ASPECT

Assessing Students' Progress on the Energy Concept

Solar Car: AP40-6 (CR) and AP63-2 (MC)

Elementary School – Thermal Energy

TASK OVERVIEW

Students view a video of a person playing with a solar car. They are asked to make observations and record those observations in a data table. Students use their observations from the video and additional data about the current that is flowing through the wires in the car as evidence for the idea that energy can be transferred via light and electric currents. The task culminates with students creating a model of how energy is transferred from the sun to the solar panel on the car by light and then to the motor by an electric current.

TARGETED DCIs, SEPs, AND CCCs

Disciplinary core ideas

- PS3.A-4.2: Energy can be moved from place to place by moving objects or through sounds, light, or electric currents.
- PS3.B-4.1: Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced.
- PS3.B-4.2: Light also transfers energy from place to place.

Science & engineering practices

- SEP3-E.3 Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.
- SEP6-E.2: Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or design a solution to a problem.
- SEP2-E.4 Develop and/or use models to describe and/or predict phenomena.

Crosscutting concepts

- CC5-E.3: Energy can be transferred in various ways and between objects.
- CC4-E.2 A system can be described in terms of its components and their interactions.

Related Performance Expectations

- 4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents. [*Assessment Boundary*: Assessment does not include quantitative measurements of energy.]

TASK PERFORMANCE EXPECTATION

Make observations and use those observations as evidence for explaining that the energy can be transferred by light and electric current. *Develop a model* of a solar car system *that describes* how energy is transferred from the sun to a solar car's motor by light and electric current.

LINK TO ONLINE VERSION

https://assess.bscs.org/i/test/577

Task

A class is studying how light from the sun can be used to power machines. They construct a toy car with a solar panel on the top of it.

Watch the video to see what happened to the car when light was allowed to shine on the car and when light was not allowed to shine on the car.

http://assess.bscs.org/items/media/uploads/image/ASPECt_3D/Videos/Solar_Car.mp4

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1. Write your observations in the table below. You should describe what happens when light shines on the car and when light was blocked and does not shine on the car.

Observations when light from the sun shines on the car	Observations when light from the sun does not shine on the car

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2. The teacher asks the students to make sense of their observations by thinking about how energy is moved from place to place. What evidence is there from the video that energy was transferred from the sun to the car? Why does this evidence support the idea that energy was transferred from the sun to the car?

Next, the class takes a closer look at the car's parts. They see that the car has a solar panel and wires that connect the solar panel to an electric motor. The electric motor is attached to the back wheels.

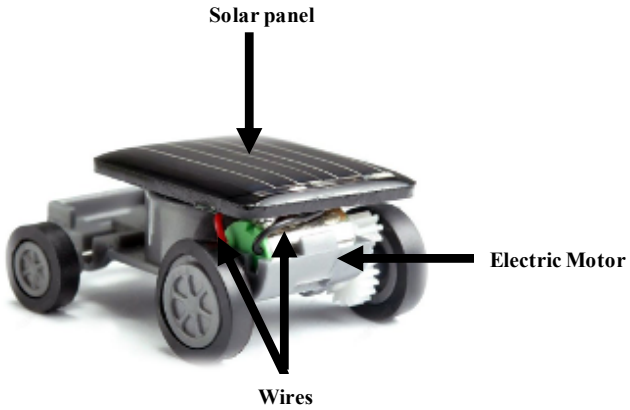


Image of an of toy car with a solar panel (DesignBoom)

The students attach a device that measures electric current to the wires. (Electric current is measured in milliamps.) They measure how much current flows in the wires when light was allowed to shine on the solar panel and when light was not allowed to shine on the solar panel. Below is a table summarizing their measurements.

	Light from the sun shines on the solar panel	Light from the sun does not shine on the solar panel
Current in the wires	10 milliamps	0 milliamps

3. Again, the teacher asks the students to make sense of these observations by thinking about how energy is moved from place to place. What evidence is there from the table that energy was transferred from the sun to the car? Why does this evidence support the idea that energy was transferred from the sun to the car?

