

ASPECT

Assessing Students' Progress on the Energy Concept

Beetles in a National Park: AP18-7 (CR) & AP52-4 (MC)

Elementary school – Energy and Chemical Reactions

TASK OVERVIEW

Students are presented with a scenario in which park rangers have discovered a new species of beetle that has entered a national park. Students are tasked with figuring out how the beetles could affect the flow of matter and energy in the national park ecosystem. Students first create a flow chart showing how the plants and animals in the ecosystem get matter and energy. Students are then asked to predict how the flow of matter and energy to different organisms in the ecosystem will be affected if the trees in the park are destroyed by the new beetle species. After examining how the organisms will be affected if the trees die, students are told new trees will be planted in the ecosystem and asked to identify what park rangers should do to make sure the new trees have the matter and energy they need to grow.

TARGETED DCIs, SEPs, AND CCCs

Disciplinary core ideas

- PS3.D-5.1: The energy released [from] food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water).
- LS1.C-5.1: Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion.
- LS1.C-5.2: Plants acquire their material for growth chiefly from air and water.
- LS2.A-5.1: The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem

Science & engineering practices

- SEP2-E.4: Develop and/or use models to describe and/or predict phenomena.

Crosscutting concepts

- CCC4-E.2: A system can be described in terms of its components and their interactions.
- CCC5-E.3: Energy can be transferred in various ways and between objects.

Related Performance Expectations

- 5-PS3-1. Use models to describe that energy in animals' food (used for body repair, growth, and motion and to maintain body warmth) was once energy from the sun. [*Clarification Statement:* Examples of models could include diagrams, and flow charts.]
- 5-LS2-1. Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment. [*Clarification Statement:* Emphasis is on the idea that matter that is not food (air, water, decomposed

materials in soil) is changed by plants into matter that is food. Examples of systems could include organisms, ecosystems, and the Earth.] [*Assessment Boundary*. Assessment does not include molecular explanations.]

TASK PERFORMANCE EXPECTATION

Create a model that describes how matter and energy flows in an ecosystem consisting of plants and animals. *Use the model to predict* how the matter and energy flow will change in response to the introduction of a new organism into the ecosystem.

LINK TO ONLINE VERSION

http://

Link to online version of the task: <http://assess.bscs.org/i/test/599>

Task

Park rangers in the Shenandoah National Park have found a new kind of beetle in the park called the Emerald Ash Borer.



Photograph of an Emerald Ash Borer (from USDA)

The beetles make holes in the bark of the trees in the park. This can kill the trees. The park rangers wonder if the beetles will also affect the rabbits and bobcats in the park.



*Photographs of a rabbit and bobcat
(from HarveyHenkelmann on Wikimedia Commons and C Watts on Flickr)*

The park rangers observe what the rabbits and bobcats typically eat. They find that

- Rabbits eat sticks and bark from the ash trees.
- Bobcats eat rabbits.

1. Using the park rangers' findings and what you know about plants and animals, create a flow chart that shows where the trees, rabbits, and bobcats get the matter and energy they need to live. Arrows should point from the source of the matter or energy to the organism getting the matter or energy.

Your flow chart can include:



It should also include:

- Black Arrows to represent how matter flows in the ecosystem.
- Red Arrows to represent how energy flows in the ecosystem.

[Students created diagram]

Using your flow chart, answer the following questions. (Assume that no new plants or animals enter the ecosystem and none of the animals in the ecosystem eats the beetles.)

-----Constructed-response Version of #2-----

2. What will happen to the rabbits' sources of matter and energy if the ash trees continue to die because of the beetles? Explain why. (Remember that we are assuming that no new plants or animals enter the ecosystem.)

-----Multiple-choice Version of #2-----

2. What will happen to the rabbits' sources of matter and energy if the ash trees continue to die because of the beetles? (Remember that we are assuming that no new plants or animals enter the ecosystem.)
 - A. The trees' dying will not affect the rabbits' sources of matter and energy.
 - B. The trees' dying will decrease the rabbits' sources of matter but will not affect the rabbits' sources of energy.
 - C. The trees' dying will decrease the rabbits' sources of energy but will not affect the rabbits' sources of matter.
 - D. The trees' dying will decrease both the rabbits' sources of matter and their sources of energy.

