A New Vision for Science Standards and Assessments

The Louisiana Student Standards for Science (LSS for science) were created by over eighty content experts and educators with input from parents and teachers from across the state. Educators envisioned what students should know and be able to do to compete in our communities and created standards that would allow students to do so. The LSS for Science provide appropriate content for all grades or courses, maintain high expectations and create a logical connection of content across and within grades. The LSS for Science represent the knowledge and skills needed for students to successfully transition to postsecondary education and the workplace. The standards call for students to

1) apply content knowledge;
2) investigate, evaluate, and reason scientifically; and
3) connect ideas across disciplines.

This guide includes:

INTRODUCTION TO THE FIELD TEST

Transition to New Science Assessments

Students in grades 3-8 will take a science **field test only** during the regular testing window, and will not take an operational science test in Spring 2018. New full-length science assessments will be developed from successful field-tested items. This will allow the Department to end the multi-grade assessments in grades 4 and 8, and align the assessment in all tested grades to the LSS for Science.

Key Goals for New Science Assessments

Starting in the 2018-2019 school year, students in grades 3-8 will take the new LEAP 2025 science assessments, which provide

- questions that have been reviewed by Louisiana educators to ensure their alignment to the Louisiana Student Standards for Science (LSS for Science) and appropriateness for Louisiana students;
- measurement of the full range of student performance, including that of high- and low-performing students; and
- information for educators and parents about student readiness in science and whether students are "on track" for college and careers.

ITEM AND SET DESIGN

Supporting Key Shifts in Science Instruction

The spring 2018 Field Test is designed to produce questions for a spring 2019 operational test that will assess a student's understanding of the grade 6 LSS for Science reflecting the multiple dimensions of the standards.

Shift: Apply content knowledge and skills (Disciplinary Core Idea, DCI)

In the classroom, students develop skills and content knowledge reflected in the Performance Expectations (PE) and detailed in the Disciplinary Core Ideas (DCI), the key ideas in science that have broad importance within or across multiple science or engineering disciplines. However, simply having content knowledge and scientific skills are not enough. Students must investigate and apply content knowledge to scientific phenomena. Phenomena are real world observations that can be explained through scientific knowledge and reasoning (e.g., water droplets form on the outside of a water glass, plants tend to grow toward their light source, different layers of rock can be seen on the side of the road).

On the field test, students answer questions aligned to PE bundles (groupings of like PEs) and the corresponding DCIs. The students begin each set of questions by reading through stimulus materials connected to a scientific phenomenon.

Shift: Investigate, evaluate, and reason scientifically (Science and Engineering Practice, SEP)

In the classroom, students do more than learn about science; they "do" science. Science instruction must integrate the practices, or behaviors, of scientists and engineers (Science and Engineering Practices; SEPs) as students investigate real-world phenomena and design solutions to problems.

On the field test, students do more than answer recall questions about science; they apply the practices, or behaviors, of scientists and engineers as students investigate each real-world phenomenon and design solutions to problems.

Shift: Connect ideas across disciplines (Crosscutting Concept, CCC)

In the classroom, students develop a coherent and scientifically-based view of the world, they must make connections across the domains of science (life science, physical science, earth and space science, environmental science, and engineering, technology, and applications of science). These connections are identified as crosscutting concepts (CCC). The crosscutting concepts have applications across all domains.

On the field test, sets of questions assess student application of knowledge across the domains of science for a comprehensive picture of student readiness for their next grade or course in science.

Set-Based Design

The field tests include item sets, task sets, and discrete items. A scientific **phenomenon** provides the focus for the sets. Stimulus materials, related to the scientific phenomenon, provide context for and anchor both **item sets** and **task sets** comprised of four to five questions. In addition to the information presented in the stimulus materials, the questions require students to bring in content knowledge from the course to demonstrate their understanding of science. The questions include selected-response (multiple-choice and/or multiple-select), technology-enhanced, and two-part questions. Some **item sets** culminate with a short constructed-response and the **task set** culminates with an extended-response item. Each field test includes a few **discrete items** made of selected-response, technology-enhanced, and two-part questions.

The Phenomenon and Stimulus Materials

A variety of stimulus materials provide context for each described phenomenon. Art is used to help convey information in a simplified form, examples include maps, charts, data tables, bar or line graphs, diagrams, pictures, photographs, or artist's renderings.

Item Types

- Selected Response (SR): includes traditional multiple-choice (MC) questions with four answer options and only one correct answer, as well as multiple-select (MS) questions with five to seven answer options and more than one correct answer. For MS items, the question identifies the number of correct answers. All SR items are worth one point each.
- Technology Enhanced (TE): uses technology to capture student comprehension in authentic ways, previously difficult to score by machine for large-scale assessments. TE items are worth up to two points and may include item types such as, but not limited to, drag and drop, dropdown menus, and hot spots. The Online Tools Training allows students to experience TE items and practice answering them to prepare for the computer-based test.
- Two-part Item: requires students to answer two related questions, worth two points. Two-part items may combine SR and/or TE item types.
  - Two-part Dependent (TPD): the first part must be correct in order to earn credit for the second part.
  - Two-part Independent (TPI): each part is scored independently.
- Constructed Response (CR): requires a brief response provided by the student and will be scored using a 2-point rubric. These items may require a brief paragraph, a few sentences, and/or completion of a chart.
- Extended Response (ER): asks students to write an in-depth response that expresses the students' ability to apply all three dimensions of the LSS for Science and will be scored using a 9-point rubric.

Field Test Design

The following table identifies the design of the field tests to be administered in grade 6.

2018 Field Test Design

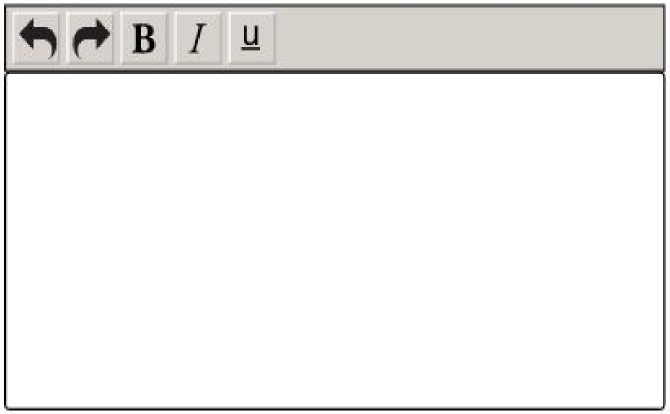
Session	Component	Numbers and Types of Questions	Time Allowed
1	Item Set	4 Items (SR, TE, and/or Two Part)	60 minutes
	Item Set	4 Items (SR, TE, and/or Two Part), 1 CR	
	Discrete Items	3 Items (SR, TE, and/or Two Part)	
2	Task Set	4 Items (SR, TE, and/or Two Part), 1 ER	55 minutes
Total Field Test Form		**15 SR, TE, and/or Two-Part, 1 CR, 1 ER**	**115 minutes**

NOTE: The spring 2019 operational assessment design will differ from the field test design, as it will be a full-length assessment.