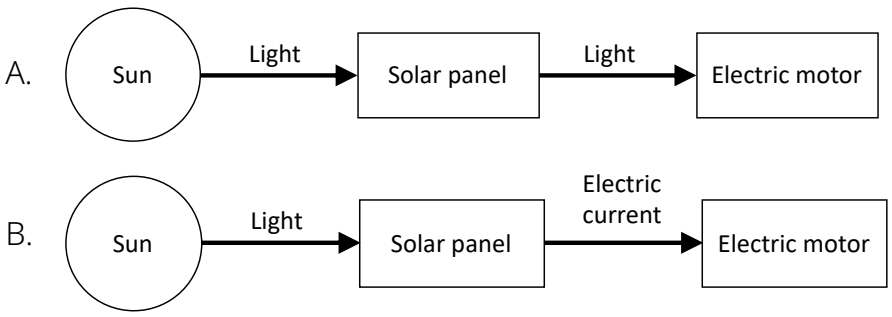
----------Constructed-response version of #4----------

4. Use the drawing tools below to create a model that shows how energy was transferred between the sun, solar panel, and electric motor when light was allowed to shine on the car. Your model should include all of the following:
    1. The shapes in the drawing toolbox labeled Electric Motor, Solar Panel, and Sun
    2. Arrows to show the flow of energy
    3. Labels on the arrows to show how energy moved between the electric motor, solar panel, and sun

----------Multiple-choice version of #4----------

4. Which of the following models best represents how energy moved between the sun, solar panel, and electric motor when light was allowed to shine on the car?

    Arrows in the models show the direction of energy transfer and the labels on the arrows show how energy moved between the electric motor, solar panel, and sun.



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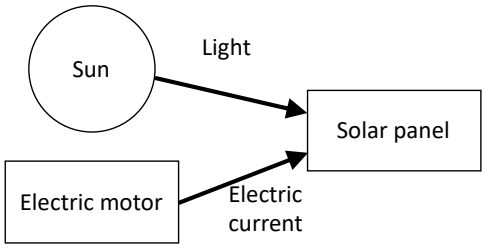

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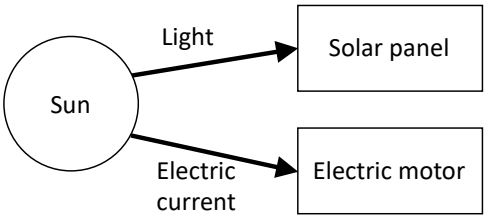

Alignment to Targeted DCIs, SEPs, and CCCs and Scoring Rubrics

QUESTION 1

Write your observations in the table below. You should describe what happens when light shines on the car and when light was blocked and does not shine on the car.

Observations when light from the sun shines on the car	Observations when light from the sun does not shine on the car

LEARNING GOAL

Learning Performance

- Make and record observations about the motion of a solar car when light is and isn't shining on the solar car.

Targeted SEP

- SEP3-E.3 Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.

SCORING RUBRIC

Ideal Response

Observations when light from the sun shines on the car	Observations when light from the sun does not shine on the car
The car started moving.	The car slowed down and eventually stopped.

Elements of a Correct Response

Categories	Elements
Student makes observations from the video	• For "Observations when light from the sun shines on the car," the student indicates that the car started moving or implies the car started moving (i.e., the car was able to drive). • For "Observations when light was blocked and could not shine on the car," the student indicates that the car slowed down and/or stopped.

Sample Student Responses

Observations when light from the sun shines on the car	Observations when light from the sun does not shine on the car	Scoring description
"The car uses the energy"	"The energy stops"	Score = 0 These are not observations.
"When the sun shines on the car the energy from the sun is transfers from the sun to the car"	"When the sun does not shine on the car the car does not get any energy so it does not move"	Score = 1 The first statement is an explanation instead an observation. The second statement was awarded a

		point for the observation that the car does not move.
"The car starts to move quickly"	"The car comes to a slow stop."	Score = 2 These statements describe correct observations for both cells.

QUESTION 2

The teacher asks the students to make sense of their observations by thinking about how energy is moved from place to place. What evidence is there from the video that energy was transferred from the sun to the car? Why does this evidence support the idea that energy was transferred from the sun to the car?

LEARNING GOAL

Learning Performance

- Cite evidence from a video and explain how the evidence supports the idea that energy is transferred from the sun by light.

Targeted DCI and SEP

- PS3.B-4.1: Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced.
- SEP6-E.2: Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or design a solution to a problem.

SCORING RUBRIC

Ideal Response

When light from the sun shined on the solar panel, the car started to move, which means that energy was transferred to the car because things that move have energy.

When the light was blocked, the car slowed down, which means the transfer of energy stopped.

Elements of a Correct Response

Categories	Elements
Student cites evidence	• When light from the sun shined on the car it moves. • When light was blocked and not allowed to shine the car slowed down. Note: If the student writes that the car *only* moves when light shines on it, they receive credit for both cases.
Student states or uses a general science idea	• Energy is present whenever there are moving objects (i.e., the car has more energy when it is moving than when it stops). [*links speed and energy*]
Student uses reasoning to link evidence and general science idea	• The car moves when the light shines on it, which means it has more energy. This energy came from the sun.

