

Engage with **STEM Gauge**®

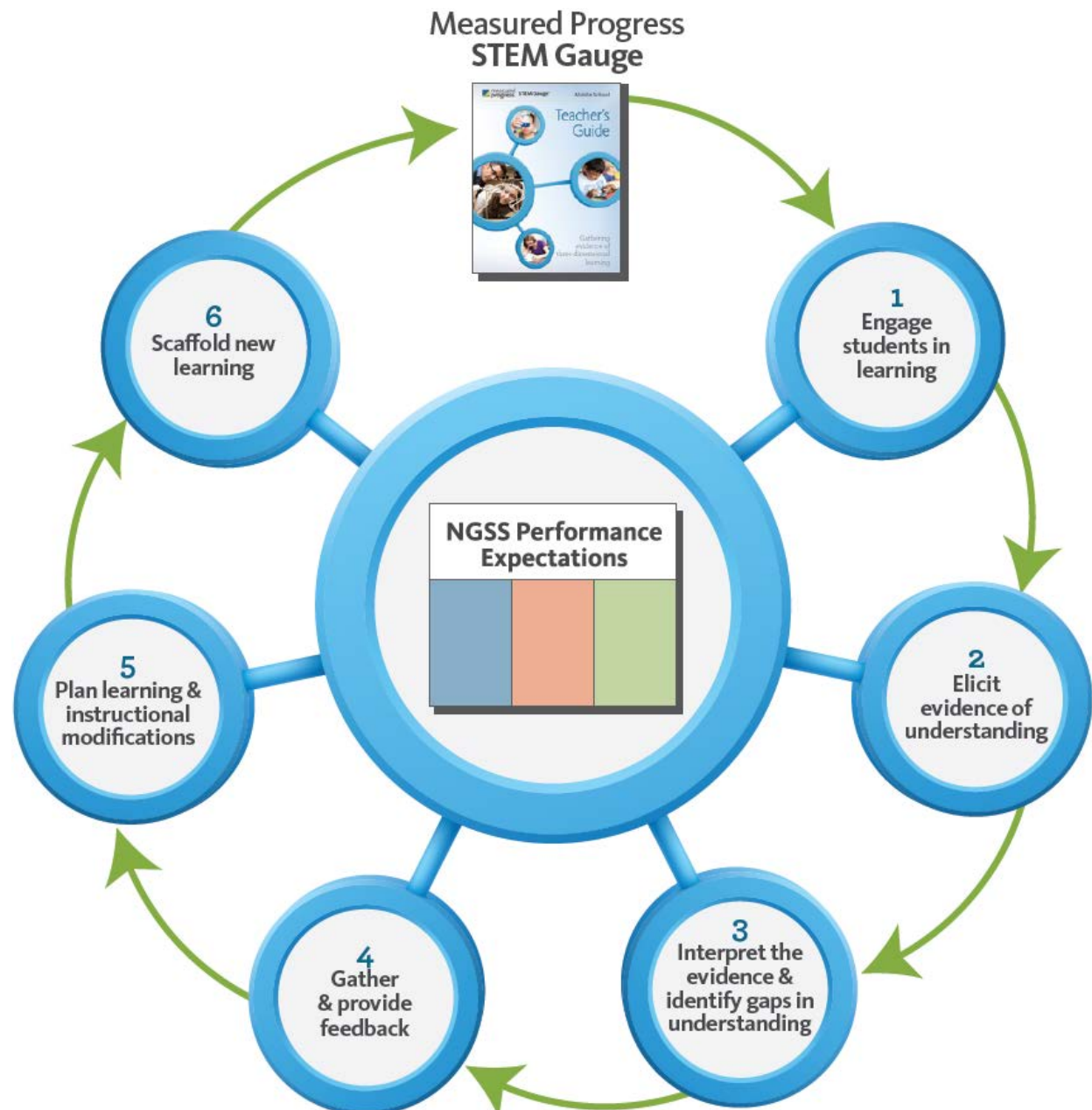
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Sample Items for Middle School