All LEAP 2025 assessments, including the science field test, are **timed**. No additional time is permitted, except for students who have a documented extended time accommodation (e.g., an IEP).

FIELD TEST ADMINISTRATION POLICIES

Students in grades 5 through 8 must take the field test online. **The computer-based testing window opens April 9, 2018 and runs through May 4, 2018.** For more information about the scheduling of the field test and online administration policies, refer to the CBT Guidance document, found in the LDOE assessment library.



Computer-Based Tests

Students will enter their answers into the online testing system. When composing their written responses for science constructed- or extended-response item, students will type their responses into an answer box, like the one shown.

The toolbar at the top of the response box allows students to undo or redo and action; and add boldface, italics, or underlining to their response. There is a limit to the amount of characters that can be typed into the response box; however, it is set well beyond what a student might produce given the LEAP 2025 expectations for written responses and timing. The character count is not included on the response box so students focus on the quality of their responses rather than the amount of writing.

The computer-based tests include the following online tools, which allow a student to select answer choices, “mark” items, eliminate answer options, take notes, enlarge the item, and guide the reading of a text or an item line by line (similar to what a student can do on the paper-based tests). A help tool is also featured to assist students as they use the online system.

- Pointer tool 
- Highlighter tool 
- Cross-Off tool 
- Sticky Note tool 
- Magnifying tool 
- Line Guide 

- Help Tool 

All students taking the computer-based field test should work through the Online Tools Training available through INSIGHT in Winter 2017-2018 to practice using the online tools so students are well prepared to navigate the online testing system.

Testing Materials

All students should receive scratch paper and two pencils from their test administrator.

SAMPLE FIELD TEST ITEMS

This section includes sample field test items. With each item, item set, and task set, is a table containing alignment information and the answer key, where possible. Additionally, analyses of the multi-dimensional alignment for the item set and the task set are included. Rubrics for CRs and ERs are included with the items.

DISCRETE ITEMS

Item Type	PE	DCI	SEP	CCC	Points
TEI	6-MS-PS4-1	MS.PS4A.a	5. MCT	PAT	2
MC	6-MS-PS2-4	MS.PS2B.b	7. ARG		1
TPD	6-MS-LS2-2	MS.LS2A.d	6. E/S		2
MC	6-MS-LS2-1	MS.LS2A.c	4. DATA		1
TEI	6-MS-PS2-3	MS.PS2B.a	1. Q/P		1

SEP = blue; DCI = orange; CCC = green An asterisk (*) denotes correct answer(s).

Technology-Enhanced Item

Performance Expectation

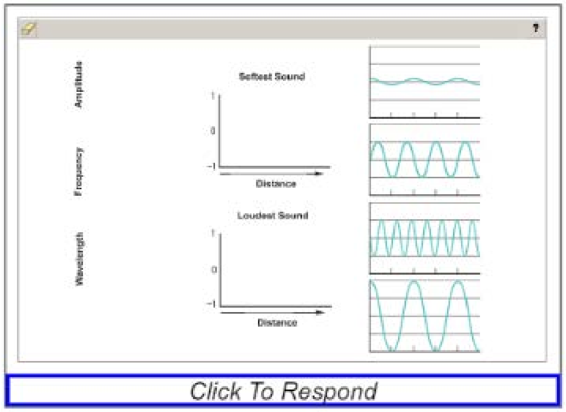
6-MS-PS4-1 Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave and how the frequency and wavelength change the expression of the wave.

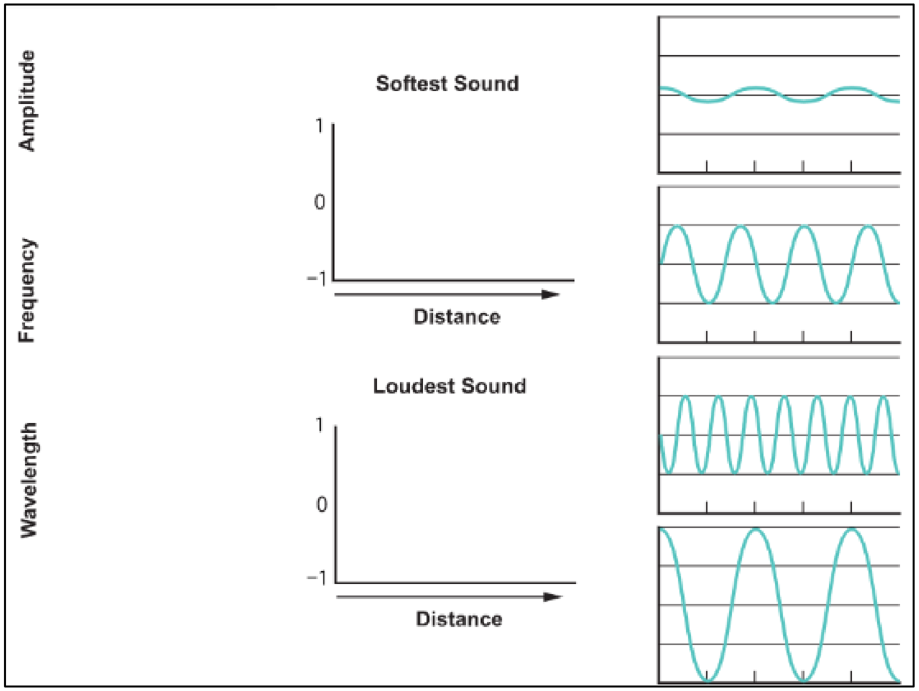
A student makes a simple musical instrument using a single hollow steel pipe. The student taps the pipe to produce soft sounds and taps it again to make loud sounds.

Identify the graphs that **best** respresent the softest sound and the loudest sound produced, and label the *y*-axis on each graph, by following these two steps:

Step 1: Drag the correct graphs into **each** of the boxes above the arrows labeled "Distance" to show the difference between the softest sound and the loudest sound produced when the student taps the pipe. Not all graphs will be used.

Step 2: Drag the correct labels into **each** of the boxes along the *y*-axis to show what the *y*-axis in each graph represents. Each label may be used more than once.