Sample Student Responses

Student response	Scoring description
"the energy frome the light was transfered to the energy in the car"	Score = 0 This response does not cite evidence.
"The car started moving when sun touched it but when they covered the car in shade again it slowed"	Score = 1 This response includes evidence but does not include any science ideas or reasoning.
"when sunlight shines on the car, the car moves, which is kinetic energy."	Score = 2 This response uses evidence from the video and includes the science idea that speed and energy are related, but it does not describe how this evidence supports the idea that energy is transferred from the sun to the car.

"The only thing that changed to make the car move was the sun shining on it. So, the energy from the sun must be what caused the car to move."	Score = 3 This response includes evidence, science ideas, and reasoning.

QUESTION 3

Again, the teacher asks the students to make sense of these observations by thinking about how energy is moved from place to place. What evidence is there from the table that energy was transferred from the sun to the car? Why does this evidence support the idea that energy was transferred from the sun to the car?

LEARNING GOAL

Learning Performance

- Cite evidence from a table and explain how the evidence supports the idea that energy was transferred from the sun to the car.

Targeted DCI and SEP

- PS3.A-4.1: Energy can be moved from place to place by moving objects or through sounds, light, or electric currents.
- SEP6-E.2: Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or design a solution to a problem.

SCORING RUBRIC

Ideal Response

The table shows that there is a current in the wires when the light shines on the car, which means that energy is being transferred through the wires. There is no current when the light is blocked, which means that no energy is being transferred through the wires. This means the energy being transferred through the wires when the sun shines on the car came from the sun.

Elements of a Correct Response

Categories	Elements
Student cites evidence	• A current was detected when light shined on the car. • A current was not detected when the light was blocked. Note: If the student writes that a current flows only when light shines on the car, they receive both points.
Student states or uses a general science idea	• Energy can be moved from place to place through electric currents (i.e., the current in the wire is transferring energy from the solar panel to the engine). [*links electric current and energy transfer*]
Student uses reasoning to link evidence and general science idea	• The current is detected when the light shines on the car, which means energy is being transferred from the solar panel to the motor/wheels to make the car move. This energy came from the sun.

Sample Student Responses

Student response	Scoring description
"The car only moves when the light is shining on it."	Score = 0 This response does not cite evidence from the table.
"The current is only present when the sun is shining."	Score = 1 This response includes evidence but not how this evidence supports the idea that energy is transferred from the sun to the car.
"The solar panel consumes energy and converts it to electricity, then it goes through the wires, which brings that energy to the electric motor, causing the car to move."	Score = 2 This response uses reasoning with science ideas but does not cite evidence from the table.

"The amount of milliamps increased greatly when there was light shining on the car. This is supporting evidence because more milliamps signifies energy being transferred from somewhere to the car, and the only variable was the sunlight."	Score = 3 This response includes evidence, science ideas, and reasoning.

QUESTION 4

Use the drawing tools below to create a model that shows how energy was transferred between the sun, solar panel, and electric motor when light was allowed to shine on the car. Your model should include all of the following:

1. The shapes in the drawing toolbox labeled Electric Motor, Solar Panel, and Sun
2. Arrows to show the flow of energy
3. Labels on the arrows to show how energy moved between the electric motor, solar panel, and sun

LEARNING GOAL

Learning Performance

- Develop a model that shows how energy was transferred between the sun, solar panel, and electric motor by light and electric currents.

Targeted DCIs, SEP, and CCCs

- PS3.B-4.1: Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced.
- PS3.A-4.1: Energy can be moved from place to place by moving objects or through sounds, light, or electric currents.
- PS3.B-4.2: Light also transfers energy from place to place.
- SEP2-E.4 Develop and/or use models to describe and/or predict phenomena.
- CC5-E.3: Energy can be transferred in various ways and between objects.

- CC4-E.2 A system can be described in terms of its components and their interactions

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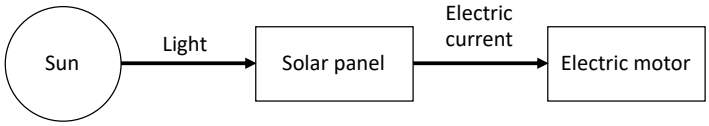
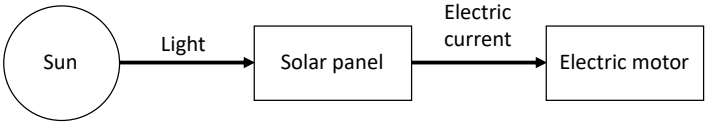
SCORING RUBRIC