-----Constructed-response Version of #3-----

3. What will happen to the bobcats' sources of matter and energy if the ash trees continue to die because of the beetles? Explain why. (Remember that we are assuming that no new plants or animals enter the ecosystem.)

-----Multiple-choice Version of #3-----

3. What will happen to the bobcat's sources of matter and energy if the ash trees continue to die because of the beetles? (Remember that we are assuming that no new plants or animals enter the ecosystem.)
 - A. The trees' dying will not affect the bobcats' sources of matter and energy.
 - B. The trees' dying will decrease the bobcats' sources of matter but will not affect the bobcat's sources of energy.
 - C. The trees' dying will decrease the bobcats' sources of energy but will not affect the bobcats' sources of energy.
 - D. The trees' dying will decrease both the bobcats' sources of matter and their sources of energy.

4. The park rangers think the beetles will make it more difficult for the bobcats to survive in the ecosystem. Do you agree or disagree with the park rangers?
- A. Yes, I agree that the beetles will make it more difficult for the bobcats to survive.
 - B. No, I disagree. I do not think that the beetles will make it more difficult for the bobcats to survive.
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5. Why do you agree or disagree with the park rangers? Be sure to write about where the bobcat gets matter and energy.
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6. The park rangers' plant young ash trees to replace the trees that died. They want to make sure that these young trees have the matter and energy needed to grow. What should the park rangers do to make sure the young trees have the matter and energy necessary to grow? Choose all that apply.
- A. They should water the young trees because water is a source of matter for the trees.
 - B. They should make sure the young trees have plenty of air because air is a source of matter for the trees.
 - C. They should make sure the young trees have plenty of soil because the nutrients in the soil are a source of energy for the trees.
 - D. They should make sure the young trees have plenty of sunlight because sunlight is a source of energy for the trees.
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Alignment to Targeted DCIs, SEPs, and CCCs and Scoring Rubrics

QUESTION 1

Using what you know about plants and animals, create a flow chart that shows where the trees, rabbits, and bobcats all get the matter and energy they need to live. Arrows should point from the source of the matter or energy to the organism getting the matter or energy.

Your flow chart can include:



It should also include:

- Black Arrows to represent how matter flows in the ecosystem.
- Red Arrows to represent how energy flows in the ecosystem.

LEARNING GOAL

Learning Performance

- Create a model in the form of a flow chart showing matter and energy transfers in an ecosystem.

Targeted DCIs, SEP, and CCC

- LS2.A-5.1: The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem
- PS3.D-5.1: The energy released [from] food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water).
- LS1.C-5.1: Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion.
- LS1.C-5.2: Plants acquire their material for growth chiefly from air and water.
- SEP2-E.4: Develop and/or use models to describe and/or predict phenomena.

- CCC4-E.2: A system can be described in terms of its components and their interactions.
- CCC5-E.3: Energy can be transferred in various ways and between objects.

SCORING RUBRIC


Ideal Response

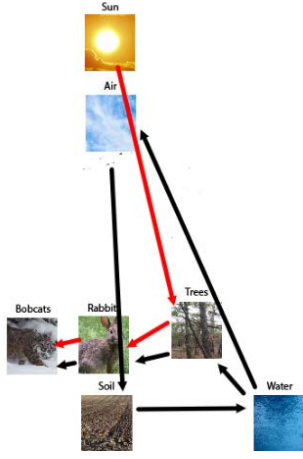
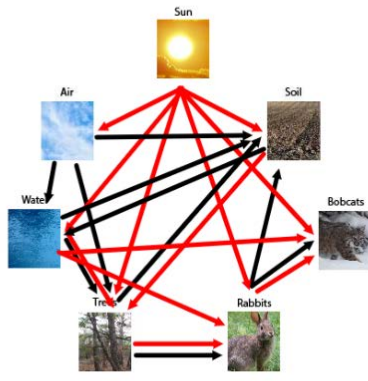
The student should draw a flow chart that include matter arrows from air and water to trees, an energy arrow from the sun to trees, matter and energy arrows from trees to rabbits, and matter and energy arrows from rabbits to bobcats.

Elements of a Correct Response

Categories	Elements
Student model includes the flow of matter (<u>black arrows</u>)	<ul style="list-style-type: none"> • Black arrows from water to trees <ul style="list-style-type: none"> ◦ <u>Note</u>: Also acceptable is a black arrow from water to soil plus a black arrow from soil to trees indicating that the trees take in water from the soil. • Black arrows from air to trees • Black arrows from trees to rabbits • Black arrows from rabbits to bobcats
Student model includes the flow of energy (<u>red arrows</u>)	<ul style="list-style-type: none"> • Red arrows from sun to trees, • Red arrows from trees to rabbit • Red arrows from rabbit to bobcat
<u>Note</u> : If elements are clustered next to an arrow, it can be assumed that the arrow is coming from all the elements.	

Sample Student Responses

Student response	Scoring description
	<p>Score = 0</p> <p>The response does not include the correct arrows.</p>

	<p>Score = 1</p> <p>The response includes the correct energy arrows but does not include the correct matter arrows. It is missing the arrow from the air to the trees.</p>
	<p>Score = 2</p> <p>The response includes the correct matter and energy arrows. The additional arrows beyond the ones listed in the rubric did not affect the scoring.</p>

QUESTION 2

What will happen to the rabbits' sources of matter and energy if the ash trees continue to die because of the beetles? Explain why. (Remember that we are assuming that no new plants or animals enter the ecosystem.)

LEARNING GOAL

Learning Performance

- Use a model to predict what will happen to the transfer of matter and energy to the rabbit if ash trees continue to die.

Targeted DCIs, SEP, and CCC

- LS1.C-5.1: Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion.
- SEP2-E.4: Develop and/or use models to describe and/or predict phenomena.

SCORING RUBRIC

Ideal Response

The rabbits' source of matter and energy will decrease/disappear if the ash trees continue to die because the trees are food for rabbits and food is an organism's source of matter and energy.

Elements of a Correct Response

Categories	Elements
Student makes a claim about the matter and energy.	<ul style="list-style-type: none"> • The rabbits will have less matter if the trees die. • The rabbits will have less energy if the trees die. <p><u>Note:</u> Also acceptable for both of these points is “the rabbits’ sources will decrease” or “They will decrease” implying that both matter and energy sources decrease.</p>
Student supports their prediction using the model and/or evidence	<ul style="list-style-type: none"> • Trees are food, or sources of matter and/or energy, for rabbits.
OR	
Student selects the correct multiple-choice answer	D. The trees’ dying will decrease both the rabbit’s sources of matter and energy.

Sample Student Responses

Student response	Scoring description
“they will die because they need food to survive.”	Score = 0 The response does not make a claim about the changes in the

	rabbits' sources of matter and energy or make explicit the relationship between trees and rabbits.
"The rabbits would die because it eats the bark of the trees and if they continue to die then they have no food"	Score = 1 The response does not make a claim about the changes in the rabbits' sources of matter and energy but does include the correct relationship between trees and rabbits.
"If ash trees die off, then the rabbit's source of matter and energy ceases to exist. This is because the trees are the sources of matter and energy for the rabbit."	Score = 2 The response includes all the elements of the rubric.

QUESTION 3

What will happen to the bobcats' sources of matter and energy if the ash trees continue to die because of the beetles? Explain why. (Remember that we are assuming that no new plants or animals enter the ecosystem.)

LEARNING GOAL

Learning Performance

- Use a model to predict what will happen to the transfer of matter and energy to the bobcat if ash trees continue to die.

Targeted DCIs, SEP, and CCC

- LS1.C-5.1: Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion.
- SEP2-E.4: Develop and/or use models to describe and/or predict phenomena.

SCORING RUBRIC

Ideal Response

The bobcats's source of matter and energy will decrease (disappear, deminish) if the ash trees continue to die because the trees are food for rabbits and rabbits are food for bobcats. If the rabbits don't have food, they will die. If the rabbits die, bobcat's won't have any food.

Elements of a Correct Response

Categories	Elements
Student makes a claim about the matter and energy	<ul style="list-style-type: none"> The bobcats will have less matter if the trees die. The bobcats will have less energy if the trees die. <p><u>Note:</u> Also acceptable for both of these points is "the bobcats' sources will decrease" or "They will decrease" implying that both matter and energy sources decrease.</p>
Student supports their prediction using the model and/or evidence	<ul style="list-style-type: none"> Trees are food, or sources of matter and/or energy, for rabbits. Rabbits are food, or sources of matter and/or energy, for bobcats. <p><u>Note:</u> Implying that trees are food for rabbits and rabbits are food/ sources of matter and energy for bobcats is acceptable.</p>
Student either states or uses a general science idea	<ul style="list-style-type: none"> Organisms can only survive in environments in which their particular needs are met (i.e., if the rabbits' food source is reduced, they will die, leave the ecosystem, or won't be able to survive). [<i>links needs and survival</i>] <p><u>Note:</u> It is acceptable to write that the rabbits will leave the ecosystem and that's why there is less matter and energy sources for the bobcats.</p>
Student supports their prediction with reasoning	<ul style="list-style-type: none"> The dying ash trees will reduce the matter and energy sources for the rabbits, which means some rabbits will die and there will be less matter and energy for bobcats.
OR	

Student selects the correct multiple-choice answer	D. The trees' dying will decrease both the bobcat's sources of matter and energy.
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Sample Student Responses

Student response	Scoring description
"I think that they will be fine and that they can survive well."	Score = 0 The response does not answer the question about what happens to the bobcats' sources of matter and energy.
"first the rabbits will die then the bobcats will die because there is no food"	Score = 1 The response includes the science idea linking needs and survival, but it does not make a claim or include evidence.
"The bobcats' sources of matter and energy if the ash trees continue to die will decrease as their chemical energy is from eating the rabbits."	Score = 2 The response includes the correct claim and cites evidence but does not use reasoning with science ideas.
"Since the bobcats eat the rabbits, they won't be able to get enough matter or energy either. They were able to have energy transferred to them through the consumption of the rabbits, but since the rabbits won't get enough energy from the trees, the bobcats won't get enough from the rabbits. The same goes for the matter of the rabbits."	Score = 3 The response includes a claim, evidence, and reasoning but does not state or use the science idea linking needs and survival.
"Because the ash tree is the rabbit's source and matter and if it stops that means the rabbit species and population deplete meaning because the bobcat's main source	Score = 4 The response includes all the elements in the rubric.

and the matter is the rabbit it goes down then further meaning that the bobcat's population will also start to deplete as the trees and rabbits deplete."	
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QUESTIONS 4 & 5

The park rangers think the beetles will make it more difficult for the bobcats to survive in the ecosystem. Do you agree or disagree with the park rangers?

- A. Yes, I think that the beetles will make it more difficult for the bobcats to survive.
- B. No, I do not think that the beetles will make it more difficult for the bobcats to survive.

Why do you agree or disagree with the park rangers? Be sure to write about where the bobcat gets matter and energy.

LEARNING GOAL

Learning Performance

- Explain whether the presence of the beetles will make it difficult for bobcats to survive in the ecosystem.

Targeted DCIs, SEP, and CCC

- LS2.A-5.1: The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem.
- SEP2-E.4: Develop and/or use models to describe and/or predict phenomena.

SCORING RUBRIC

Ideal Response

I agree that the beetles will make it more difficult for the bobcats to survive because they will decrease the amount of matter and energy the bobcats can get. The beetles will eat and damage the trees, which are food for the rabbits. This will cause the rabbits to have less food and therefore they won't have enough matter and energy. Rabbits will likely die resulting in less food for the bobcats, and therefore the bobcats won't have enough matter and energy and will likely die too.