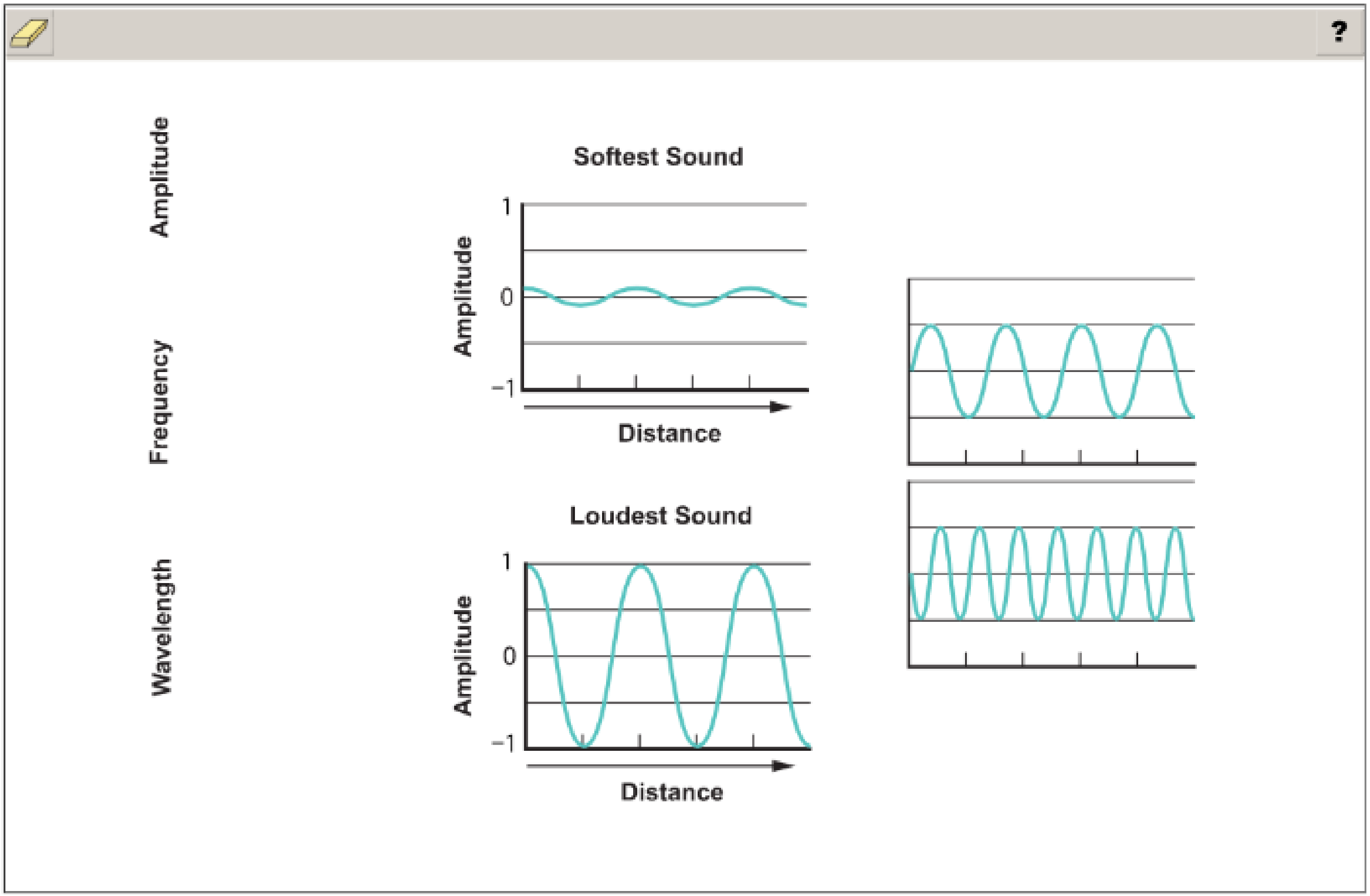




Multi-Dimensional Alignment

The item requires the student to apply the science practice of using mathematics and computational thinking by using mathematical representations to describe phenomena and knowledge of how waves have a repeating pattern of with a specific wavelength, frequency, and amplitude to demonstrate an understanding of patterns.

Scoring Information



Multiple-Choice Item

Performance Expectation

6-MS-PS2-4 Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.

A student claims that all objects exert a gravitational force on one another. However, it is difficult to observe the effect of the force of gravity unless the mass of one of the objects is very large.

Which observation **best** supports the student's argument?

A. The Moon stays in orbit around Earth.*
B. Earth spins on its axis at a constant speed.
C. The masses of the Moon and Earth are constant.
D. The solar system has moons of different masses.

Multi-Dimensional Alignment

While effectively applying the science practice of **engaging in an argument** by **selecting evidence to support an explanation**, the student demonstrates knowledge of **how gravitational forces are always attractive and the gravitational force between any two masses is very small except when one or both objects have large mass**.

Two-Part Dependent Item (Part A: Multiple-Choice Item, Part B: Multiple-Select Item)
Performance Expectation
6-MS-LS2-2 Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

Lichens are made up of two tiny living things: fungi and algae. The fungi and the algae live close together, giving a lichen the appearance that it is a single organism. Algae produce food through photosynthesis, and the fungi gather water. In this way, lichens can survive harsh weather that would kill a fungus or an alga growing on its own. Lichens can grow on sand, trees, and even rocks, but they are very sensitive to pollution sources and are seldom observed near factories or roads.

Part A
Which type of relationship is **best** represented by fungi and algae in a lichen?

A. parasitic
B. symbiotic*
C. predator-prey
D. competitive

Part B
Which statements are evidence that supports the answer to Part A?

Select **all** that apply.

A. Lichens are sensitive to pollution.
B. Algae can live on their own, but fungi cannot.
C. Fungi and algae are different types of organisms.
D. Algae produce food, but fungi do not.*
E. Fungi and algae have different ways of using energy.
F. Fungi gather water much better than algae do.*

Multi-Dimensional Alignment

While effectively applying the science practice of constructing an explanation by selecting qualitative relationships to explain phenomena, the student demonstrates knowledge of how mutually beneficial interaction may become so interdependent that each organism required the other for survival.

Multiple-Choice Item

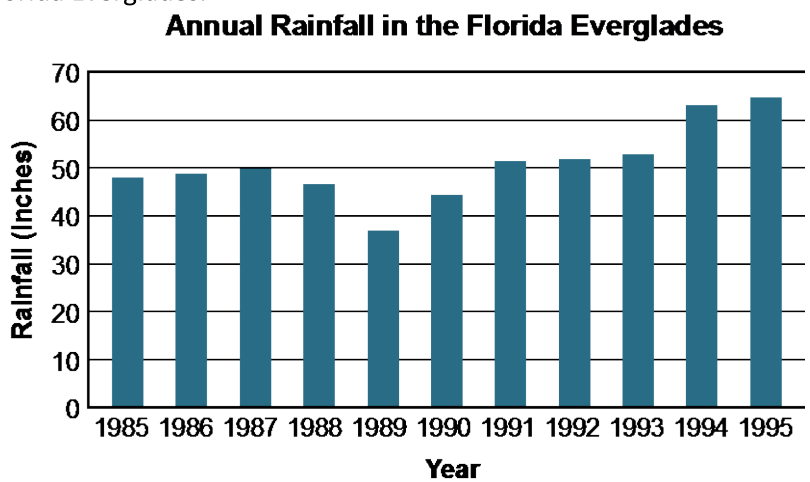
Performance Expectation

6-MS-LS2-1 Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem

Alligators depend on water resources in their environments in many different ways, three of which are listed.