Multiple-Choice 1

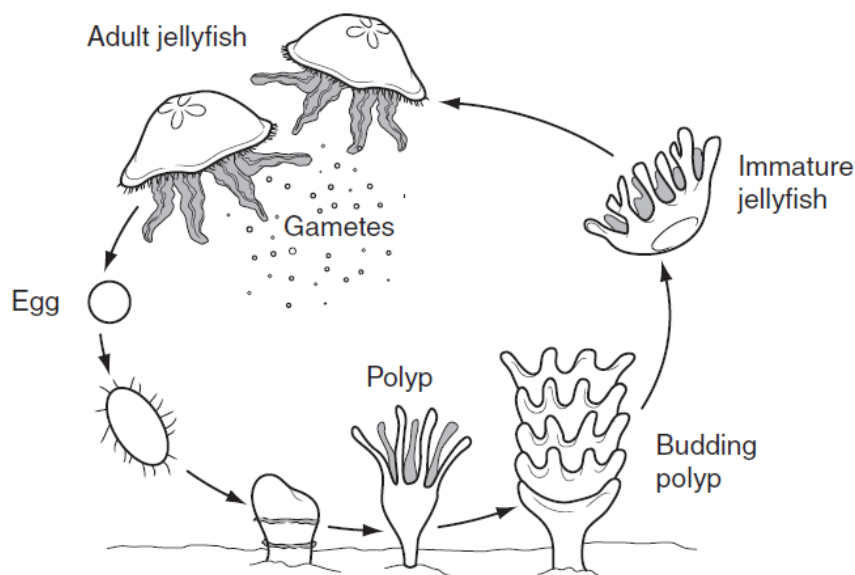
Diamonds form when carbon deep in Earth is affected by extreme temperatures and pressures. They form at depths greater than 150 kilometers. However, the mines where diamonds are found are less than 1 kilometer deep.

Rocks from one mine were examined for age. The diamonds found within certain rocks were 1.6 billion years old, but the rocks were only 100 million years old. Which statement uses evidence in the paragraph to explain why the diamonds were found within younger rocks?

- Ⓐ Magma from deep in Earth pushed the diamonds closer to the surface.
- Ⓑ Diamonds were pushed up closer to Earth's surface by a tectonic plate.
- Ⓒ Diamonds take longer to form than the other rocks, so the diamonds are older.
- Ⓓ Erosion of Earth's crust wore away the original rocks surrounding the diamonds.

Constructed-Response

Jellyfish reproduce both sexually and asexually. During their life cycle, jellyfish alternate generations; one generation reproduces sexually and the next generation reproduces asexually. The diagram is a model of the life cycle of a jellyfish.



Sexual reproduction takes place in the water between male and female gametes. Asexual reproduction takes place when a polyp produces a bud that forms into an immature jellyfish.

Use the model to describe the results of both sexual and asexual reproduction in jellyfish.

Extended-Response 1

This table contains data on deforestation of rainforests in the state of Rondonia, Brazil.

**Deforestation in
Rondonia, Brazil**





Year	Deforested Area (sq km)
1978	4,200
1988	30,000
1998	53,000
2003	67,764

Using your understanding of the water cycle, draw a model and describe how the water cycle in Rondonia would be affected by the changes indicated by the data in the table.

Multiple-Choice 2

Jaleesa draws a model of a chemical reaction between two substances. She uses a black circle to represent one kind of atom and a white circle to represent another kind of atom.

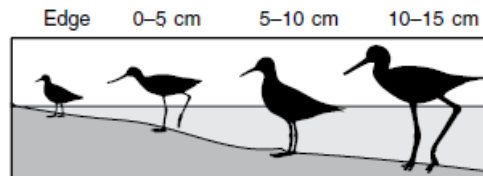
Which model shows that a chemical reaction takes place and that mass is conserved?

- (A) 
- (B) 
- (C) 
- (D) 

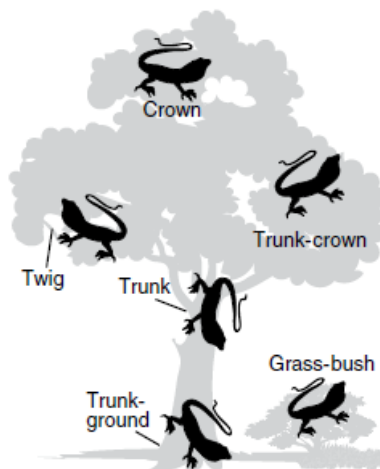
Extended-Response 2

Read the information about a phenomenon that is similar in two different ecosystems.

Along a midwestern lake shoreline in the United States, flocks of migratory shorebirds pause in their long journeys for much-needed food. The illustration shows the depths of water where four different shorebird species find similar food along the same shoreline. As the birds feed together, each species feeds in a more narrow range of water depth than if each species was alone.