Elements of a Correct Response

Categories	Elements
Student selects the correct claim.	A. Yes, I think that the beetles will make it more difficult for the bobcats to survive. <u>Note:</u> If the student neglects to select a claim but writes a correct claim in their response, they should get this point.
Student supports their prediction using the model and/or evidence	<ul style="list-style-type: none">• The model or written answer shows that the bobcats' food supply is affected by the beetle. Examples of this include listing what each animal in the ecosystem eats to demonstrate that bobcats are linked to trees or citing their flow chart model showing how bobcats are linked to trees in the food web<ul style="list-style-type: none">○ Bobcats eat rabbits, and rabbits eat trees.○ The animals that the bobcats eat eat trees.○ The model shows that bobcats can trace their food source back to trees. <u>Note:</u> Implying these relationships is acceptable and students do not have to list all.
Student either states or uses a science idea	<ul style="list-style-type: none">• Newly introduced species (or, more generally, changes in the ecosystem) can damage the balance of an ecosystem (i.e., the beetles are not normally present in the ecosystem, so introducing them will affect all the animals in the park or the ecosystem has a fragile balance and the beetles will set off a chain reaction

	<p>damaging the balance of the ecosystem). [<i>links new species and ecosystem changes</i>]</p> <ul style="list-style-type: none"> Organisms can only survive in environments in which their particular needs are met (i.e., if the rabbits' or bobcats' food/matter and energy sources are reduced, they may not survive). [<i>links needs and survival</i>] <u>Note</u>: Students do not have to explicitly list the specific needs that are not being met (i.e., specific food sources).
Student supports their claim using reasoning	<ul style="list-style-type: none"> The food for bobcats can be traced back to trees, so when the beetles kill the trees bobcats will end up having less food and, therefore, will have difficulty surviving. <p><u>Note</u>: Students may indicate that the bobcats' food can be traced back to the trees by listing the connections in the food chain/web that link the bobcats and trees, noting that they are connected through the food web/chain, or making a statement that indicates the bobcats' food source is linked to the trees that are damaged by the beetles.</p>

Sample Student Responses

Student response	Scoring description
Student selects B and writes "Becuase bobcats are animals that can survive through tough situations.."	Score = 0 The student disagrees with the correct claim.
Student selects A and writes "i agree because beetle not only destroy but take over"	Score = 1 The response includes the correct claim but does not provide an explanation that includes where the bobcats get their matter and energy.
Student selects A and writes	Score = 2 The response includes the correct claim and uses the science idea

<p>"Beetles are ruining the food source for these animals so if they can't eat then their population will suffer"</p>	<p>that organisms can only survive if their needs are met.</p>
<p>Student selects A and writes "I agree with this because bobcats eat rabbits and if the rabbits are gone because of the tree it will be more difficult for bobcats to survive."</p>	<p>Score = 3 The response includes a claim, evidence, and reasoning but does not state or use the science idea.</p>
<p>Student selects A and writes "I agree because the beetles are eating the tree ash and rabbits need that to eat and they will get hungry and die and then the bobcats will have nothing to eat so they will die of hunger to."</p>	<p>Score = 4 The response includes all the elements in the rubric.</p>

QUESTION 6

The park rangers' plant young ash trees to replace the trees that died. They want to make sure that these young trees have the matter and energy needed to grow. What should the park rangers do to make sure the young trees have the matter and energy necessary to grow? Choose all that apply.

- A. They should water the young trees because water is a source of matter for the trees.
- B. They should make sure the young trees have plenty of air because air is a source of matter for the trees.
- C. They should make sure the young trees have plenty of soil because the nutrients in the soil are a source of energy for the trees.
- D. They should make sure the young trees have plenty of sunlight because sunlight is a source of energy for the trees.

LEARNING GOAL

Learning Performance

- Identify what park rangers should provide young trees so they are able to grow.

Targeted DCIs, SEP, and CCC

- PS3.D-5.1: The energy released [from] food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water).
- LS1.C-5.2: Plants acquire their material for growth chiefly from air and water.
- CCC5-E.3: Energy can be transferred in various ways and between objects.

SCORING RUBRIC

Ideal Response

Student chooses answer choices A, B, and D and does not chose answer choice C.

Elements of a Correct Response

Categories	Elements
Student selects the correct multiple-choice answers	<p>A. They should water the young trees because water is a source of matter for the trees.</p> <p>B. They should make sure the young trees have plenty of air because air is a source of matter for the trees.</p> <p>D. They should make sure the young trees have plenty of sunlight because sunlight is a source of energy for the trees.</p> <p><u>Note:</u> Students receive one point for the correct answers they select and loses one point for selecting C.</p>

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