- Nesting sites
- Habitat/space to live
- Food supply

The graph shows annual rainfall in the Florida Everglades.



Which claim is **best** supported by the data in the graph and by the information on how alligators depend on water resources?

A. From 1990 to 1995, the alligator population increased due to an increase in nesting sites, food supply, and habitat.*

B. From 1990 to 1995, the alligator population increased due to an increase in nesting sites and a decrease in food supply.

C. From 1985 to 1995, the alligator population remained the same, but individual alligators had increased ranges within their habitats.

D. From 1985 to 1995, the alligator population remained the same, but individual alligators grew larger due to increased food supply and habitat.

Multi-Dimensional Alignment

While effectively applying the science practice of analyzing and interpreting data by interpreting data to provide evidence for a phenomenon, the student demonstrates knowledge of how population increases are limited by access to resources.

Technology-Enhanced Item

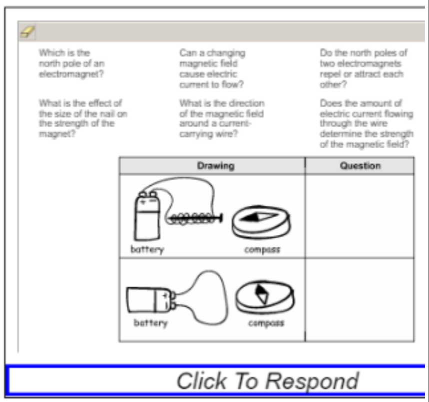
Performance Expectation

6-MS-PS2-3 Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.

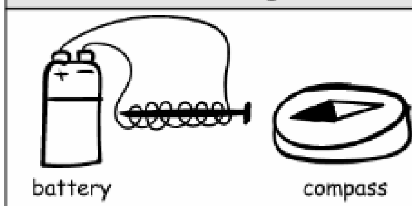
Students designed two experiments to study questions about electric current and magnetic fields. The students drew pictures of their experiments. Which questions is each experiment **most likely** designed to answer?

For each experimental design drawing, drag a question that the students could answer with that design into the box beside the drawing.

Not all questions will be used.



- Which is the north pole of an electromagnet?
- Can a changing magnetic field cause electric current to flow?
- Do the north poles of two electromagnets repel or attract each other?
- What is the effect of the size of the nail on the strength of the magnet?
- What is the direction of the magnetic field around a current-carrying wire?
- Does the amount of electric current flowing through the wire determine the strength of the magnetic field?

Drawing	Question
	
	

Multi-Dimensional Alignment

While effectively applying the science practice of asking questions by selecting questions that can be investigated, the student demonstrates knowledge of how electric and magnetic (electromagnetic) forces can be attractive and depend on the charges, magnitudes, current, or magnetic strengths between two interacting objects.

Scoring Information

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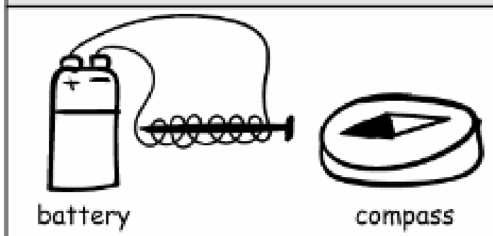
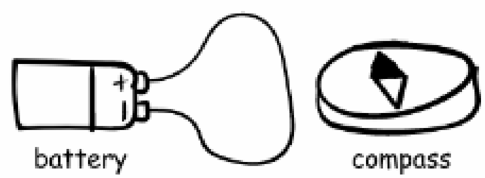
Can a changing magnetic field cause electric current to flow?

Do the north poles of two electromagnets repel or attract each other?

What is the effect of the size of the nail on the strength of the magnet?

Does the amount of electric current flowing through the wire determine the strength of the magnetic field?

Drawing	Question
	Which is the north pole of an electromagnet?
	What is the direction of the magnetic field around a current-carrying wire?

ITEM SET: Eclipses

Performance Expectations

6-MS-ESS1-1 Develop and use a model of the Earth-sun-moon system to describe the reoccurring patterns of lunar phases, eclipses of the sun and moon, and seasons.

6-MS-ESS1-2 Use a model to describe the role of gravity in the motions within galaxies and the solar system.

Item Type	PE	DCI	SEP	CCC	Points
TPI	6-MS-ESS1-2	MS.ESS1B.a	2. MOD	SYS	2
TEI	6-MS-ESS1-1	MS.ESS1A.a; MS.ESS1B.b	2. MOD		1
MC	6-MS-ESS1-1	MS.ESS1A.a	2. MOD	PAT	1
CR	6-MS-ESS1-1	MS.ESS1A.a; MS.ESS1B.b	2. MOD	PAT	2

SEP = blue; DCI = orange; CCC = green An asterisk (*) denotes correct answer(s).

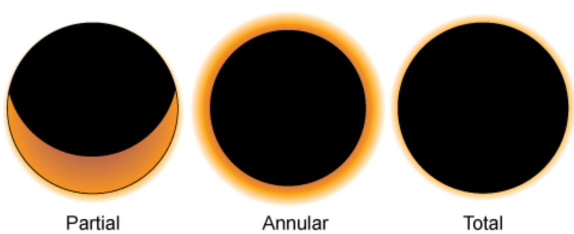
Stimulus Materials

Use the information about eclipses and your knowledge of science to answer the question.

Eclipses

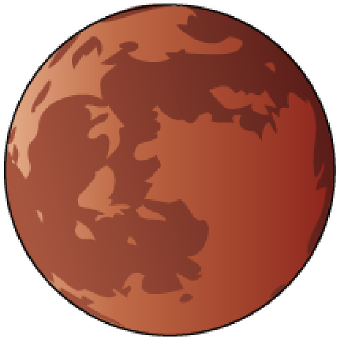
The orbits of Earth and the Moon around the Sun follow elliptical paths that sometimes result in different types of eclipses. During a solar eclipse, people in certain locations on Earth can view changes in the appearance of the Sun. The changes depend on whether the solar eclipse is partial, annular, or total. An annular solar eclipse has a visible ring of light around its shadow. The three different types of solar eclipses are shown in Figure 1.