Different lizard species on a tropical island all feed on similar types of insects. Careful observations of these lizards reveal that each species prefers to hunt for food at different heights within the ecosystem. The illustration compares the locations of where each lizard species prefers to hunt.



- Identify the type of interaction among the similar species in each ecosystem. Provide evidence to support your answer.
- Describe the phenomenon that is observed in both ecosystems.
- Use the described phenomenon to make a prediction about similar species' interactions in other ecosystems.

Distractor Rationales and Rubrics

Multiple-Choice 1

PERFORMANCE EXPECTATION: MS-ESS3-1: Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.

Distractor Rationales

- A. Key. This option correctly addresses both the age and location evidence. Rocks formed by molten magma will be younger in age than the diamonds carried within the magma. Rising magma is the only force that will move materials from that deep within the crust closer to the surface.
- B. Plate tectonic forces act on the scale of landmasses and continents. Plate tectonic forces do not act on the scale of individual mineral deposits. Also, this option does not address the age evidence.
- C. This option attempts to address the age evidence but does not address the location evidence.
- D. This would suggest that the diamonds are found at the depth where they form, but it is known they are found at shallower depths.

Constructed-Response

Constructed-Response Rubric

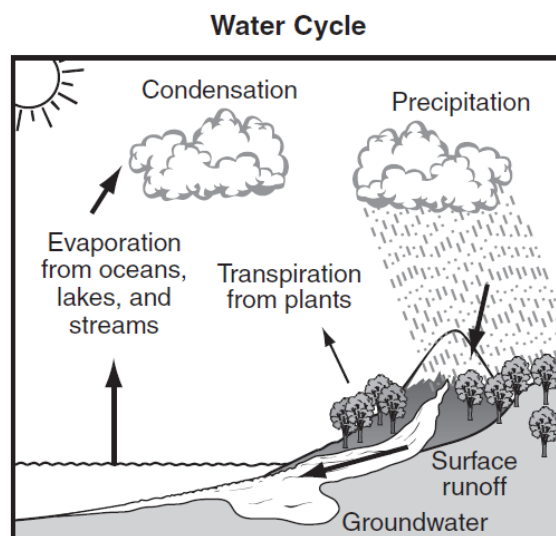
PE: MS-LS3-2: Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.		
	Level of Understanding	Evidence of Understanding
2	Demonstrating Expected Understanding	Student response provides clear evidence of using the dimensions* to make sense of scientific phenomena and/or to design solutions to problems. Student is able to: <ul style="list-style-type: none"> ▪ use the model to describe the results of both asexual and sexual reproduction in jellyfish.
1	Progressing toward Understanding	Student response provides partial evidence of using the dimensions* to make sense of scientific phenomena and/or to design solutions to problems. The response lacks some critical information and details or contains some errors. Student is able to: <ul style="list-style-type: none"> ▪ use the model to describe the results of both asexual and sexual reproduction in jellyfish BUT the description is incomplete or contains incorrect information; OR ▪ describe the results of both asexual and sexual reproduction BUT the description does not use the model or describe jellyfish reproduction.
0	Not Showing Understanding	Student does not respond or student response is inaccurate, irrelevant, or contains insufficient evidence of using the dimensions* to make sense of scientific phenomena and/or to design solutions to problems.
*As outlined in the Performance Expectations (PE) of the NGSS, the three dimensions are the disciplinary core ideas (DCI), science and engineering practices (SEP), and crosscutting concepts (CCC). Note that due to the complexity of the PEs, individual assessment items may not address all three dimensions.		

Scoring Notes:

Possible answers include:

- Sexual reproduction: As shown in the model of the jellyfish life cycle, sexual reproduction happens when mature male and female jellyfish release gametes into the water, which then combine to form an egg. The egg settles to the bottom of the ocean and develops into a polyp. Since the polyp is a result of sexual reproduction, each new polyp is a combination of the two parents, and therefore not genetically identical to either parent.
- Asexual reproduction: The part of the model of the jellyfish life cycle where a polyp buds to form immature jellyfish shows asexual reproduction. In this case, there is only one parent, the polyp, and therefore all offspring (immature jellyfish) that form in this way would have the same genetic information as the parent polyp.

Extended-Response 1



Extended-Response Rubric

PE: MS-ESS2-4 Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.

