Greek prefixes where appropriate. Prefixes will be limited to represent values from one to 10. Given the name of an ionic or covalent substance, formulas can be written. Naming organic molecules is beyond this grade level and is reserved for an advanced chemistry course. Prediction of bond types from electronegativity values, polar covalent bonds, writing formulas and naming compounds that contain polyatomic ions or transition metals will be addressed in the chemistry syllabus.

##### Cognitive Demand

Recalling Accurate Science (R)

Requires students to provide accurate statements about scientifically valid facts, concepts and relationships. Recall only requires students to provide a rote response, declarative knowledge or perform routine mathematical tasks. This cognitive demand refers to students' knowledge of science fact, information, concepts, tools, procedures and basic principles.

##### Explanation of the Item

This one-point multiple choice item requires the student to identify the formula of a compound formed between beryllium, an alkaline earth element, and iodine, a halogen. Since beryllium is a metal and iodine is a nonmetal, the compound is most likely ionic. Beryllium is in Group 2 and tends to form ions with a +2 charge. Iodine is in Group 17 and tends to form ions with a -1 charge. In order for the total net charge to be zero in the compound, one beryllium ion will form a compound with two iodide ions and the formula will be  $\text{BeI}_2$ , Option C.

99

### Question 15

What is the chemical formula of the compound formed between beryllium (Be), an alkaline earth element, and iodine (I), a halogen?

- A  $\text{BeI}$   
 B  $\text{Be}_2\text{I}$   
 C  $\text{BeI}_2$   
 D  $\text{Be}_2\text{I}_2$

Points Possible: 1

See Alignment for more detail.

#### Scoring Guidelines

**Rationale for Option A:** This is incorrect. Since a beryllium ion typically has a charge of +2 and an iodide ion typically has a charge of -1, the net charge on  $\text{BeI}$  would be  $(+2) + (-1)$  or -1. Stable chemical compounds have a net charge of zero.

**Rationale for Option B:** This is incorrect. Since a beryllium ion typically has a charge of +2 and an iodide ion typically has a charge of -1, the net charge on  $\text{Be}_2\text{I}$  would be  $(+2) + (+2) + (-1)$  or +3. Stable chemical compounds have a net charge of zero.

**Rationale for Option C: Key** – Since a beryllium ion typically has a charge of +2 and an iodide ion typically has a charge of -1, the net charge on  $\text{BeI}_2$  would be  $(+2) + (-1) + (-1)$  or zero which is a net charge of a stable chemical compounds.

**Rationale for Option D:** This is incorrect. Since a beryllium ion typically has a charge of +2 and an iodide ion typically has a charge of -1, the net charge on  $\text{Be}_2\text{I}_2$  would be  $(+2) + (+2) + (-1) + (-1)$  or +2. Stable chemical compounds have a net charge of zero.

98

#### Sample Response: 1 point

What is the chemical formula of the compound formed between beryllium (Be), an alkaline earth element, and iodine (I), a halogen?

- A  $\text{BeI}$   
 B  $\text{Be}_2\text{I}$   
 C  $\text{BeI}_2$   
 D  $\text{Be}_2\text{I}_2$

100

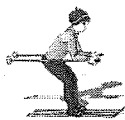
## Physical Science EOY Practice Test

### Question 16

#### Question and Scoring Guidelines

### Question 16

A skier with a weight of 700 N glides along a flat, horizontal surface at the bottom of a hill. Her acceleration is  $-2.0 \text{ m/s}^2$ .



What is the magnitude of the total force acting on the skier due to friction and air resistance?

Ⓐ 70 N  
Ⓑ 140 N  
Ⓒ 350 N  
Ⓓ 1400 N

Points Possible: 1

See Alignment for more detail.

### Scoring Guidelines

**Rationale for Option A:** This is incorrect. While the mass of the skier is 70 kg [ $m = (700 \text{ N}) / (10 \text{ N/kg}) = 70 \text{ kg}$ ], the magnitude of the net force is 140 N [ $|F_{\text{net}}| = |(70 \text{ kg})(-2 \text{ m/s}^2)| = |(-140 \text{ N})| = 140 \text{ N}$ ].

**Rationale for Option B: Key –** The mass of the skier is 70 kg [ $m = (700 \text{ N}) / (10 \text{ N/kg}) = 70 \text{ kg}$ ], the magnitude of the net force is 140 N [ $|F_{\text{net}}| = |(70 \text{ kg})(-2 \text{ m/s}^2)| = |(-140 \text{ N})| = 140 \text{ N}$ ].

**Rationale for Option C:** This is incorrect. The net force acting on the skier is not 350 N. The mass of the skier is 70 kg [ $m = (700 \text{ N}) / (10 \text{ N/kg}) = 70 \text{ kg}$ ], the magnitude of the net force is 140 N [ $|F_{\text{net}}| = |(70 \text{ kg})(-2 \text{ m/s}^2)| = |(-140 \text{ N})| = 140 \text{ N}$ ].

**Rationale for Option D:** This is incorrect. The net force acting on the skier is not 1400 N. The mass of the skier is 70 kg [ $m = (700 \text{ N}) / (10 \text{ N/kg}) = 70 \text{ kg}$ ], the magnitude of the net force is 140 N [ $|F_{\text{net}}| = |(70 \text{ kg})(-2 \text{ m/s}^2)| = |(-140 \text{ N})| = 140 \text{ N}$ ].

101

102

### Alignment

#### Topic

Forces and Motion

#### Subtopic

Dynamics

#### Content Elaboration

"An object does not accelerate (remains at rest or maintains a constant speed and direction of motion) unless an unbalanced net force acts on it. The rate at which an object changes its speed or direction (acceleration) is proportional to the vector sum of the applied forces (net force,  $F_{\text{net}}$ ) and inversely proportional to the mass ( $a = F_{\text{net}}/m$ ). When the vector sum of the forces (net force) acting on an object is zero, the object does not accelerate. For an object that is moving, this means the object will remain moving without changing its speed or direction. For an object that is not moving, the object will continue to remain stationary. These laws will be applied to systems consisting of a single object upon which multiple forces act. Vector addition will be limited to one dimension (positive and negative). While both horizontal and vertical forces can be acting on an object simultaneously, one of the dimensions must have a net force of zero."

#### Cognitive Demand

Interpreting and Communicating Science Concepts (C)

Requires students to use subject-specific conceptual knowledge to interpret and explain events, phenomena, concepts and experiences using grade-appropriate scientific terminology, technological knowledge and mathematical knowledge. Communicate with clarity, focus and organization using rich, investigative scenarios, real-world data and valid scientific information.


#### Explanation of the Item

This one-point multiple choice item requires the student to apply the force-mass-acceleration relationship to determine the net force acting on a skier. The rate at which an object changes its speed or direction (acceleration) is proportional to the vector sum of the applied forces (net force,  $F_{\text{net}}$ ) and inversely proportional to the mass,  $m$ , according to the equation  $a = F_{\text{net}}/m$ . Multiplying both sides of the equation by  $m$  to solve for  $F_{\text{net}}$ , gives  $F_{\text{net}} = m a$ . The item identifies the acceleration as  $-2.0 \text{ m/s}^2$  and the weight as 700 N. The weight is the force of gravity acting on the object,  $F_g$ , and is directly proportional to the mass according to this equation,  $F_g = m g$ , where  $g$  is the gravitational field strength or  $10 \text{ N/kg}$ . The equation can be solved for mass by dividing both sides by  $g$  to give  $m = F_g / g$ . Substituting values into this equation gives  $m = (700 \text{ N}) / (10 \text{ N/kg}) = 70 \text{ kg}$ . Substituting the acceleration and the mass into the equation  $F_{\text{net}} = m a$  gives  $F_{\text{net}} = (70 \text{ kg})(-2 \text{ m/s}^2) = -140 \text{ N}$ . The magnitude is the force without respect to direction. Since the negative sign indicates a downward direction, the magnitude of the force is the absolute value of  $-140 \text{ N}$ , or 140 N, Option B.

103

### Sample Response: 1 point

A skier with a weight of 700 N glides along a flat, horizontal surface at the bottom of a hill. Her acceleration is  $-2.0 \text{ m/s}^2$ .



What is the magnitude of the total force acting on the skier due to friction and air resistance?

Ⓐ 70 N  
Ⓑ 140 N  
Ⓒ 350 N  
Ⓓ 1400 N

104

The Ohio Department of Education does not discriminate on the basis of race, color, national origin, sex, religion, age, or disability in employment or the provision of services.

Copyright © 2014 by the Ohio Department of Education. All rights reserved.