Figure 1. Types of Solar Eclipses



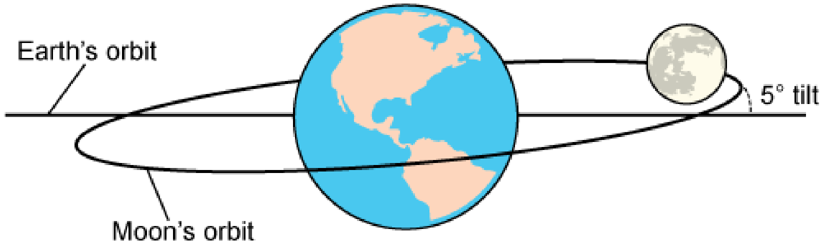
During a lunar eclipse, people on the night side of Earth can view changes in the appearance of the Moon. In a total lunar eclipse, the Moon appears to have a reddish-orange color before turning dark, as shown in Figure 2.

Figure 2. Appearance of the Moon during a Lunar Eclipse



Solar and lunar eclipses occur, on average, a few times per year. They do not occur every month because the orbit of the Moon is tilted about 5 degrees, compared to Earth's orbit, as shown in the model in Figure 3. As a result, Earth, the Moon, and the Sun rarely line up exactly.

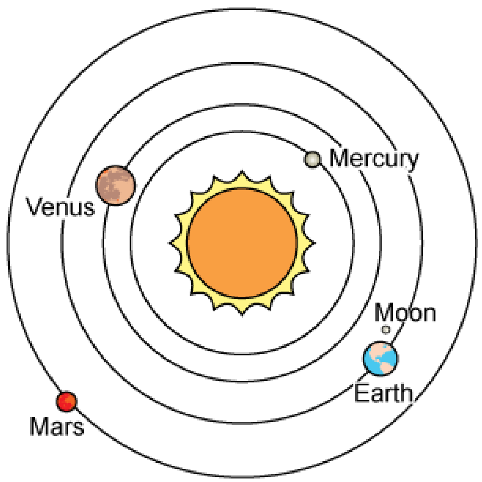
Figure 3. Tilt of the Moon's Orbit around Earth



Note: Not to scale

The Earth–Moon system orbits the Sun in the inner solar system. A model of the inner solar system is shown in Figure 4.

Figure 4. The Inner Solar System



Note: Not to scale

Two-Part Independent Item (Part A: Multiple-Choice Item, Part B: Multiple-Select Item)

Part A

Which statement **best** explains what the orbits in Figure 4 show about the role of gravity in the motions of the Earth–Moon system?

A. The force of gravity between Earth and the Moon causes the Moon to orbit Earth while the Earth–Moon system orbits the Sun.*

B. The force of gravity between the Moon and the Sun causes the Moon to orbit Earth while the Earth–Moon system orbits the Sun.

C. The force of gravity acts separately between Earth and the Sun and between the Moon and the Sun to cause the motions of the Earth–Moon system.

D. The forces of gravity between Earth and the Sun and between the Moon and the Sun are equal and do not affect the motions of the Earth–Moon system.

Part B

Which factors affect the motion of the Earth–Moon system and therefore affect the timing of solar and lunar eclipses?

Select the **two** correct answers.

A. the color of the Moon

B. the tilt of the Moon's orbit*

C. the distance between Earth and the Moon*

D. the amount of sunlight emitted by the Sun

E. the amount of sunlight reflected by the Moon

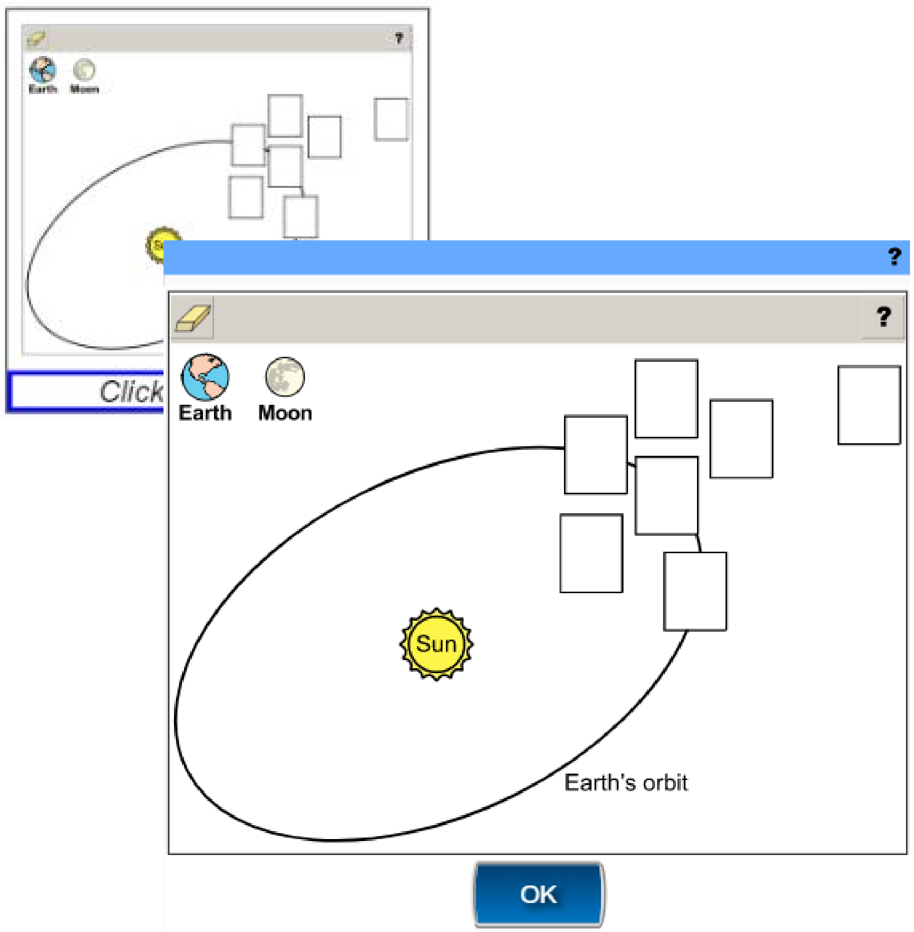
Multi-Dimensional Alignment

The item requires the student to apply the science practice of developing and using models by using models to describe phenomena and knowledge of how all of the objects in our solar system, including planets and their natural satellite(s), are held in orbit around the Sun by its large gravitational pull to demonstrate an understanding of systems and system models.

Technology-Enhanced Item

Drag the images of Earth and the Moon into the correct boxes to model the positions of **both** Earth and the Moon that result in annular and total solar eclipses.

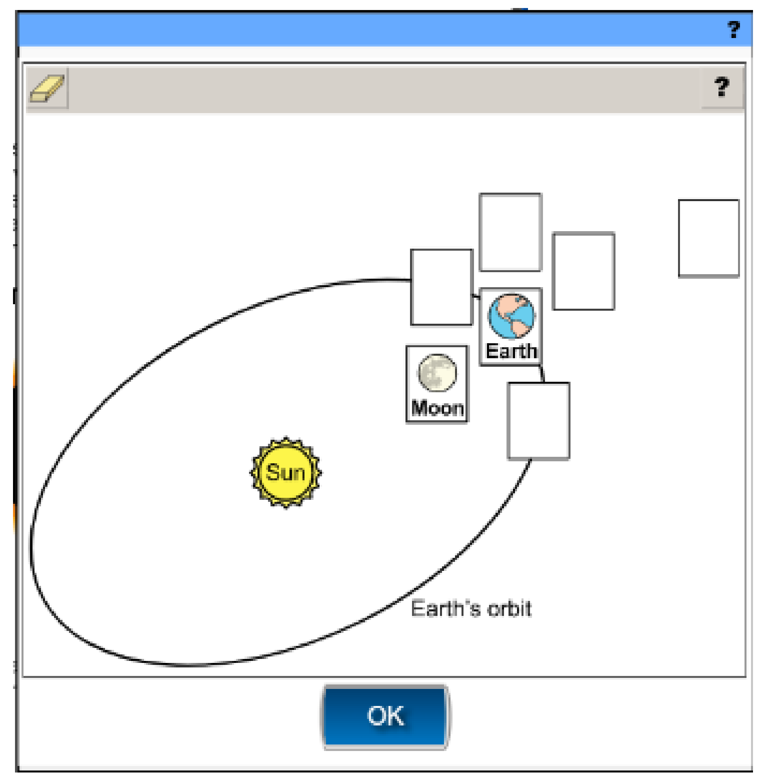
Each image will be used once.



Multi-Dimensional Alignment

While effectively applying the science practice of developing and using models by using models to predict phenomena, the student demonstrates knowledge of how the patterns of the apparent motion between Earth, the Moon, and the Sun can be observed and predicted with models, and how a model of the solar system can explain eclipses of the Sun and the Moon.

Scoring Information



Multiple-Choice Item

The model in Figure 4 can be used to explain why lunar eclipses are visible from larger areas of Earth, compared to solar eclipses. Which statement **best** explains how Figure 4 helps to explain this phenomenon?

A. Figure 4 shows that the Sun is larger than Earth, so Earth creates a larger shadow on the Moon.

B. Figure 4 shows that Earth is larger than the Moon, so the Moon creates a larger shadow on Earth.

C. Figure 4 shows that Earth is larger than the Moon, so Earth creates a larger shadow on the Moon.*

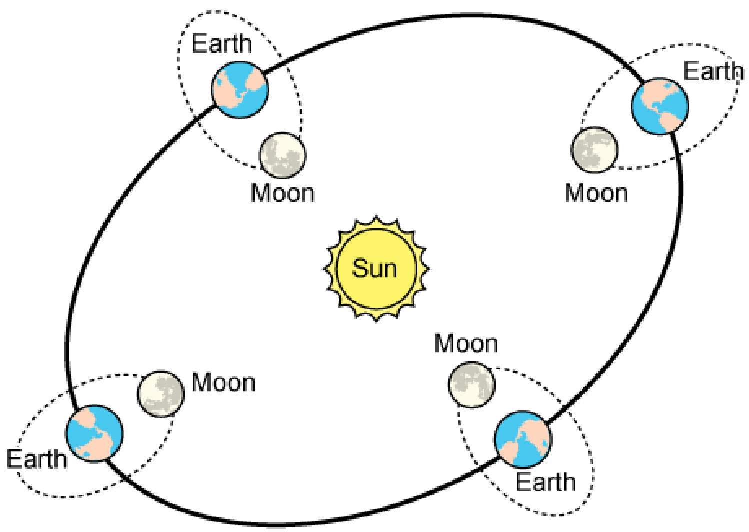
D. Figure 4 shows that the Sun is larger than the Moon, so the Moon creates a larger shadow on Earth.

Multi-Dimensional Alignment

The item requires the student to apply the science practice of **developing and using models** by **using models to describe phenomena** and knowledge of **how the patterns of apparent motion of Earth, the Moon, and the Sun can be predicted with models** to demonstrate an understanding of patterns.

Constructed-Response Item

Four positions of the Earth–Moon system that result in a new moon when viewed from Earth are shown in the model.



Note: Not to scale

Use this model and the model in Figure 3 to explain why a solar eclipse does **not** occur at every new moon. Explain how information from the two models and your knowledge of patterns could be combined to predict when a solar eclipse could occur.

Multi-Dimensional Alignment

The item requires the student to apply the science practices of developing and using models by using a model to describe phenomena and knowledge of how the patterns of motion between the Earth, Moon, and Sun can be predicted, and how a model of the solar system can explain eclipses of the Sun and the Moon to demonstrate an understanding of patterns.

Scoring Guide

Scoring Information	
Score	**Description**
2	Student's response correctly uses the two models to explain why a solar eclipse does not occur at every new moon **and** correctly explains how information from the two models, along with knowledge of patterns, could be combined to predict when a solar eclipse could occur.
1	Student's response correctly uses the two models to explain why a solar eclipse does not occur at every new moon **or** correctly explains how information from the two models, along with knowledge of patterns, could be combined to predict when a solar eclipse could occur.
0	Student's response does **not** correctly use the two models to explain why a solar eclipse does not occur at every new moon **or** correctly explain how information from the two models, along with knowledge of patterns, could be combined to predict when a solar eclipse could occur.

Sample Response

The model shows that the Moon is between the Sun and Earth during each new moon. However, the model in Figure 3 shows that the Moon's orbit is tilted, compared to Earth's, so that Earth, the Moon, and the Sun are not in a perfect line at each new moon. To predict when a solar eclipse could occur, ovals could be added to this model to show the tilt of the Moon's orbit, and the points where the Moon's orbit intersects with Earth's orbit could be marked. Since the Moon travels around Earth in a predictable pattern, knowing this pattern can help determine how often the Moon is in a position where the orbits intersect as Earth travels around the Sun. *Accept other reasonable answers.*

TASK SET: Laws of Motion and Bicycle Helmets

Performance Expectations

6-MS-PS2-1 Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.

6-MS-PS2-2 Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.