	Level of Understanding	Evidence of Understanding
3	Demonstrating Expected Understanding	<p>Student response provides clear evidence of using the dimensions* to make sense of scientific phenomena and/or to design solutions to problems. Student is able to:</p> <ul style="list-style-type: none"> draw a model that is an accurate representation of the water cycle; <p>AND</p> <ul style="list-style-type: none"> describe how the water cycle in Rondonia would be affected by the changes indicated by the data in the table.
2	Progressing toward Understanding	<p>Student response provides partial evidence of using the dimensions* to make sense of scientific phenomena and/or to design solutions to problems. The response lacks some critical information and details or contains some errors. Student is able to:</p> <ul style="list-style-type: none"> draw a model that is an accurate representation of the water cycle BUT cannot describe how the water cycle in Rondonia would be affected by the changes indicated by the data in the table <p>OR</p> <ul style="list-style-type: none"> describe how the water cycle in Rondonia would be affected by the changes indicated by the data in the table BUT cannot draw a model that is an accurate representation of the water cycle.
1	Beginning to Develop Understanding	<p>Student response is incomplete or provides minimal evidence of using the dimensions* to make sense of scientific phenomena and/or to design solutions to problems.</p>
0	Not Showing Understanding	<p>Student does not respond or student response is inaccurate, irrelevant, or contains insufficient evidence of using the dimensions* to make sense of scientific phenomena and/or to design solutions to problems.</p>

**As outlined in the Performance Expectations (PE) of the NGSS, the three dimensions are the disciplinary core ideas (DCI), science and engineering practices (SEP), and crosscutting concepts (CCC). Note that due to the complexity of the PEs, individual assessment items may not address all three dimensions.*

Scoring Notes:

Possible answers include:

The water cycle would be affected because there are fewer plants. Fewer plants means less transpiration; so, less water is in the air. Less water in the air means less condensation, which results in less precipitation. This means less water falls on the soil and fewer plants can grow.

Multiple-Choice 2

PERFORMANCE EXPECTATION: MS-PS1-5: Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.

Distractor Rationales

- A. Key. The model shows that a chemical reaction takes place because a new substance is formed. The model also shows conservation of matter, because the same number of each kind of atom are shown before and after the reaction.
- B. The model shows the same number of atoms shown before and after the reaction, but the same number of each kind of atom is necessary to represent conservation of matter.
- C. The same molecules before and after the reaction represents the conservation of matter during a chemical reaction, but the model does not represent a chemical reaction because a new substance is not formed.
- D. The model shows the same number of atoms shown before and after the reaction, but the same number of each kind of atom is necessary to represent conservation of matter.

Extended-Response 2

Extended-Response Rubric

PE: MS-LS2-2: Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.		
	Level of Understanding	Evidence of Understanding
3	Demonstrating Expected Understanding	<p>Student response provides clear evidence of using the dimensions* to make sense of scientific phenomena and/or to design solutions to problems. Student is able to:</p> <ul style="list-style-type: none"> identify the type of interaction among the similar species in each ecosystem and provide evidence to support the answer; <p>AND</p> <ul style="list-style-type: none"> describe the phenomenon observed in both ecosystems; <p>AND</p> <ul style="list-style-type: none"> make a prediction about similar species' interactions in other ecosystems by using the described phenomenon.
2	Progressing toward Understanding	<p>Student response provides partial evidence of using the dimensions* to make sense of scientific phenomena and/or to design solutions to problems. The response lacks some critical information and details or contains some errors. Student is able to:</p> <ul style="list-style-type: none"> identify the type of interaction among the similar species in each ecosystem AND provide evidence to support the answer AND describe the phenomenon observed in both ecosystems BUT the prediction about similar species' interactions in other ecosystems by using the described phenomenon contains errors or is not provided; <p>OR</p> <ul style="list-style-type: none"> make a prediction about similar species' interactions in other ecosystems by using the described phenomenon BUT the identification of the type of interaction among the similar species in each ecosystem, the evidence to support the answer, OR the description of the phenomenon observed in both ecosystems contains errors or is not provided.
1	Beginning to Develop Understanding	Student response is incomplete or provides minimal evidence of using the dimensions* to make sense of scientific phenomena and/or to design solutions to problems.
0	Not Showing Understanding	Student does not respond or student response is inaccurate, irrelevant, or contains insufficient evidence of using the dimensions* to make sense of scientific phenomena and/or to design solutions to problems.