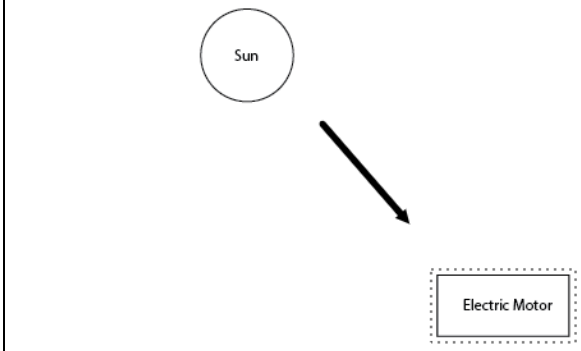
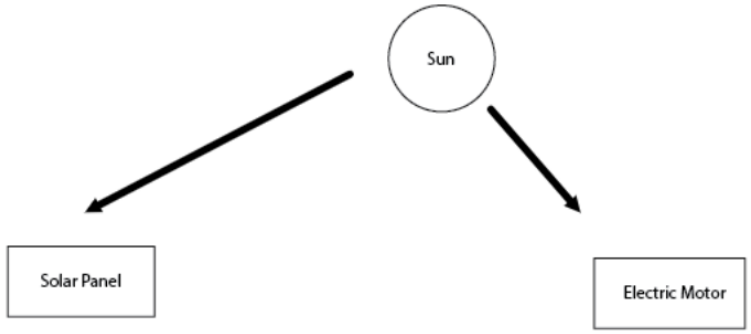
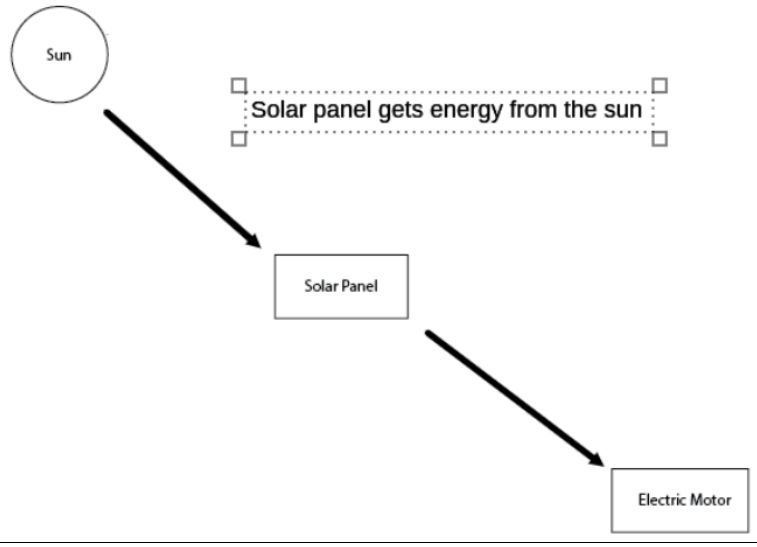
Ideal Response

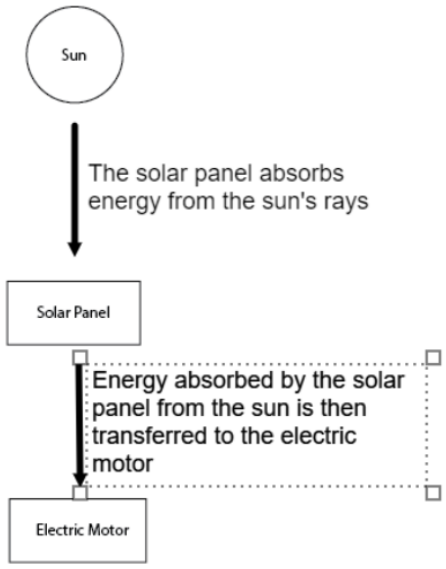


Elements of a Correct Response

Categories	Elements
Student includes the all the correct components	• Sun • Solar panel • Motor
Student includes all the correct interactions	• Arrow from sun to solar panel • Arrow from solar panel to motor
Student labels the arrows using a general science idea	• Energy can be moved from place to place by light (i.e., label on arrow between sun and solar panel says "light"). [links light and energy transfer] • Energy can be moved from place to place through electric currents (i.e., label on arrow between solar panel and motor says "current"). [links electric current and energy transfer] <u>Note</u>: The labels must use the words "light" and "current" to get a point. Simply writing "the sun transfers energy to the car" is not sufficient because it doesn't include the transfer mechanism.
OR	
Student selects the correct multiple-choice answer	B. 

Sample Student Responses

Student response	Scoring description
	Score = 0 This response does not include all the components and interactions.
	Score = 1 This response includes the components but does not include the correct interactions or science ideas about energy transfer.
	Score = 2 This response includes the components and interactions but does not include the ideas that light and electric currents transfer energy.



Score = 3

This response includes the components and interactions and uses science ideas to describe how energy is transferred between the components.

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