Item Type	PE	DCI	SEP	CCC	Points
MC	6-MS-PS2-1	MS.PS2A.a	6. E/S		1
TEI	6-MS-PS2-2	MS.PS2A.b	3. INV		2
MC	6-MS-PS2-2	MS.PS2A.b		S/C	1
TPD	6-MS-PS2-1	MS.PS2A.a; MS.ETS1B.a	6. E/S		2
ER	6-MS-PS2-1; 6-MS-PS2-2	MS.PS2A.a; MS.PS2A.b; MS.ETS1B.a	6. E/S; 3. INV	S/C	9

SEP = blue; DCI = orange; CCC = green An asterisk (*) denotes correct answer(s).

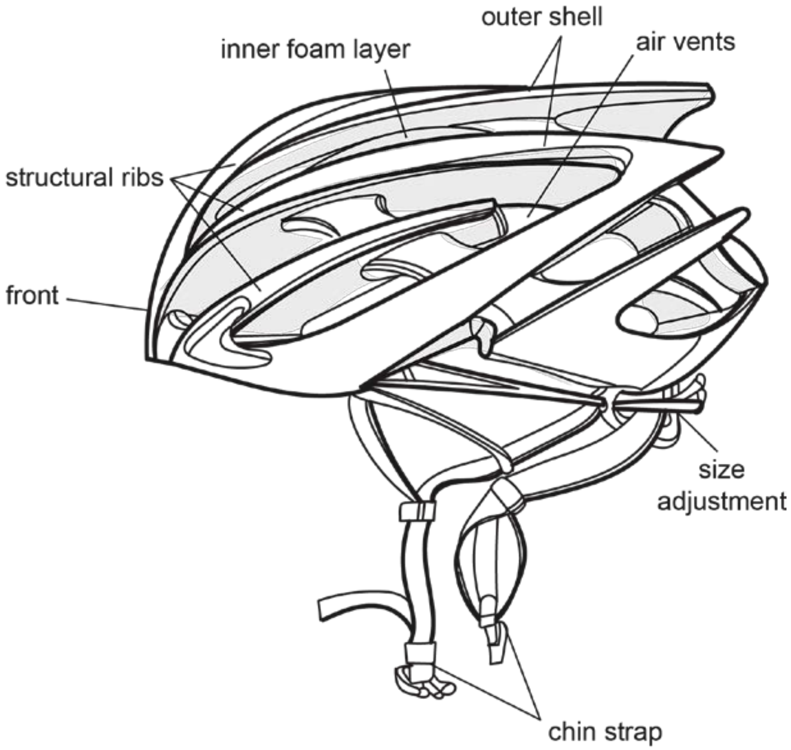
Stimulus Materials

Use the information about laws of motion and bicycle helmets and your knowledge of science to answer the questions.

Laws of Motion and Bicycle Helmets

The main function of bicycle helmets is to prevent head injuries. This is made possible by several design features. Other features that are part of bicycle helmet design are for shape, comfort, vision, and airflow. Figure 1 shows a typical bicycle helmet design.

Figure 1. Bicycle Helmet Design



The hard plastic outer shell can resist an impact and can distribute the force of the impact across the front of the helmet. The inner layer of plastic foam is soft, and it absorbs the remaining force of impact and makes the shock less sudden. The shape of a bicycle helmet reduces friction with the air. Straps for making adjustments provide a comfortable fit. Vents in the helmet are open areas that allow airflow, helping keep the rider's head cooler.

Many of the design features of bicycle helmets are based on Newton's laws of motion. Attempts to reduce the harm caused by a sudden impact are based on the *impulse theorem*, which is an expression of Newton's second law:

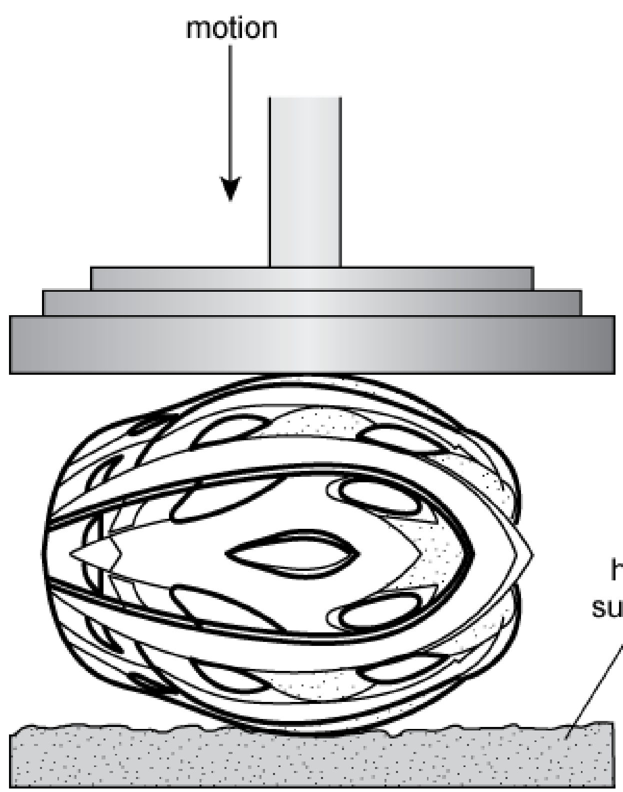
$$F = ma$$

where F is the force exerted on the cyclist's head, m is the mass of the cyclist, and a is the deceleration (negative acceleration) of the cyclist.

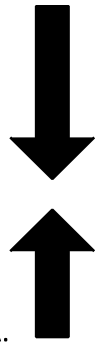
Research on how to improve bicycle helmets is ongoing. New materials and designs are being developed to improve helmet safety, comfort, and overall performance.

Multiple-Choice Item

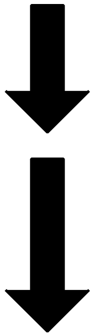
A bicycle helmet company is testing a new helmet design for its ability to withstand impact with a hard road surface. The helmet is placed on a machine that applies downward force to the helmet and causes the helmet to impact a hard surface. The result of the test is shown in the diagram.

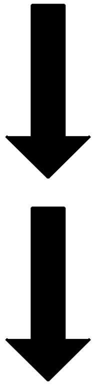


Which set of arrows **best** models the strengths and directions of the forces that occur when the helmet impacts the hard surface in this system?

A. 

B.* 

C. 

D. 

Multi-Dimensional Alignment

While effectively applying the science practice of constructing explanations by applying scientific ideas, the student demonstrates knowledge of when two objects collide, the force exerted on each is the same but in opposite directions.

Technology-Enhanced Item

When a bicycle helmet is involved in a collision, the outcome is determined by the objects involved in the collition. A bicycle helmet company wants to investigate how objects with different masses affect the outcome of a collision. The company designs an investigation to test the effect of the force exerted on a helmet by different objects.

Complete the table by selecting the boxes to identify the independent, dependent, and control variables for the investigation.

Select **one** box per row.

	Independent	Dependent	Control
Mass of object to be dropped on helmet	☐	☐	☐
Amount of force exerted on helmet	☐	☐	☐
Height of dropped object	☐	☐	☐

Multi-Dimensional Alignment

While effectively applying the science practice of **planning and carrying out investigations** by **selecting the variables for the investigation**, the student demonstrates knowledge of **how the sum of the forces acting on an object change the object's motion**.

Scoring Information

	Independent	Dependent	Control
Mass of object to be dropped on helmet	☑	☐	☐
Amount of force exerted on helmet	☐	☑	☐
Height of dropped object	☐	☐	☑

Multiple-Choice Item

How does the flexible foam lining inside a bicycle helmet change the outcome of a collision so as to reduce the risk of head injury for a rider?

A. by reducing the rider's change in velocity

B. by transmitting the force away from the rider's head

C. by increasing the time over which force is exerted on the rider*

D. by reducing the amount of the rider's mass on which the force acts

Multi-Dimensional Alignment

The item requires the student to apply knowledge of **how the sum of the forces acting on an object change the object's motion** to demonstrate an understanding of **stability and change**.

Two-Part Dependent Item (Part A: Multiple-Choice Item, Part B: Multiple-Select Item)

Part A

In high-speed road races, the shape and weight of a bicycle helmet are important. Engineers want to change the design of a road-racing helmet to be more suitable for off-road mountain bike races, where speeds are much lower but crashes are more frequent. Which change should the engineers make to adapt the helmet?

A. Make the inner lining thinner.

B. Make the design more aerodynamic.

C. Make the chin strap easier to remove.

D. Make the hard plastic outer shell thicker.*

Part B

Which statements **best** support the answer to Part A?

Select **all** that apply.

A. More ventilation is needed at lower speeds.

B. Wind resistance is less important at lower speeds.*

C. Injuries are reduced if the chin strap unbuckles quickly.

D. An aerodynamic design is more important at lower speeds.

E. Spreading forces over a larger area reduces risk of skull fracture.*

Multi-Dimensional Alignment

While effectively applying the engineering practice of designing solutions by applying scientific principles to construct an object, the student demonstrates knowledge of:

- how, when two objects collide, the force exerted on each is the same but in opposite directions, and
- how a solution needs to be tested and evaluated to ensure it is valid.

Extended-Response Item

A bicycle helmet company designs new cycling helmets for a bicycle racing team. The company will test and modify the new helmet design using two criteria:

- **Criterion 1**: minimize head injury in the event of a crash (safety, most important)
- **Criterion 2**: have the least effect on a rider's maximum speed (speed, second-most important)

As you respond to Part A and Part B, follow the directions below.

- Address all of the instructions in each prompt.
- Use evidence from the information provided and your own knowledge of science to support your responses.

Part A

Describe how the company should test the new helmets to determine how the new helmets meet each criterion. In your description, answer four questions as they relate to **each** criterion:

1. Which part of the helmet design would you test (see Figure 1)?
2. How would you carry out the test?
3. What is the dependent variable in your test?
4. What forces are involved in the test?

Be sure to address **both** criteria when answering each question.

Part B

Explain how you would apply the results of the tests you described in Part A to modify the helmet design to better meet **each** criterion.

Multi-Dimensional Alignment

The item requires the student to apply the science and engineering practices of constructing explanations and designing solutions by applying scientific ideas to design and test an object and planning investigations by identifying the design, including variables, tools, measurements and knowledge of:

- how, when two objects collide, the force exerted on each is the same but in opposite directions;
- how a solution needs to be tested and evaluated to ensure it is valid; and
- how the sum of the forces acting on an object change the object's motion

to demonstrate an understanding of stability and change.

Score Points

An ER item may contain a single part or multiple parts. For multiple-part items: The student's score is the sum total of all the points earned across all parts (up to an item-maximum of 9 points) of the item. No response (blank) or a response that does not address the prompt earns 0 points.

Part A (8 points maximum)

1. 2 points: 1 point each for answer to part of the helmet design to test for each criterion
2. 2 points: 1 point each for answer to how to carry out the test for each design criterion
3. 2 points: 1 point each for identifying the independent variable for each criterion test
4. 2 points: 1 point each for describing the forces involved in each criterion test

Part B (1 point maximum)

- 1 point for explanation of change

Sample Response

Part A:

Test different thicknesses and materials for the shell and inner foam (minimizing head injuries) and test different helmet shapes in a wind tunnel (maximizing speed). Put the helmet on a test dummy and crash it into a wall at different speeds for each combination of thickness and material. Then, increase the speed until the helmet cracks (minimizing head injuries). Measure the amount of force needed to keep the helmet from moving in a high wind at a given wind speed. Repeat for each design, recording the force for each (maximizing speed). The dependent variables would be the highest speed at which the helmet does not fail (minimizing head injuries) and the force of air resistance (maximizing speed). The forces involved are the force that the helmet exerts on the wall and the force that the wall exerts on the helmet (minimizing head injuries), and the force that air exerts on the helmet and the force that the helmet exerts on the air (maximizing speed).

Accept any other plausible explanation of how the company should test the new helmets to meet each criterion identified. Also accept force of head on lining and force of lining on head.

Part B:

I would compare the helmet materials of the new design to those of other designs for the crash test and modify by adjusting the padding and outer plastic layer to ensure that they adequately protect the rider without being bulky. I would use the shape of the helmet that had the least air resistance, and/or enlarge holes in the plastic up until they become too large to adequately protect the rider.

RESOURCES

- K-12 Louisiana Student Standards for Science (2017): provides the performance expectations and three-dimensional learning for all grades
- Science Standards - Shifts In Science: supports teachers in understanding how the three-dimensional learning impacts instruction
    - Appendix A - Learning Progressions: describes the development of SEPs, DCIs, and CCCs as appropriate for grade spans across K-2, 3-5, middle school, and high school
    - Appendix B - Connections to ELA and Math K-12: details the connections between the Louisiana Student Standards for Science and the Louisiana Student Standards for Math and ELA
- Grade 6 Sample Scope and Sequence: includes sample units to assist educators in transitioning to the new science standards.
- Grade 6 Science Library: contains resources and supporting instructional material, including sample tasks
- Online Tools Training (OTT): provides students and teachers opportunities to become familiar with the tools available in the online testing platform; currently available in INSIGHT or here using the Chrome browser
- LEAP Accessibility and Accommodations Manual: provides information about Louisiana's accessibility features and accommodations for testing
- LEAP 2025 Technology Enhanced Item Types: provides a summary chart of technology enhanced items students may encounter in any of the computer-based tests across courses and grade-levels
- 2017-2018 Louisiana Assessment Calendar: includes information on testing windows for test administrations