*As outlined in the Performance Expectations (PE) of the NGSS, the three dimensions are the disciplinary core ideas (DCI), science and engineering practices (SEP), and crosscutting concepts (CCC). Note that due to the complexity of the PEs, individual assessment items may not address all three dimensions.

Scoring Notes:

Possible answers include:

- a. In both examples, the type of interaction among similar species is competitive. Evidence includes:
 - The migratory shorebirds are all feeding on similar food in the same place at the same time. They are competing for food.
 - The lizard species all feed on similar insects at the same time. They are competing for food.
- b. The migratory shorebirds divide up the shoreline so that each one can feed in a part of the food resource they share. The lizard species do the same thing; they each take a part of the tree or bush instead of all trying to feed in the same exact location.
- c. Similar species competing for a limited resource will each use a more narrow part of the resource to reduce competition among species.

Sample Items for Elementary School

Multiple-Choice 3

PERFORMANCE EXPECTATION: 5-PS2-1: Support an argument that the gravitational force exerted by Earth on objects is directed down.

Vanessa makes a scientifically correct claim about gravity affecting all objects on Earth. She wants evidence to support her claim.

Vanessa uses the Internet to communicate with students around the world. She asks these students to use a basketball to investigate a question.

Which question will **most likely** provide the strongest evidence to support Vanessa's claim?

- (A) How far does a basketball roll along the ground after being kicked?
- (B) How high does a basketball bounce after being thrown onto the ground?
- (C) What happens when you let some air out of a basketball and then bounce it?
- (D) What happens when you hold a basketball above the ground and then release it?

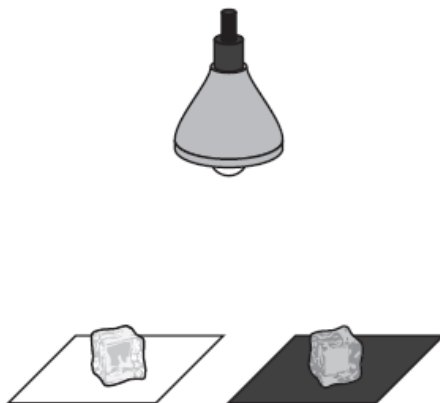
Distractor Rationales

- A. The distance the basketball rolls depends on the force of the kick, not the gravitational force of Earth on the basketball.
- B. The height the basketball bounces depends on the force used to throw it onto the ground. Although gravity pulls the ball downward all the time, this question is not the best way to provide evidence to support Vanessa's claim because it introduces other variables.
- C. Letting air out of the basketball will mostly affect its bounce. Although gravity pulls the ball downward all the time, this question is not the best way to provide evidence to support Vanessa's claim because it introduces other variables.
- D. Key. Holding the basketball above the ground and then releasing it will show the effect of the gravitational force of Earth on the basketball when the basketball falls to the ground.

Multiple-Choice 4

PERFORMANCE EXPECTATION: 4-PS3-2: Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents

Malik is investigating the transfer of energy. He hangs a lamp above two ice cubes, as shown.



One ice cube is on white paper and the other ice cube is on black paper. Malik can turn the light on and off.

What observation could Malik make that provides the **best** evidence of the transfer of energy from the light?

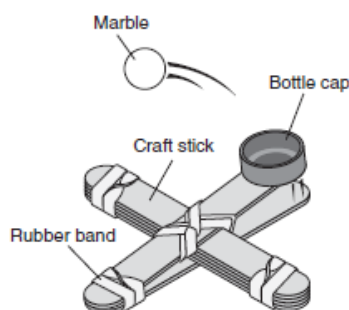
- (A) Both ice cubes melt when the light is on.
- (B) Only the ice cube on the black paper melts.
- (C) Both ice cubes melt faster when the light is on than when the light is off.
- (D) The ice cube on the black paper melts slower than the ice cube on the white paper.

Distractor Rationales

- A. Both ice cubes will melt because light transfers energy from the lamp directly to both ice cubes. However, this is not the best evidence because of other factors such as energy from the air. Heat could be transferred from warm air surrounding both ice cubes.
- B. Although black paper absorbs light energy, and some of the heat energy from the black paper will be absorbed by the ice cube, the best evidence to support energy transfer from the light is the melting of both ice cubes regardless of the color of the paper underneath them.
- C. **Key.** Both ice cubes will melt because light transfers energy from the lamp directly to both ice cubes. The only difference between the light being on and off is the energy from the light. The ice cubes will not melt as fast when the light is off.
- D. Although black paper absorbs light energy, and some of the heat energy from the black paper will be absorbed by the ice cube, the best evidence to support energy transfer from the light is the melting of both ice cubes regardless of the color of the paper underneath them. Each ice cube receives light energy directly from the lamp, which changes to heat energy and causes the ice cubes to melt. Also, the ice cube on the black paper should melt faster, not slower, than the ice cube on the white paper.

Constructed-Response 2

George builds a catapult using craft sticks, rubber bands, and a bottle cap. He glues the cap to the end of one craft stick. George puts a marble in the cap, pushes the cap down until it touches the table, and releases it. The marble flies through the air, as shown.



George observes the marble fly through the air and then fall to the ground. He wonders why the marble falls to the ground.

- Make a claim about why the marble falls to the ground.
- Support your claim with another observation that George could make using the marble.

Constructed-Response Rubric

PE: 5-PS2-1: Support an argument that the gravitational force exerted by Earth on objects is directed down.		
	Level of Understanding	Evidence of Understanding
2	Demonstrating Expected Understanding	Student response provides clear evidence of using the dimensions* to make sense of scientific phenomena and/or to design solutions to problems. Student is able to: <ul style="list-style-type: none"> make a claim about why the marble falls to the ground; AND <ul style="list-style-type: none"> support your claim with another observation that George could make using the marble.
1	Progressing toward Understanding	Student response provides partial evidence of using the dimensions* to make sense of scientific phenomena and/or to design solutions to problems. The response lacks some critical information and details or contains some errors. Student is able to: <ul style="list-style-type: none"> make a claim about why the marble falls to the ground BUT support of the claim with another observation that George could make using the marble contains errors or is not provided.
0	Not Showing Understanding	Student does not respond or student response is inaccurate, irrelevant, or contains insufficient evidence of using the dimensions* to make sense of scientific phenomena and/or to design solutions to problems.
*As outlined in the Performance Expectations (PE) of the NGSS, the three dimensions are the disciplinary core ideas (DCI), science and engineering practices (SEP), and crosscutting concepts (CCC). Note that due to the complexity of the PEs, individual assessment items may not address all three dimensions.		

Scoring Notes

Possible answers include:

- The marble falls to the ground because Earth's gravitational force is pulling the marble down (or pulling the marble toward Earth's center).
- [Another observation that George could make using the marble may include one of the following:]
 - George could throw the marble and observe it fall to the ground.
 - George could drop the marble and observe it fall to the ground.
 - George could let go of the marble at the top of a ramp (slope) and observe it move down toward the ground.

A team of students designs and builds a balloon-powered car, as shown.



a. Describe the change in form of energy that takes place when the student lets go of the straw. Explain your thinking.

- 11

Extended-Response Rubric

PE: 4-PS3-4: Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.

	Level of Understanding	Evidence of Understanding
3	Demonstrating Expected Understanding	Student response provides clear evidence of using the dimensions* to make sense of scientific phenomena and/or to design solutions to problems. Student is able to: <ul style="list-style-type: none"> describe the change in form of energy that takes place when the student lets go of the straw and explain their thinking; AND <ul style="list-style-type: none"> describe one way the team could increase the distance that the car travels and explain their thinking.
2	Progressing toward Understanding	Student response provides partial evidence of using the dimensions* to make sense of scientific phenomena and/or to design solutions to problems. The response lacks some critical information and details or contains some errors. Student is able to: <ul style="list-style-type: none"> describe the change in form of energy that takes place when the student lets go of the straw and explain their thinking AND describe one way the team could increase the distance that the car travels BUT the explanation of their thinking in part (b) contains errors or is not provided; OR <ul style="list-style-type: none"> describe the change in form of energy that takes place when the student lets go of the straw AND describe one way the team could increase the distance that the car travels and explain their thinking BUT the explanation of their thinking in part (a) contains errors or is not provided.
1	Beginning to Develop Understanding	Student response is incomplete or provides minimal evidence of using the dimensions* to make sense of scientific phenomena and/or to design solutions to problems.
0	Not Showing Understanding	Student does not respond or student response is inaccurate, irrelevant, or contains insufficient evidence of using the dimensions* to make sense of scientific phenomena and/or to design solutions to problems.

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Scoring Notes

Possible answers include:

- The form of energy changes from stored energy [compressed air] to energy of motion. The air in the balloon is stored energy, which causes the car to move when the student lets go of the straw.
- [A description and explanation may include one of the following:]
 - Add more air to the balloon—This increases the amount of stored energy in the balloon. More stored energy will cause the car to move farther when fully released.
 - Make sure the wheels spin smoothly OR reduce the weight of the car OR test the car on a smoother surface—This decreases the amount of energy lost [to friction] or transferred to heat, which will cause the car to move farther.

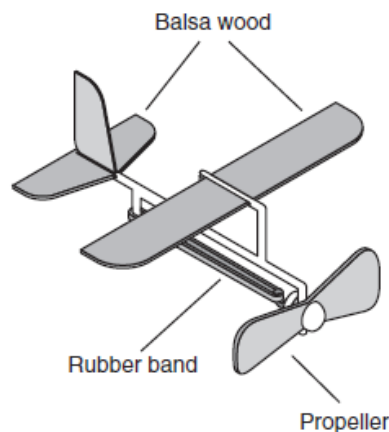
[Note: Students may respond to part (b) with answers that relate to other PEs and/or to force.]

Extended-Response 4

A team of students designed and built an airplane to meet the following criteria (goals):

- fly for at least 60 seconds
- change stored energy into motion energy

The airplane is made of balsa wood (a light wood), a plastic propeller, and a rubber band, as shown.



To test the airplane, the team turns the propeller 10 times to twist the rubber band before releasing the airplane. When the rubber band untwists, the propeller spins and the airplane flies. The team records the number of seconds that the airplane flies. The team does four trials of the same test. The results are shown in the table.

**Results of Four
Airplane Trials**

Trial	Time Flying (seconds)
1	60
2	65
3	62
4	61

- Explain whether the airplane meets the design criteria (goals). Explain your thinking.
- Describe one way the team could change the design to make the airplane fly longer. Explain your thinking.

Extended-Response Rubric

PE: 4-PS3-4: Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.		
	Level of Understanding	Evidence of Understanding
3	Demonstrating Expected Understanding	Student response provides clear evidence of using the dimensions* to make sense of scientific phenomena and/or to design solutions to problems. Student is able to: <ul style="list-style-type: none"> explain that the airplane meets the design criteria (goals) and explain their thinking; AND describe one way the team could change the design to make the airplane fly longer and explain their thinking.
2	Progressing toward Understanding	Student response provides partial evidence of using the dimensions* to make sense of scientific phenomena and/or to design solutions to problems. The response lacks some critical information and details or contains some errors. Student is able to: <ul style="list-style-type: none"> explain that the airplane meets the design criteria (goals) and explain their thinking AND describe one way the team could change the design to make the airplane fly faster BUT the explanation of their thinking contains errors or is not provided.
1	Beginning to Develop Understanding	Student response is incomplete or provides minimal evidence of using the dimensions* to make sense of scientific phenomena and/or to design solutions to problems.
0	Not Showing Understanding	Student does not respond or student response is inaccurate, irrelevant, or contains insufficient evidence of using the dimensions* to make sense of scientific phenomena and/or to design solutions to problems.
*As outlined in the Performance Expectations (PE) of the NGSS, the three dimensions are the disciplinary core ideas (DCI), science and engineering practices (SEP), and crosscutting concepts (CCC). Note that due to the complexity of the PEs, individual assessment items may not address all three dimensions.		

Scoring Notes

Possible answers include:

a. Yes, the airplane meets the design criteria because:

- The results of the four tests show that the airplane can fly for at least 60 seconds.
- The airplane changes stored energy in the twisted rubber band into motion energy when it flies.

b. The team could twist the rubber band more times. Twisting the rubber band more times would store more energy. The energy for spinning the propeller comes from the energy stored in the twisted rubber band. The spinning propeller causes the airplane to fly. More energy will make the airplane fly longer (farther).

[Note: Students may describe other design changes such as making the plane lighter, changing the wing design/shape, or changing the propeller. For the same amount of stored energy, these design changes can make the airplane fly longer because the airplane uses less energy to fly (uses the energy more efficiently).]

Formative Assessment Tools

Frayer Model

Directions:

1. In the oval in the middle, write the topic you will be learning about.
2. Write what you already know about the topic in the white part of each box.
3. At the end of the lesson, review your response, and revise it based on what you've learned. Write your new responses in the shaded areas.

Definition	Essential Characteristics
Examples	Nonexamples

Pass the Question Protocol

Directions:

1. In the box below, write your own response to the question you have been given.

2. Share your response with a partner and then combine your responses into one response.
3. As partners, trade your response with another partner group.
4. Read and discuss your responses with each partner. What is similar to and different from your response?
5. Rejoin your first partner and share your findings.

Three-Fact Fold Chart

List three ideas or facts that you remember from today's lesson and fold your paper to cover your responses. Exchange your list with a partner. Without looking at each other's ideas, you and your partner record your own three facts in the "Partner Share" section. Trade back your charts, and together discuss the ideas or facts you had in common. Record the commonalities in the space at the bottom of your own chart.

Student Name:
1.
2.
3.

Fold back at this line

Partner Share:
1.
2.
3.

What Facts or Ideas Did You Have in Common?
1.
2.
3.

Student Self-Assessment

Learning Targets Write in the Learning Targets you focused on in this topic.	Gauge Your Understanding Can you do what is described in the Learning Target ? Draw a pointer on the gauge to show where you think you are.	Reflect I'm still wondering about...
		
		
		
		
		
		

Student Self-Reflection

Directions:

1. In each space in the center column, write in one of the Disciplinary Core Ideas (DCIs) that you focused on in this topic.
2. Reflect on the ways that the Science and Engineering Practices and the Crosscutting Concepts connect to each of the DCIs in the middle column.
3. Draw lines to show the connections you made across the three dimensions.

Connecting the 3 Dimensions

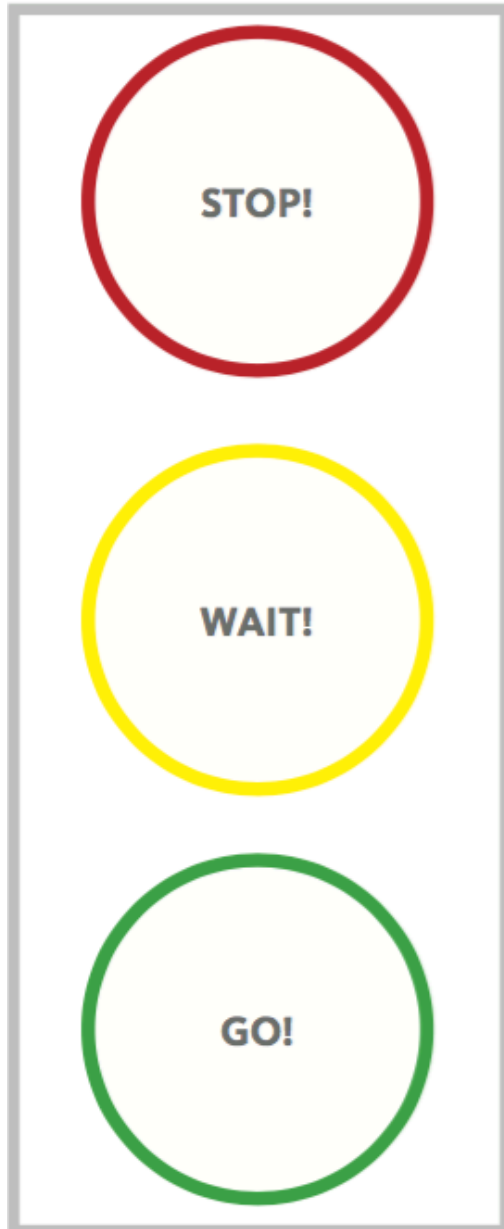
Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking questions (for science) and defining problems (for engineering)		Patterns
Developing and using models		Cause and effect
Planning and carrying out investigations		Scale, proportion, and quantity
Analyzing and interpreting data		Systems and system models
Using mathematics and computational thinking		Energy and matter
Constructing explanations (for science) and designing solutions (for engineering)		Structure and function
Engaging in argument from evidence		Stability and change
Obtaining, evaluating, and communicating information		

Stoplight Self-Assessment

Name: _____

PE Code: _____

Student Learning Target: _____



STOP!

WAIT!

GO!

I am just beginning this.

I am working toward learning this but still wondering...

I can do this! I'm ready to go on!!

Name:

3 2 1	Things I learned today:
	Things I found interesting or surprised me:
	Question I still have:

Name:

3 2 1	Things I learned today:
	Things I found interesting or surprised me:
	Question I still have:

Name:

3 2 1	Things I learned today:
	Things I found interesting or surprised me:
	Question I still have: