

- G7. A car manufacturer carries out a series of tests on a new model. Two cars, P and Q, of equal mass, moving at the same speed, are on a collision course as shown in Figure 1. A third car, R, of the same mass as the others and moving at the same speed, is on a collision course with an immovable wall of very high mass, as shown in Figure 2. In both cases the cars come to rest after collision.



Figure 1



Figure 2

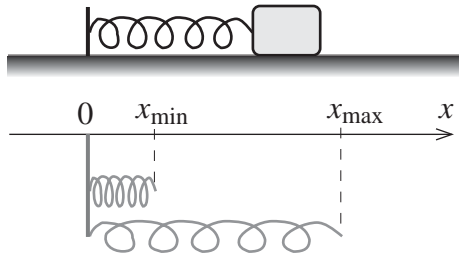
The amount of kinetic energy transformed into energy of deformation and heat in the case of car P is

- A. greater than that of car R.
- B. equal to that of car R.
- C. less than that of car R.
- D. not possible to answer because of insufficient information.

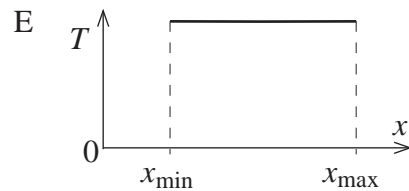
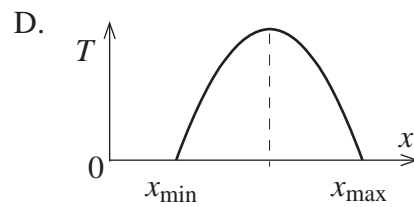
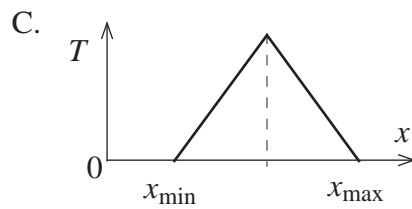
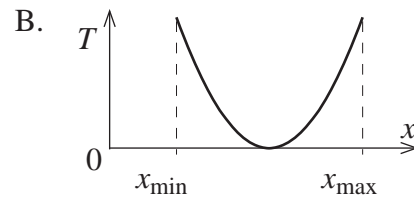
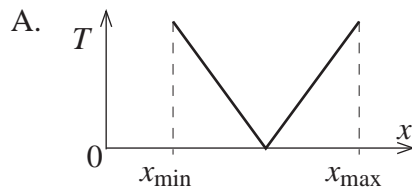
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Subject	Item Key	Content Category	Performance Expectation	International Average Percent of Students Responding Correctly	International Difficulty Index
Physics	B	Mechanics	Theorizing, Analyzing, and Solving Problems	30%	719

- G8. A block oscillates with negligible friction on the end of a spring as shown in the figure below. The minimum and maximum lengths of the spring as it oscillates are, respectively,  $x_{\min}$  and  $x_{\max}$ .



Which one of the following graphs represents the total mechanical energy ( $T$ ) of the block and spring system as a function of  $x$ ?



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Subject	Item Key	Content Category	Performance Expectation	International Average Percent of Students Responding Correctly	International Difficulty Index
Physics	E	Mechanics	Using Tools, Routine Procedures, and Science Processes	36%	676

I16. A metal spoon, a wooden spoon, and a plastic spoon are placed in hot water. After 15 seconds, which spoon will feel hottest?

- A. The metal spoon
- B. The wooden spoon
- C. The plastic spoon
- D. The three spoons will feel the same.

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Subject	Item Key	Content Category	Performance Expectation	International Average Percent of Students Responding Correctly		International Difficulty Index
				Upper Grade	Lower Grade	
Science	A	Physics	Understanding Simple Information	83%	80%	341

- L4. Machine A and Machine B are each used to clear a field. The table shows how large an area each cleared in 1 hour and how much gasoline each used.

	Area of field cleared in 1 hour	Gasoline used in 1 hour
Machine A	2 hectares	$\frac{3}{4}$ liter
Machine B	1 hectare	$\frac{1}{2}$ liter

L-4

Which machine is more efficient in converting the energy in gasoline to work?  
Explain your answer.

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Subject	Item Key	Content Category	Performance Expectation	International Average Percent of Students Responding Correctly		International Difficulty Index
				Upper Grade	Lower Grade	
Science	next page	Physics	Theorizing, Analyzing, and Solving Problems	36%	29%	688

P4. What happens when an animal hibernates?

- A. There is no life in any of its parts.
- B. It stops breathing.
- C. Its temperature is higher than when it is active.
- D. It is absorbing energy for use when it is active.
- E. It is using less energy than when it is active.

P-4

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Subject	Item Key	Content Category	Performance Expectation	International Average Percent of Students Responding Correctly		International Difficulty Index
				Upper Grade	Lower Grade	
Science	E	Life Science	Understanding Complex Information	56%	51%	559

Q13. A tight metal lid on a jar of pickles may loosen when it has been held in hot water. This is because the hot water causes the

- A. glass jar to contract
- B. metal lid to contract
- C. glass jar to expand more than the metal lid expands
- D. metal lid to expand more than the glass jar expands

Q-13

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Subject	Item Key	Content Category	Performance Expectation	International Average Percent of Students Responding Correctly		International Difficulty Index
				Upper Grade	Lower Grade	
Science	D	Physics	Understanding Simple Information	59%	52%	528

Y1. Electrical energy is used to power a lamp.

Is the amount of light energy produced more than, less than, or the same as the amount of electrical energy used?

The amount of light energy produced is

\_\_\_\_\_ more than

\_\_\_\_\_ less than

(check one)

\_\_\_\_\_ the same as  
the amount of electrical energy used.

Give a reason to support your answer.

Y-1

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Subject	Item Key	Content Category	Performance Expectation	International Average Percent of Students Responding Correctly		International Difficulty Index
				Upper Grade	Lower Grade	
Science	next page	Physics	Theorizing, Analyzing, and Solving Problems	8%	4%	963

## Y-1 Coding Guide

Y1. Electrical energy is used to power a lamp.

Is the amount of light energy produced more than, less than, or the same as the amount of electrical energy used?

The amount of light energy produced is

\_\_\_ more than

\_\_\_ less than

(check one)

\_\_\_ the same as  
the amount of electrical energy used.

Give a reason to support your answer.

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Code	Response
<b>Correct Response</b>	
<b>10</b>	Less. Mentions that (much) energy is transformed to heat.
<b>11</b>	Less. Mentions that energy is needed to warm up the lamp.
<b>12</b>	Less. Mentions that energy (heat) is lost to the surroundings.
<b>19</b>	Less. Other correct.
<b>Incorrect Response</b>	
<b>70</b>	The same. With erroneous explanation. <i>Examples: Energy is always preserved.</i> <i>When the sun is out you don't need electrical energy.</i>
<b>71</b>	The same. No explanation is given.
<b>72</b>	More. With or without explanation.
<b>73</b>	Less. No explanation.
<b>74</b>	Less. Energy is lost in transport. <i>Example: Electricity is lost in the wire</i>
<b>75</b>	Less. Other erroneous explanations.
<b>79</b>	Other incorrect.
<b>Nonresponse</b>	
<b>90</b>	Crossed out/erased, illegible, or impossible to interpret.
<b>99</b>	BLANK

Energy released from car engine						B02
Content Category	Performance Expectation	Item Key	Score Points	International Average Percentage of 8th Grade Students Responding Correctly	Used in 1995	
Physics	Understanding Simple Information	B	1	58	Y	

Most of the chemical energy released when gasoline burns in a car engine is not used to move the car, but is changed into

A. electricity

B. heat

C. magnetism

D. sound

Sequence of energy changes					D04
Content Category	Performance Expectation	Item Key	Score Points	International Average Percentage of 8th Grade Students Responding Correctly	Used in 1995
Physics	Understanding Complex Information	C	1	59	Y

Chemical Energy
→
Heat Energy
→
Mechanical Energy  
(with wasted heat)

The sequence of energy changes shown in the diagram explains which event?

A. A flashlight is on.

B. A candle burns.

C. Gasoline burns to power a car.

D. Electric current runs a refrigerator.

Energy stored in food					H05
Content Category	Performance Expectation	Item Key	Score Points	International Average Percentage of 8th Grade Students Responding Correctly	Used in 1995
Physics	Understanding Simple Information	B	1	24	Y

People get energy from the food they eat. Where does the energy stored in food come from?

A. Fertilizers

B. The Sun

C. Vitamins

D. The soil

Efficiency of machines					L04
Content Category	Performance Expectation	Item Key	Score Points	International Average Percentage of 8th Grade Students Responding Correctly	Used in 1995
Physics	Theorizing, Analyzing and Solving Problems	Rubric	1	31	N

Machine A and Machine B are each used to pump water from a river. The table shows what volume of water each machine removed in one hour and how much gasoline each of them used.

	Volume of Water Removed in 1 Hour (liters)	Gasoline Used in 1 Hour (liters)
Machine A	1000	1.25
Machine B	500	0.5

a) Which machine is more efficient in converting the energy in gasoline to work?  
 Answer: \_\_\_\_\_

b) Explain your answer.

**Note:** A correct response must identify **B** and include an explanation based on the concept of energy efficiency (ratio of energy output to energy input) that compares the volume of water pumped for an equivalent volume of gasoline used for the two machines. Responses based **ONLY** on comparing the amount of gasoline used **OR** the amount of water pumped by the machines without considering the ratio of water/gasoline are scored as incorrect (Codes 70 and 72). No credit is lost for missing/incorrect units or for minor computational errors, provided the correct conclusion and explanation are given.

Code	Response	Item: S022017
<b>Correct Response</b>		
10	B. With correct explanation based on the concept of energy efficiency (B uses less gasoline than A for an equivalent volume of water pumped).  Examples: B. Because it uses 1L of gas per 1000L of water and A used 1.25L for 1000L of water. B. Because it uses less gasoline per liter of water. B. Because it can pump the same amount of liters using less gas.	
<b>Incorrect Response</b>		
70	B. It uses less gasoline (no comparison of efficiency based on volume of water pumped).  Examples: B. It used .5L of gas in an hour, and A used 1.25L in an hour. B. Its uses less gas in an hour. B. The engine used .75L less gas.	
71	B. Other incorrect/inadequate or no explanation.	
72	A. It removes more water in 1 hour (no comparison of efficiency based on gas used).  Examples: A. It pumps more water. A. It pumps 1.25 liters and B only pumps 0.5 liters. A. It pumped 500L more than B.	
73	A. Other incorrect/inadequate or no explanation.	
79	Other incorrect (including crossed out/erased, stray marks, illegible, or off task).	
<b>Nonresponse</b>		
99	BLANK	

Conversion of electrical/light energy				X01	
Content Category	Performance Expectation	Item Key	Score Points	International Average Percentage of 8th Grade Students Responding Correctly	Used in 1995
Physics	Theorizing, Analyzing and Solving Problems	Rubric	1	8	N

Electrical energy is used to power a lamp. How does the amount of electrical energy used compare to amount of light energy produced?

a) The amount of electrical energy used is:  
(Check one)

☐ more than the amount of light energy produced.

☐ less than the amount of light energy produced.

☐ the same as the amount of light energy produced.

b) Give a reason to support your answer.

**Note:** A correct response must identify **more** and include a correct explanation based on electrical energy being converted to heat (Code 10) or a more general description of energy losses or low efficiency (Code 11). Responses that include explanations based on heat, energy losses or low efficiency but with an incorrect application to the problem by checking **less** are scored as incorrect (Code 72).

Code	Response	Item: S022282
	<b>Correct Response</b>	
10	MORE: With an explanation based on (much) energy being converted to heat. <i>Examples: More. When a lamp is on it heats up. So some of the electricity goes into heat instead of light. More. Some of the electrical energy is changed into heat energy to make the lamp work and only a small amount of the energy is actually changed into light.</i>	
11	MORE: With other correct explanation of energy (power) loss or low efficiency. [Must clearly indicate that "some" energy goes elsewhere]. <i>Examples: More. Because some of the energy is lost in conversions. More. The lamp is not very efficient, so not all of the electrical energy is changed into light.</i>	
19	MORE: Other correct explanation.	
	<b>Incorrect Response</b>	
70	MORE: Incorrect/inadequate or no explanation. <i>Examples: More. The light gives out lots of energy. More. The people have got to make the electricity first. More. Because of all the electricity from the wall socket.</i>	
71	SAME: Explanation is based on the concept of conservation of energy without considering energy losses. <i>Examples: Same. Energy is always preserved. Same. You cannot create or destroy energy, so it has to be the same.</i>	
72	LESS: Explanation based on heat, energy losses or low efficiency but with an incorrect application. <i>Examples: Less. Some of the electrical energy is changed into heat. Less. The lamp is not very efficient.</i>	
73	LESS: Any other incorrect or no explanation. <i>Examples: Less. Today's lamps do not use up much voltage. Less. It does not take much electricity to power a lamp.</i>	
79	Other incorrect (including crossed out/erased, stray marks, illegible, or off task).	
	<b>Nonresponse</b>	
99	BLANK	

## TIMSS 2003

Content Domain

**Physics**

Main Topic

**Energy types, sources and conversions**

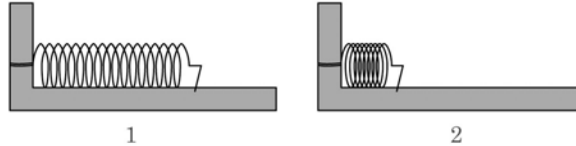
Cognitive Domain

**Conceptual Understanding**

Key

**B**

Spring 1 and Spring 2 were the same. Then, Spring 1 was pushed together a little and clamped in place. Spring 2 was pushed together a lot and clamped.



Which spring has more stored energy?

- (A) Spring 1
- (B) Spring 2
- (C) Both springs have the same energy.
- (D) You cannot tell unless you know what the springs are made of.

S012002

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**TIMSS 2003**

Content Domain

**Physics**

Main Topic

**Energy types, sources and conversions**

Cognitive Domain

**Conceptual Understanding**

Key

**See scoring guide**

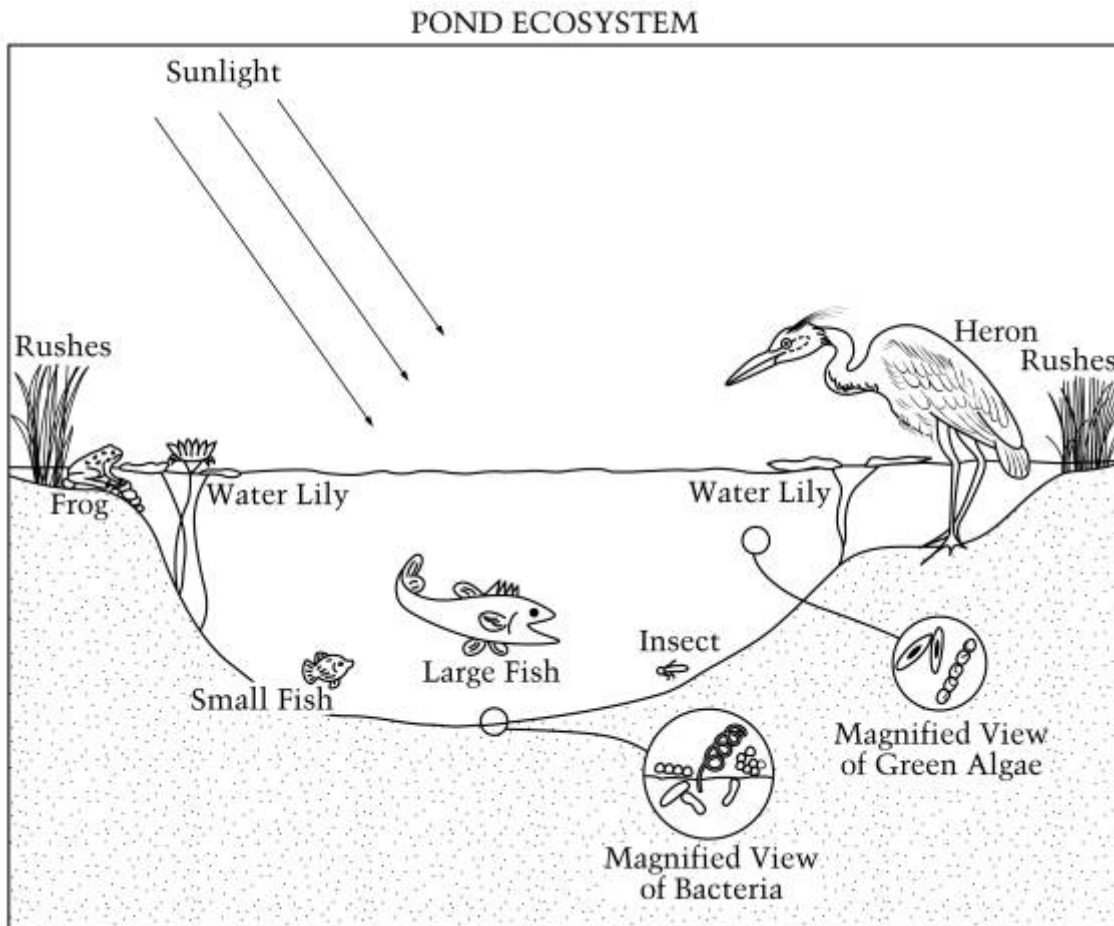
S032131

When a nail is pulled out of a wooden board, the nail becomes warm.  
Explain why.

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**Additional Information (1)****Questions 1-13**

The picture below shows a pond ecosystem. Use this picture and what you know about the things in it to answer the questions in this section.



1. Household appliances convert electricity into one or more different forms of energy. An electric fan can best be described as converting electricity into

- A) heat energy only
- B) heat energy and sound energy only
- C) heat energy, sound energy, and mechanical energy only
- D) heat energy, sound energy, mechanical energy, and chemical energy

2. Is a hamburger an example of stored energy? Explain why or why not.

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3. Right before Anna was about to run in a long race, she drank a large glass of orange juice to get energy. Tell how the energy that was in the orange juice actually came from the Sun.

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/U> refer to the way electricity is conducted.

-

4. Suppose that you have one of the items from the list in Question 7 that you believe conducts electricity, and that you also have a battery, several wires, and a light bulb.

Explain how you could use these things to do a test to find out if the item you chose from the list in Question 7 does conduct electricity. Draw a picture to help explain your answer.

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5. Household appliances convert electricity into one or more different forms of energy. An electric fan can best be described as converting electricity into

- A) heat energy only
- B) heat energy and sound energy only
- C) heat energy, sound energy, and mechanical energy only
- D) heat energy, sound energy, mechanical energy, and chemical energy

6. When propane gas reacts with oxygen in the air to form carbon dioxide and water, heat is released. What is the source of this heat energy?

- A) The kinetic energy of the oxygen
- B) The kinetic energy of the propane
- C) The nuclear energy stored in the oxygen and propane
- D) The chemical energy stored in the oxygen and propane

*Question 7 refers to Additional Information (1)*

7. Which of the following living things in the pond system uses the energy from sunlight to make its own food?

- A) Insect
- B) Frog

- C) Water lily
- D) Small fish

*Question 8 refers to Additional Information (1)*

8. Each of the animals in the pond needs food. What are two things that the animals get from their food that keep them alive?

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9. Why would a person be cooler on a hot sunny day in a light-colored T-shirt and shorts than in a dark-colored T-shirt and shorts made of the same material?

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Some people have proposed that ethyl alcohol (ethanol), which can be produced from corn, should be used in automobiles as a substitute for gasoline.

10. Discuss two environmental impacts that could result from substituting ethyl alcohol for gasoline.

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Some people have proposed that ethyl alcohol (ethanol), which can be produced from corn, should be used in automobiles as a substitute for gasoline.

11. Assuming that gasoline and ethyl alcohol cost the same per gallon, outline a plan for comparing the cost of using gasoline to the cost of using ethyl alcohol.

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Some people have proposed that ethyl alcohol (ethanol), which can be produced from corn, should be used in automobiles as a substitute for gasoline.

12. Discuss two factors other than environmental concerns and fuel costs that should be considered before making a decision to use ethyl alcohol as an automobile fuel.

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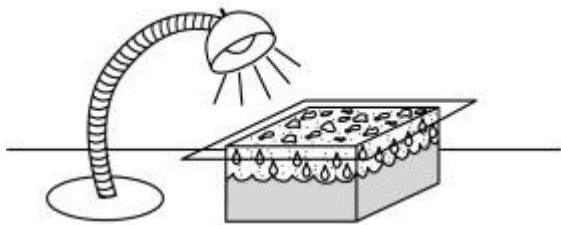
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13. Which of the following is designed to convert energy into mechanical work?

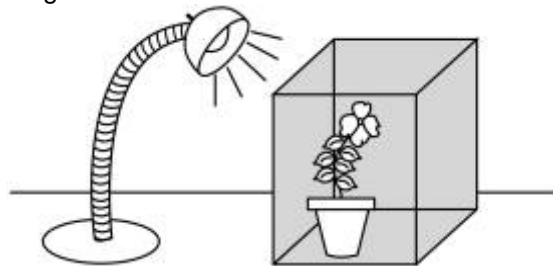
- A) Electric fan
- B) Kerosene heater
- C) Flashlight
- D) Baking oven

14. Which of the following would be the best model to show the interactions between water and the Sun's heat energy in cycles of precipitation?

- A) A light shines on an aquarium covered with glass, and water droplets form on the inside of the glass.



- B) A light shines on a closed cardboard box containing a plant.



- C) A light shines on a man's face. Droplets of sweat form on his face as he exercises.



D) A light shines on a glass of iced tea. Water droplets form on the outside of the glass.




The following question refer to the way electricity is conducted.

15. Look at each item in the list below. Decide if it conducts electricity or does not conduct electricity. Put an X in the box to show what you decided.

Item	Conducts Electricity	Does Not Conduct Electricity
House Key		
Rubber Band		
Coin		
Wooden Toothpick		
Metal Fork		
Plastic Spoon		
Aluminum Foil		

Question 1**Key**

1. Household appliances convert electricity into one or more different forms of energy. An electric fan can best be described as converting electricity into
- A) heat energy only
  - B) heat energy and sound energy only
  -  C) heat energy, sound energy, and mechanical energy only
  - D) heat energy, sound energy, mechanical energy, and chemical energy

Question 2**Scoring Guide**

Score & Description
<b>Complete</b> Student response indicates "yes" and states that a hamburger contains fat (grease), protein, carbohydrate, nutrients and gives some indication of energy transfer. OR Student response indicates "yes" and traces the energy through the food chain.
<b>Partial</b> Student response indicates "yes" and states that a hamburger contains fat (grease), protein, carbohydrates, nutrients. OR Student response indicates "yes" and states that transfer of energy takes place. OR Student response indicates "yes" and states that food is energy/meat is energy/ meat contains energy.
<b>Unsatisfactory/Incorrect</b> Student demonstrates no understanding of the concept of stored energy by answering "no", or answers "yes" and gives no or an incorrect or irrelevant response.


Question 3**Scoring Guide**

Score & Description
<b>Complete</b> Student correctly explains energy transference from the Sun to orange juice.
<b>Partial</b> Student traces part of the path of energy from the Sun to the orange juice.
<b>Unsatisfactory/Incorrect</b> Student does not trace any part of the path of energy from the Sun to the orange juice.

Question 4**Scoring Guide**

<b>Score &amp; Description</b>
<b>Complete</b> Student draws and/or describes how a battery, wires, and a light bulb could be used to test for electrical conductivity.
<b>Partial</b> Student describes some elements of a complete circuit, but does not clearly describe how the circuit could be modified to test for electrical conductivity (e.g., "hook up the wires to the battery and light bulb"), or student draws a partially correct picture or diagram, or draws an incorrect diagram but specifies that the lighting of the bulb would indicate conductivity.
<b>Unsatisfactory/Incorrect</b> Student is unable to describe an electrical circuit or to explain accurately how to test an item for electrical conductivity.

Question 5**Key**

5. Household appliances convert electricity into one or more different forms of energy. An electric fan can best be described as converting electricity into
- A) heat energy only
  - B) heat energy and sound energy only
  -  C) heat energy, sound energy, and mechanical energy only
  - D) heat energy, sound energy, mechanical energy, and chemical energy

Question 6**Key**

6. When propane gas reacts with oxygen in the air to form carbon dioxide and water, heat is released. What is the source of this heat energy?

- A) The kinetic energy of the oxygen
- B) The kinetic energy of the propane
- C) The nuclear energy stored in the oxygen and propane
- D) The chemical energy stored in the oxygen and propane



Question 7**Key**

7. Which of the following living things in the pond system uses the energy from sunlight to make its own food?

- A) Insect
- B) Frog
- C) Water lily
- D) Small fish



Question 8**Scoring Guide**

<b>Score &amp; Description</b>
<p><b>Complete</b></p> <p>Student demonstrates an understanding that living things require energy and raw materials to sustain them by naming two things animals need from their food. Response consists of one of the following:</p> <ol style="list-style-type: none"><li>Response states that animals get both energy and nutrients.</li><li>Response states that animals get energy and names one specific nutrient.</li><li>Response names two specific nutrients.</li></ol> <p>Examples of specific nutrients include proteins, carbohydrates, lipids, vitamins, and minerals.</p>
<p><b>Partial</b></p> <p>Student response names one thing animals need from their food. Response consists of one of the following:</p> <ol style="list-style-type: none"><li>Response states that animals get energy.</li><li>Response states that animals get nutrients and names one specific nutrient.</li><li>Response names one specific nutrient.</li></ol>
<p><b>Unsatisfactory/Incorrect</b></p> <p>Student response provides no reasonable answer about what animals get from their food. Response may state that animals get nutrients from their food without naming a specific nutrient, or may give examples of different types of food the animals eat.</p>

Question 9**Scoring Guide**

Score & Description
<b>Complete</b>  Student response compares the reflective and/or absorptive properties of light-colored and dark-colored clothes when such clothes are exposed to the heat from sunlight. Response explains either that light-colored clothes reflect more sunlight than dark-colored clothes, or that dark-colored clothes absorb more sunlight than light-colored clothes.
<b>Partial</b>  Student response provides a partial explanation that lacks a comparison between light and dark clothing, or provides an explanation that contains some technically incorrect terminology.
<b>Unsatisfactory/Incorrect</b>  Student provides no evidence of understanding why light-colored clothes are cooler on a hot sunny day than dark clothes.

Question 10**Scoring Guide**

Score & Description
<b>Complete</b>  Student response must discuss two ways that substituting ethyl alcohol for gasoline could impact the environment in either negative and/or positive ways. For example, less air pollutants may result leading to improved air quality; forests may have to be cleared for crop growth resulting in habitat destruction and increased carbon dioxide concentrations in the atmosphere; and stocks of fresh water may be depleted due to increased crop irrigation.
<b>Partial</b>  Student response discusses one positive or one negative environmental impact that could result from substituting ethyl alcohol for gasoline.
<b>Unsatisfactory/Incorrect</b>  Student response does not discuss any environmental impacts that could result from substituting ethyl alcohol for gasoline.

Question 11**Scoring Guide**

<b>Score &amp; Description</b>
<b>Complete</b>  Student response provides an appropriate plan to compare the cost of using the two fuels by comparing the miles per gallon obtained. The plan must include appropriate controls such as using the same car and driving it the same distance.
<b>Partial</b>  Student response provides a partially appropriate plan to compare the costs of using the two fuels. Appropriate controls are not discussed.
<b>Unsatisfactory/Incorrect</b>  Student provides no appropriate plan to compare the cost of using the two fuels.

Question 12**Scoring Guide**

Score & Description
<b>Complete</b>  Student discusses or explains two factors that should be considered before making a decision to use ethyl alcohol as an automobile fuel. Factors include performance of car, need to convert cars, possible car damage, miles per gallon, effect on jobs, marketing/acceptability, health/safety of people, abundance of supply, reduction of dependence on foreign oil supply.
<b>Partial</b>  Student discusses or explains one factor that should be considered before making a decision to use ethyl alcohol as an automobile fuel.
<b>Unsatisfactory/Incorrect</b>  Student provides little or no information of the factors that should be considered prior to deciding whether to use ethyl alcohol as a fuel.

Question 13**Key**

13. Which of the following is designed to convert energy into mechanical work?



- A) Electric fan
- B) Kerosene heater
- C) Flashlight
- D) Baking oven

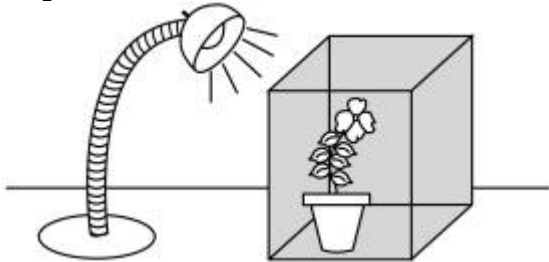
Question 14**Key**

14. Which of the following would be the best model to show the interactions between water and the Sun's heat energy in cycles of precipitation?

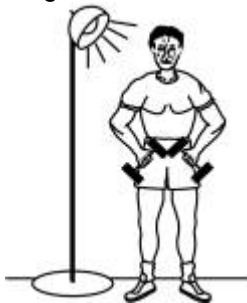
- ▶ A) A light shines on an aquarium covered with glass, and water droplets form on the inside of the glass.



- B) A light shines on a closed cardboard box containing a plant.



- C) A light shines on a man's face. Droplets of sweat form on his face as he exercises.



- D) A light shines on a glass of iced tea. Water droplets form on the outside of the glass.



Question 15**Scoring Guide**

<b>Score &amp; Description</b>
<b>Complete</b> Student places all 7 items in the correct classification:  Conductors: coin, metal fork, aluminum foil, house key Non-conductors: rubber band, toothpick, plastic spoon
<b>Essential</b> Student places 4 – 6 items in the correct classification.
<b>Partial</b> Student places 1 – 3 items in the correct classification.
<b>Unsatisfactory/Incorrect</b> Student places no items in the correct classification.

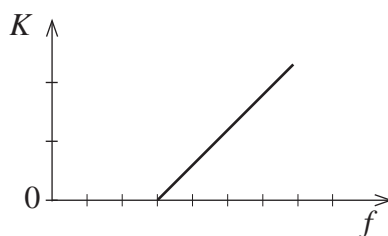
G6. By what process do most stars release energy?

- A. Electromagnetic induction resulting from strong magnetic fields
- B. Rapid rotation of the star
- C. Radioactivity in the interior of the star
- D. Nuclear fusion in the interior of the star
- E. Heat which was stored when the star was 'born'

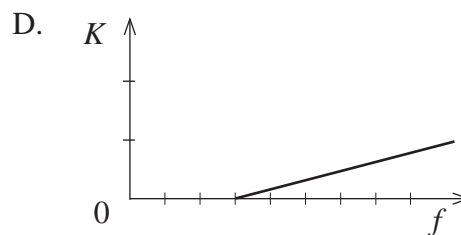
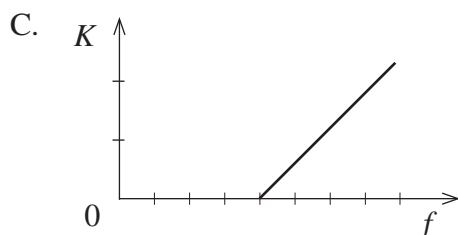
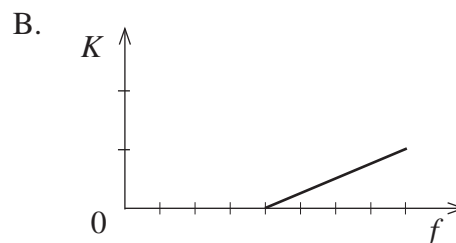
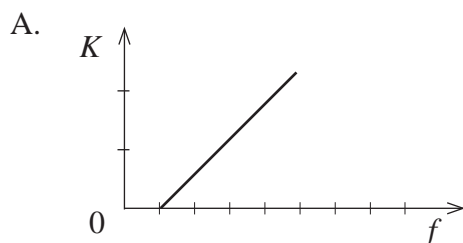
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Subject	Item Key	Content Category	Performance Expectation	International Average Percent of Students Responding Correctly	International Difficulty Index
Physics	D	Modern Physics: Particle, Quantum and Astrophysics, and Relativity	Understanding	59%	541

- H3. The graph shows the maximum kinetic energy ( $K$ ) of electrons emitted from a certain metal by the photoelectric effect as a function of the frequency ( $f$ ) of the incoming radiation.



Which one of the following graphs best represents the kinetic energy-frequency relationship for another metal with a smaller work function? All the graphs have the same frequency scale and kinetic energy scale.



H-3

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Subject	Item Key	Content Category	Performance Expectation	International Average Percent of Students Responding Correctly	International Difficulty Index
Physics	A	Modern Physics: Particle, Quantum and Astrophysics, and Relativity	Using Tools, Routine Procedures, and Science Processes	39%	666

A1. Nuclear energy can be generated by fission or fusion. Fusion is not currently being used in reactors as an energy source. Why is this?

- A. The scientific principles on which fusion is based are not yet known.
- B. The technological processes for using fusion safely are not developed.
- C. The necessary raw materials are not readily available.
- D. Waste products from the fusion process are too dangerous.

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Subject	Item Key	Content Category	Performance Expectation	International Average Percent of Students Responding Correctly	International Difficulty Index
Science Literacy	B	Science Literacy	Understanding	40%	619

J5. Which form of solar radiation causes sunburn?

- A. Visible
- B. Ultraviolet
- C. Infrared
- D. X-rays
- E. Radio waves

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Subject	Item Key	Content Category	Performance Expectation	International Average Percent of Students Responding Correctly		International Difficulty Index
				Upper Grade	Lower Grade	
Science	B	Physics	Understanding Simple Information	68%	59%	495

K15. Fossil fuels were formed from

- A. uranium
- B. sea water
- C. sand and gravel
- D. dead plants and animals

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Subject	Item Key	Content Category	Performance Expectation	International Average Percent of Students Responding Correctly		International Difficulty Index
				Upper Grade	Lower Grade	
Science	D	Earth Science	Understanding Simple Information	62%	55%	526

P2. A flashlight close to a wall produces a small circle of light compared to the circle it makes when the flashlight is far from the wall. Does more light reach the wall when the flashlight is further away?

\_\_\_ Yes

\_\_\_ No (Check one)

Explain your answer.

P-2

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Subject	Item Key	Content Category	Performance Expectation	International Average Percent of Students Responding Correctly		International Difficulty Index
				Upper Grade	Lower Grade	
Science	next page	Physics	Theorizing, Analyzing, and Solving Problems	23%	18%	770

## P-2 Coding Guide

P2. A flashlight close to a wall produces a small circle of light compared to the circle it makes when the flashlight is far from the wall. Does more light reach the wall when the flashlight is further away?

☐ Yes

☐ No (Check one)

Explain your answer.

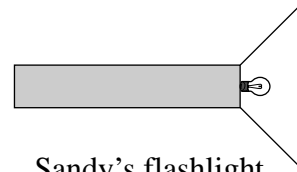
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Code	Response
<b>Correct Response</b>	
<b>10</b>	No. Explains that the same amount reaches the wall.
<b>11</b>	No. Explains that the same amount of light reaches the wall but more spread out.
<b>12</b>	No. Less light reaches the wall because of light absorption by the air.
<b>19</b>	Other correct.
<b>Incorrect Response</b>	
<b>70</b>	Yes. Because light covers a bigger area. <i>Examples: Because the light covers a bigger area.</i> <i>Because light can expand.</i> <i>Because light spreads out.</i>
<b>71</b>	Yes. No explanation.
<b>72</b>	No. There is less light at a greater distance.
<b>73</b>	No. No explanation.
<b>79</b>	Other incorrect.
<b>Nonresponse</b>	
<b>90</b>	Crossed out/erased, illegible, or impossible to interpret.
<b>99</b>	BLANK

- Q12. Jim and Sandy each make a flashlight from identical batteries and bulbs. Sandy's flashlight contains a reflector, while Jim's does not.



Jim's flashlight



Sandy's flashlight

Which flashlight shines more light on a wall 5 meters away?  
(check one)

\_\_\_\_\_ Jim's

\_\_\_\_\_ Sandy's

Explain your answer.

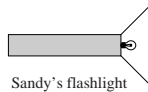
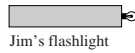
Q-12

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Subject	Item Key	Content Category	Performance Expectation	International Average Percent of Students Responding Correctly		International Difficulty Index
				Upper Grade	Lower Grade	
Science	next page	Physics	Theorizing, Analyzing, and Solving Problems	47%	41%	608

## Q-12 Coding Guide

Q12. Jim and Sandy each make a flashlight from identical batteries and bulbs. Sandy's flashlight contains a reflector, while Jim's does not.



Which flashlight shines more light on a wall 5 meters away?  
(check one)

\_\_\_\_\_ Jim's

\_\_\_\_\_ Sandy's

Explain your answer.

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Code	Response
<b>Correct Response</b>	
<b>10</b>	Sandy's. The reflector reflects all the light towards the wall.
<b>11</b>	Sandy's. In Jim's flashlight the light shines in all directions.
<b>12</b>	Any combination of codes 10, 11.
<b>19</b>	Sandy's. Other correct explanations.
<b>Incorrect Response</b>	
<b>70</b>	Jim's. <i>Examples: There is no reflector. It is not covered.</i>
<b>71</b>	Jim's but with an explanation that belongs to Sandy's.
<b>72</b>	Jim's with another explanation.
<b>73</b>	Jim's or Sandy's, with no explanation.
<b>76</b>	Merely repeats information in stem. <i>Example: Sandy's, because of the reflector.</i>
<b>79</b>	Other incorrect.
<b>Nonresponse</b>	
<b>90</b>	Crossed out/erased, illegible, or impossible to interpret.
<b>99</b>	BLANK

Why light-colored clothes are cooler					F02
Content Category	Performance Expectation	Item Key	Score Points	International Average Percentage of 8th Grade Students Responding Correctly	Used in 1995
Physics	Understanding Complex Information	A	1	65	Y

.

On a warm sunny day, you will feel cooler wearing light-colored clothes because they

A. reflect more radiation

B. prevent sweating

C. are not as heavy as dark clothes

D. let more air in

Sunscreen to protect against radiation					J08
Content Category	Performance Expectation	Item Key	Score Points	International Average Percentage of 8th Grade Students Responding Correctly	Used in 1995
Physics	Understanding Simple Information	D	1	62	N

Sunscreen is used to protect the skin from exposure to which type of solar radiation?

A. Visible

B. X-rays

C. Infrared

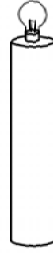
D. Ultraviolet

E. Microwaves

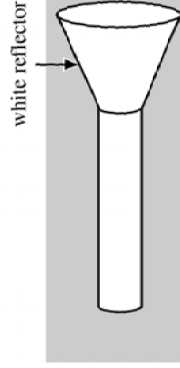
## Flashlights with white/black reflectors

Flashlights with white/black reflectors				N10
Content Category	Performance Expectation	Item Key	Score Points	International Average Percentage of 8th Grade Students Responding Correctly
Physics	Theorizing, Analyzing and Solving Problems	Rubric	1	39
				Used in 1995
				N

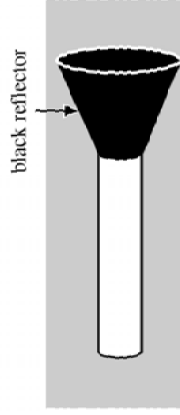
Roddy and Stephanie each make a flashlight using identical batteries and bulbs.



They then add cardboard reflectors to their flashlights as shown below. Roddy's reflector is made of white cardboard and Stephanie's reflector is made of black cardboard.



Roddy's Flashlight



Stephanie's Flashlight

The flashlights are then switched on.

a) Which flashlight shines more light on a wall two meters away?  
(check one)

☐ Roddy's (white reflector)

☐ Stephanie's (black reflector)

b) Explain your answer.

**Note:** A correct response must identify **Roddy's** and include an explanation based on the relative reflectivity of the white and black cardboard. Credit is given both for responses explicitly mentioning the higher reflectance of the white cardboard and/or the higher absorbance of the black cardboard as well as responses communicating this concept using less scientific terminology.

Code	Response	Item: S022049
<b>Correct Response</b>		
10	Roddy's. With correct explanation based on the higher <b>reflectivity</b> of the white cardboard (or lower <b>reflectivity</b> /higher <b>absorption</b> of the black cardboard). [Explicitly refers to <b>absorption</b> and/or <b>reflectivity</b> .]  <i>Examples:</i> Roddy's. Because light reflects better off lighter colors. Roddy's. Roddy's does not absorb as much as Stephanie's. Roddy's. Because white reflects light and black absorbs it. Roddy's. Dark colors absorb the light so more light would be absorbed by Stephanie's flashlight. Roddy's. Stephanie's reflector would absorb the light and not reflect it onto the wall.	
11	Roddy's. Explanation based on the concept of higher reflectivity but using other terminology. [Does not explicitly refer to absorption/reflection properties.]  <i>Examples:</i> Roddy's. The light will bounce off something brighter like the white reflector. Roddy's. White reflector throws off light better than black. Roddy's. Because black draws the light and white repels it. Roddy's. The light gets deflected more by the white one. Roddy's. More light shines off a white surface.	
19	Other correct.	
<b>Incorrect Response</b>		
70	Roddy's with an inadequate/incorrect or no explanation.  <i>Examples:</i> Roddy's. You can see the light with the white cardboard. Roddy's. White cardboard intensifies the light. Roddy's. Far away. Roddy's. Its white.	
71	Stephanie's. With or without explanation.  <i>Examples:</i> Stephanie's. The black reflector is better. Stephanie's. Black absorbs light and heat, white deflects it. Stephanie's. The light will shine through the white reflector.	
79	Other incorrect (including crossed out/erased, stray marks, illegible, or off task).	
<b>Nonresponse</b>		
99	BLANK	

Amount of light on wall and ceiling					P02
Content Category	Performance Expectation	Item Key	Score Points	International Average Percentage of 8th Grade Students Responding Correctly	Used in 1995
Physics	Theorizing, Analyzing and Solving Problems	Rubric	1	24	N

James turns on a flashlight in his bedroom and shines it on his wall one meter away to produce a small circle of light. He then shines the flashlight on his ceiling two meters away to produce a larger circle of light.

a) Does more light reach the ceiling than the wall?  
(Check one)

☐ Yes

☐ No

b) Explain your answer.

**Note:** A correct response is based on the same amount of light reaching both the ceiling and the wall but being more spread out (less bright) on the ceiling. Correct responses must identify **NO** and include an explanation that states that the light is the **same** (Code 10) or that indicates that the light is just more spread out (less bright) on the ceiling **without** explicitly stating **same** (Code 11). If the explanation merely repeats information that is in the stem, it is scored as incorrect (Code 71) even if **NO** is checked. If a response indicates that there is **less** light on the ceiling, the explanation must include a correct reason based on more air absorption/scattering at a greater distance to receive the correct Code 12. Responses that indicate **less** light at a greater distance **without** further explanation should receive Code 70.

Code	Response	Item: S022043
<b>Correct Response</b>		
10	No. Explains that the <b>same</b> amount of light reaches the wall and ceiling. (May also refer to light being more spread out on the ceiling or less concentrated/focused/bright). <i>Examples: No. It is going to be the same amount of light because James is using the same flashlight. No. The light might be bigger but will not be as bright. They are equal. No. The same amount of light hits the ceiling but is more spread out.</i>	
11	No. Explains (or shows in a diagram) that light is (only) more spread out (less bright) at a greater distance. (Does <b>not</b> explicitly state that the light is the same.) <i>Example: No. It only looks bigger because it spreads out more as it gets farther away.</i>	
12	No. Explains that <b>less</b> light reaches the ceiling because of more air absorption/scattering at a greater distance. <i>Example: No. The ceiling is further away, and a little bit more of the light is soaked up by the air.</i>	
19	No. Other correct explanation.	
<b>Incorrect Response</b>		
70	No. States that <b>less</b> light reaches the ceiling with inadequate explanation related to distance from source. (Does not include explanation of less light due to air absorption or scattering as in Code 12). <i>Examples: No. Because the flashlight is closer to the wall, the wall will receive more light. No. The ceiling is further than the wall is so there is less light.</i>	
71	No. Other incorrect/inadequate or no explanation. (Includes explanations that merely paraphrase the stem). <i>Example: No. When it is close its a smaller circle.</i>	
72	Yes. Explanation based on light being bigger or more spread out. <i>Examples: Yes. Because the light makes a bigger circle. Yes. Because if you move back it makes a large circle on the wall and if you move close it makes a small circle. Yes. The further it goes, the bigger it gets.</i>	
73	Yes. Other incorrect/inadequate or no explanation.	
79	Other incorrect (including crossed out/erased, stray marks, illegible, or off task).	
<b>Nonresponse</b>		
99	BLANK	

**TIMSS 2003**

Content Domain

**Environmental Science**

Main Topic

**Use and conservation of  
natural resources**

Cognitive Domain

**Conceptual Understanding**

Key

**See scoring guide**

Write down one renewable energy source and describe one way that people make use of it.

Energy Source: \_\_\_\_\_

Use:

S032242

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**Note:** For credit, responses must name a renewable energy source or device and a use that indicates how the energy from the source/device is applied. Credit is NOT given for responses that name a renewable source/device with no or inadequate description of its use.

Code	Response	Item: S032242
	<b>Correct Response</b>	
<b>10</b>	<b>Sun or sunlight</b> (solar energy) with a correct description of its use. <i>Examples: Sun. It is used to heat water by solar panels.</i> <i>Sunlight. It keeps us warm.</i> <b>Note:</b> Must name “sun”, “sunlight” or “solar energy” for full credit. If just “light” is named, then use Code 11.	
<b>11</b>	<b>Wind</b> (windmills) with a correct description of its use. <i>Examples: Windmills. Are for grinding corns or for pumping water.</i> <i>Wind turbines to generate electricity.</i>	
<b>12</b>	<b>Water</b> (waves, tides, water wheels, etc.) with a correct description of its use. <i>Examples: Tidal barrage. To generate electricity.</i> <i>Water. To generate electricity.</i>	
<b>19</b>	Other correct <i>Examples: Food. To give the body energy.</i> <i>Wood. It is used in wood stoves for cooking.</i>	
	<b>Incorrect Response</b>	
<b>70</b>	Names any fossil fuel (e.g., coal, oil, gasoline). <i>Examples: Gas. You can use it for heating.</i>	
<b>71</b>	Names a renewable energy source/device with no or inadequate description of use. <i>Examples: Water. You can heat, freeze and melt it.</i> <i>Sunlight.</i> <i>Windmill.</i>	
<b>72</b>	Names “light” (without connection to the Sun) with or without a correct description of use. <i>Examples: Light energy. It help us to see.</i> <i>Light.</i>	
<b>79</b>	Other incorrect (including crossed out/erased, stray marks, illegible or off task) <i>Examples: Electricity. Used for cooking.</i> <i>Batteries. To power a torch.</i>	
	<b>Nonresponse</b>	
<b>99</b>	Blank	

\* : Revised following data collection.

**TIMSS 2003**

Content Domain

**Environmental Science**

Main Topic

**Use and conservation of  
natural resources**

Cognitive Domain

**Conceptual Understanding**

Key

**C**

S032422

Which group of energy sources are ALL renewable?

- Ⓐ coal, oil, and natural gas
- Ⓑ solar, oil, and geothermal
- Ⓒ wind, solar, and tidal
- Ⓓ natural gas, solar, and tidal

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**TIMSS 2003**

Content Domain

**Earth Science**

Main Topic

**Earth processes, cycles and history**

Cognitive Domain

**Factual Knowledge**

Key

**B**

S022074

Fossil fuels were formed from

- Ⓐ volcanoes
- Ⓑ the remains of living things
- Ⓒ gases in the atmosphere
- Ⓓ water trapped inside rocks

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**TIMSS 2003**

Content Domain

**Earth Science**

Main Topic

**Earth processes, cycles and history**

Cognitive Domain

**Factual Knowledge**

Key

**C**

S012018

Which is NOT a fossil fuel?

- (A) Coal
- (B) Oil
- (C) Wood
- (D) Natural gas

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**TIMSS 2003**

Content Domain

**Environmental Science**

Main Topic

**Use and conservation of  
natural resources**

Cognitive Domain

**Conceptual Understanding**

Key

**D**

Oil is an example of a natural resource that is not renewable. Which is another example of a nonrenewable resource?

- Ⓐ Wood
- Ⓑ Seawater
- Ⓒ Sunlight
- Ⓓ Coal

S012042

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1. For each of the sources of electrical energy listed below, describe an advantage and a disadvantage of relying on that energy source for a large part of our country's electrical energy.

Solar

Advantage:

---

---

---

Disadvantage:

---

---

---

Nuclear

Advantage:

---

---

---

Disadvantage:

---

---

---

Hydroelectric

Advantage:

---

---

---

Disadvantage:

---

---

---

Fossil Fuels (coal and oil)

Advantage:

---

---

---

Disadvantage:

---

---

---


 $X \rightarrow Y + Z + \text{energy}$

2. The equation above represents a nuclear decay, in which nucleus  $X$  decays into particle  $Y$  and nucleus  $Z$  and releases energy. Which of the following can explain why energy is released in the decay?
- A) The mass of  $X$  is less than the sum of the masses of  $Y$  and  $Z$ .
  - B) The mass of  $X$  is less than the difference between the masses of  $Y$  and  $Z$ .
  - C) The mass of  $X$  is greater than the sum of the masses of  $Y$  and  $Z$ .
  - D) The mass of  $X$  is greater than the difference between the masses of  $Y$  and  $Z$ .

Question 1**Scoring Guide**

<b>Score &amp; Description</b>
<b>Complete</b> Student provides one reasonable advantage and disadvantage for each of the energy sources listed (8 parts).
<b>Essential</b> Student provides correct answers to 6-7 of the parts.
<b>Adequate</b> Student provides correct answers to 3-5 of the parts.
<b>Partial</b> Student provides correct answers to 1-2 of the parts.
<b>Unsatisfactory/Incorrect</b> Student provides no correct responses to any of the parts.

Question 2**Key**

2. The equation above represents a nuclear decay, in which nucleus  $X$  decays into particle  $Y$  and nucleus  $Z$  and releases energy. Which of the following can explain why energy is released in the decay?
- A) The mass of  $X$  is less than the sum of the masses of  $Y$  and  $Z$ .
  - B) The mass of  $X$  is less than the difference between the masses of  $Y$  and  $Z$ .
  -  C) The mass of  $X$  is greater than the sum of the masses of  $Y$  and  $Z$ .
  - D) The mass of  $X$  is greater than the difference between the masses of  $Y$  and  $Z$ .

R4. Write down one reason why the ozone layer is important for all living things on Earth.

R-4

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Subject	Item Key	Content Category	Performance Expectation	International Average Percent of Students Responding Correctly		International Difficulty Index
				Upper Grade	Lower Grade	
Science	next page	Earth Science	Understanding Complex Information	53%	43%	583

## R-4 Coding Guide

R4. Write down one reason why the ozone layer is important for all living things on Earth.

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Code	Response
<b>Correct Response</b>	
<b>10</b>	Refers to protection against the UV radiation from the sun.
<b>11</b>	Refers to protection against dangerous or too strong radiation from the sun but does not mention UV. <i>Example: Because it keeps the sun's rays from being too strong.</i>
<b>12</b>	Mentions that the ozone layer protects humans so we do not get sunburned/skin cancer. NOTE: If UV is mentioned, code 10.
<b>19</b>	Other correct.
<b>Incorrect Response</b>	
<b>70</b>	Confuses the effect of the ozone layer with the greenhouse <i>Example: It keeps the heat in.</i>
<b>71</b>	Confuses protection against heat. <i>Example: Everything will melt without it.</i>
<b>72</b>	Refers only vaguely to protection. <i>Examples: All living things will die without the ozone layer. It protects the Earth/us.</i>
<b>73</b>	Refers to or confuses oxygen, O2 with ozone, O3. <i>Example: It is needed for respiration.</i>
<b>74</b>	Sees the ozone layer as a barrier for the atmosphere. <i>Example: It keeps the air around the earth.</i>
<b>76</b>	Merely repeats information in the stem.
<b>79</b>	Other incorrect.
<b>Nonresponse</b>	
<b>90</b>	Crossed out/erased, illegible, or impossible to interpret.
<b>99</b>	BLANK

W2. Draw a diagram to show how the water that falls as rain in one place may come from another place that is far away.

W-2

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Subject	Item Key	Content Category	Performance Expectation	International Average Percent of Students Responding Correctly		International Difficulty Index
				Upper Grade	Lower Grade	
Science	next page	Earth Science	Theorizing, Analyzing, and Solving Problems	32%	27%	659

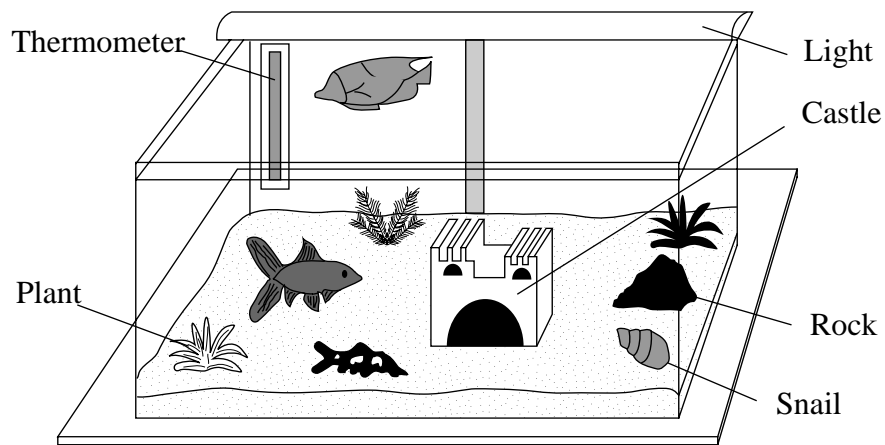
## W-2 Coding Guide

W2. Draw a diagram to show how the water that falls as rain in one place may come from another place that is far away.

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Code	Response
<b>Correct Response</b>	
<b>20</b>	Response includes the three following steps: i. Evaporation of water from a source. ii. Transportation of water as vapor/clouds to another place. iii. Precipitation in other places.
<b>Partial Response</b>	
<b>10</b>	As in code 20 but response does not mention evaporation.
<b>11</b>	As in code 20, but response does not mention transportation.
<b>12</b>	As in code 20, but response does not mention precipitation.
<b>19</b>	Other partially correct.
<b>Incorrect Response</b>	
<b>70</b>	Response indicates precipitation only; it may use vertical or diagonal lines.
<b>79</b>	Other incorrect.
<b>Nonresponse</b>	
<b>90</b>	Crossed out/erased, illegible, or impossible to interpret.
<b>99</b>	BLANK

X2. In the picture of an aquarium, six items are labeled.



Explain why each of the following is important in maintaining the ecosystem in the aquarium.

(a) the plant

X-2a

(b) the light

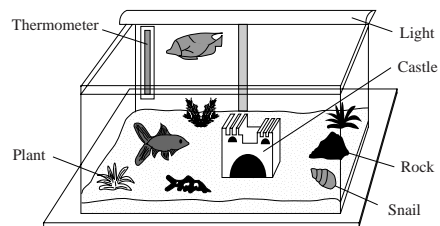
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## Part A

Subject	Item Key	Content Category	Performance Expectation	International Average Percent of Students Responding Correctly		International Difficulty Index
				Upper Grade	Lower Grade	
Science	next page	Life Science	Theorizing, Analyzing, and Solving Problems	64%	58%	474

## X-2a Coding Guide

X2. In the picture of an aquarium, six items are labeled.



Explain why each of the following is important in maintaining the ecosystem in the aquarium.

(a) the plant

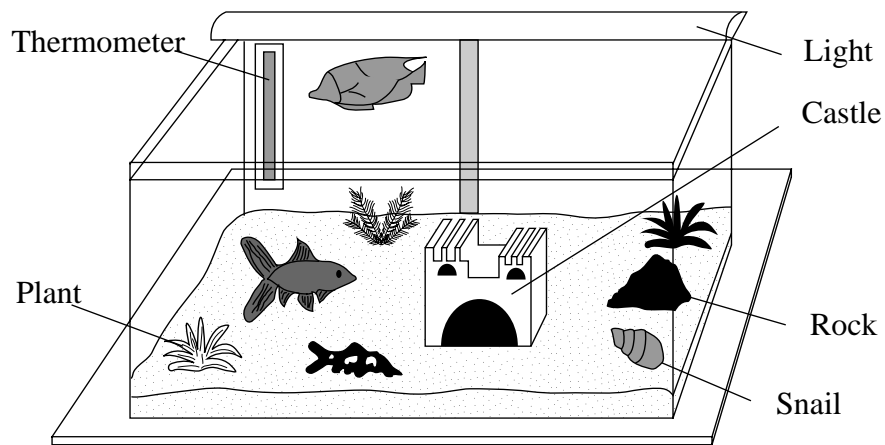
(b) the light

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### A: Codes for Plant

Code	Response
<b>Correct Response</b>	
<b>10</b>	Plants produce oxygen (by photosynthesis).
<b>11</b>	Plants clean the water.
<b>12</b>	Plants provide food for the fish.
<b>13</b>	Plants provide a place to hide/shelter, or to hide eggs.
<b>19</b>	Other correct.
<b>Incorrect Response</b>	
<b>70</b>	Plants improve the natural surroundings. <i>Examples: To make the aquarium look like an ocean.</i> <i>The fish enjoy it.</i>
<b>79</b>	Other incorrect.
<b>Nonresponse</b>	
<b>90</b>	Crossed out/erased, illegible, or impossible to interpret.
<b>99</b>	BLANK

X2. In the picture of an aquarium, six items are labeled.



Explain why each of the following is important in maintaining the ecosystem in the aquarium.

(a) the plant

X-2b

(b) the light

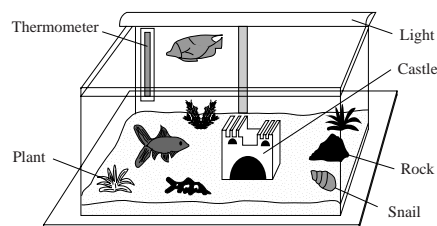
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## Part B

Subject	Item Key	Content Category	Performance Expectation	International Average Percent of Students Responding Correctly		International Difficulty Index
				Upper Grade	Lower Grade	
Science	next page	Life Science	Theorizing, Analyzing, and Solving Problems	33%	26%	685

## X-2b Coding Guide

X2. In the picture of an aquarium, six items are labeled.



Explain why each of the following is important in maintaining the ecosystem in the aquarium.

(a) the plant

(b) the light

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### B: Codes for Light

Code	Response
<b>Correct Response</b>	
<b>10</b>	Refers to photosynthesis. <i>Examples: To help the plant make photosynthesis.</i> <i>The light provides energy for the plants to make food.</i>
<b>11</b>	States that the light provides energy but does not provide further detail.
<b>19</b>	Other correct: <i>Example: Help keeps the plants alive.</i>
<b>Incorrect Response</b>	
<b>70</b>	States the light is needed so the fish can see.
<b>71</b>	States the light is needed so we can see.
<b>72</b>	Explains that light provides warmth to the fish.
<b>79</b>	Other incorrect.
<b>Nonresponse</b>	
<b>90</b>	Crossed out/erased, illegible, or impossible to interpret.
<b>99</b>	BLANK

I17. The source of energy for the Earth's water cycle is the

- A. wind
- B. Sun's radiation
- C. Earth's radiation
- D. Sun's gravity

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Subject	Item Key	Content Category	Performance Expectation	International Average Percent of Students Responding Correctly		International Difficulty Index
				Upper Grade	Lower Grade	
Science	B	Earth Science	Understanding Simple Information	41%	38%	644

K18. What is the main function of chloroplasts in a plant cell?

- A. To absorb light energy and manufacture food
- B. To remove waste materials by active transport
- C. To manufacture chemical energy from food
- D. To control the shape of the cell

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Subject	Item Key	Content Category	Performance Expectation	International Average Percent of Students Responding Correctly		International Difficulty Index
				Upper Grade	Lower Grade	
Science	A	Life Science	Understanding Simple Information	54%	50%	557

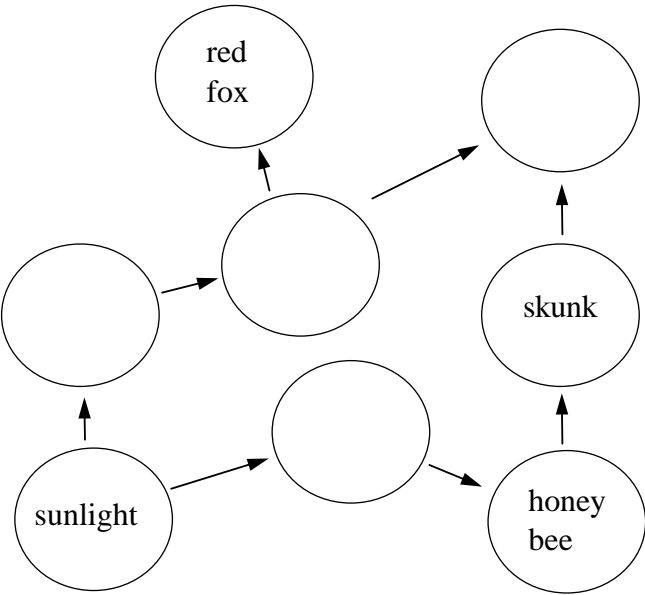
- L2. Which BEST explains why green marine algae are most often restricted to the top 100 meters of the ocean?
- A. They have no roots to anchor them to the ocean floor.
  - B. They can live only where there is light.
  - C. The pressure is too great for them to survive below 100 meters.
  - D. If the algae lived below 100 meters they would be eaten by animals.

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Subject	Item Key	Content Category	Performance Expectation	International Average Percent of Students Responding Correctly		International Difficulty Index
				Upper Grade	Lower Grade	
Science	B	Life Science	Understanding Complex Information	53%	47%	574

M11. Fill in each circle in this food web with the number of the correct plant or animal from the list. Remember that the arrows point from the energy provider to the energy user.

- 1. Owl
- 2. Rose
- 3. Grass
- 4. Rabbit



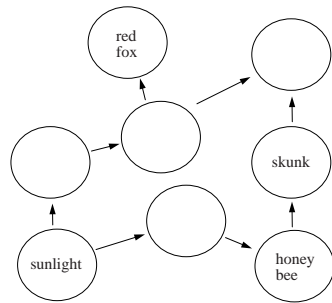
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Subject	Item Key	Content Category	Performance Expectation	International Average Percent of Students Responding Correctly		International Difficulty Index
				Upper Grade	Lower Grade	
Science	next page	Life Science	Understanding Complex Information	67%	61%	490

## M-11 Coding Guide

M11. Fill in each circle in this food web with the number of the correct plant or animal from the list. Remember that the arrows point from the energy provider to the energy user.

1. Owl
2. Rose
3. Grass
4. Rabbit



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Code	Response
<b>Correct Response</b>	
<b>10</b>	2-3-4-1 (see diagram) or appropriate names of plants/animals written in.
<b>11</b>	Three of the numbers are correct; one is missing.
<b>Incorrect Response</b>	
<b>70</b>	No number is correctly entered.
<b>71</b>	Only 2 is correct. Only 3 is correct. Only 4 is correct. Only 1 is correct.
<b>72</b>	2 and 3 only are correct. 2 and 4 only are correct. 2 and 1 only are correct. 3 and 4 only are correct. 3 and 1 only are correct. 4 and 1 only are correct.
<b>79</b>	Other incorrect.
<b>Nonresponse</b>	
<b>90</b>	Crossed out/erased, illegible, or impossible to interpret.
<b>99</b>	BLANK

O16. Write down the reason why we get thirsty on a hot day and have to drink a lot.

O-16

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Subject	Item Key	Content Category	Performance Expectation	International Average Percent of Students Responding Correctly		International Difficulty Index
				Upper Grade	Lower Grade	
Science	next page	Life Science	Theorizing, Analyzing, and Solving Problems	61%	54%	538

## O-16 Coding Guide

O16. Write down the reason why we get thirsty on a hot day and have to drink a lot.

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Code	Response
<b>Correct Response</b>	
<b>10</b>	Refers to perspiration and its cooling effect and the need to replace lost water.
<b>11</b>	Refers to perspiration and only replacement of lost water. <i>Example: Because when we are hot, our body opens the pores on our skin and we lose a lot of salt and liquid.</i>
<b>12</b>	Refers to perspiration and only its cooling effect.
<b>13</b>	Refers to perspiration or dehydration only. <i>Examples: We are sweating. Your body gives away much water. We are sweating and get drier.</i>
<b>19</b>	Other acceptable explanation.
<b>Incorrect Response</b>	
<b>70</b>	Refers to body temperature (being too hot) but does not answer why we get thirsty. <i>Example: You cool down by drinking something cold.</i>
<b>71</b>	Refers only to drying of the body. <i>Examples: Your throat/mouth gets dry. You get drier. The heat dries everything.</i>
<b>72</b>	Refers to getting more energy by drinking more water. <i>Example: You get exhausted.</i>
<b>76</b>	Merely repeats the information in the stem. <i>Examples: Because it is hot. You need water.</i>
<b>79</b>	Other incorrect: <i>Example: You lose salt.</i>
<b>Nonresponse</b>	
<b>90</b>	Crossed out/erased, illegible, or impossible to interpret.
<b>99</b>	BLANK

Large leaves on seedlings					L02
Content Category	Performance Expectation	Item Key	Score Points	International Average Percentage of 8th Grade Students Responding Correctly	Used in 1995
Life Science	Understanding Complex Information	D	1	72	N

What is the primary function of the large leaves found on seedlings growing in a forest?

A. To provide shade for the root systems

B. To get rid of excess water that is entering through the roots

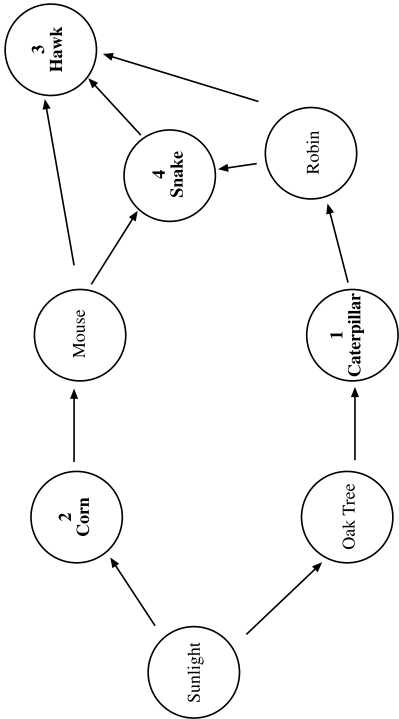
C. To allow for leaf damage by insects

D. To gather as much light as possible for photosynthesis

Complete food web					L08
Content Category	Performance Expectation	Item Key	Score Points	International Average Percentage of 8th Grade Students Responding Correctly	Used in 1995
Life Science	Understanding Complex Information	Rubric	1	55	N

An incomplete food web has been drawn for you. Complete it by filling in each of the empty circles with the number of the correct animal or plant from the list. Remember that the arrows represent energy flow and go from the provider to the user.

- 1) Caterpillar
- 2) Corn
- 3) Hawk
- 4) Snake



**Note:** There are two possible food webs that are accepted as correct. The most likely corresponds to Code 10. An alternative, but less preferred, food web with the hawk (3) and snake (4) reversed is also scored as correct (Code 11).

Code	Response	Item: S022140
	<b>Correct Response</b>	
10	Four placed correctly: 2,1,4,3 or names of animals/plants (corn, caterpillar, snake, hawk) as shown in the diagram above.	
11	Same as with Code 10 but with hawk and snake reversed.	
	<b>Incorrect Response</b>	
79	Other incorrect (including crossed out/erased, stray marks, illegible, or off task).	
	<b>Nonresponse</b>	
99	BLANK	

Result of global warming					R06
Content Category	Performance Expectation	Item Key	Score Points	International Average Percentage of 8th Grade Students Responding Correctly	Used in 1995
Environmental and Resource Issues	Understanding Simple Information	A	1	33	N

What is predicted to be a result of global warming?

A. Rising ocean level

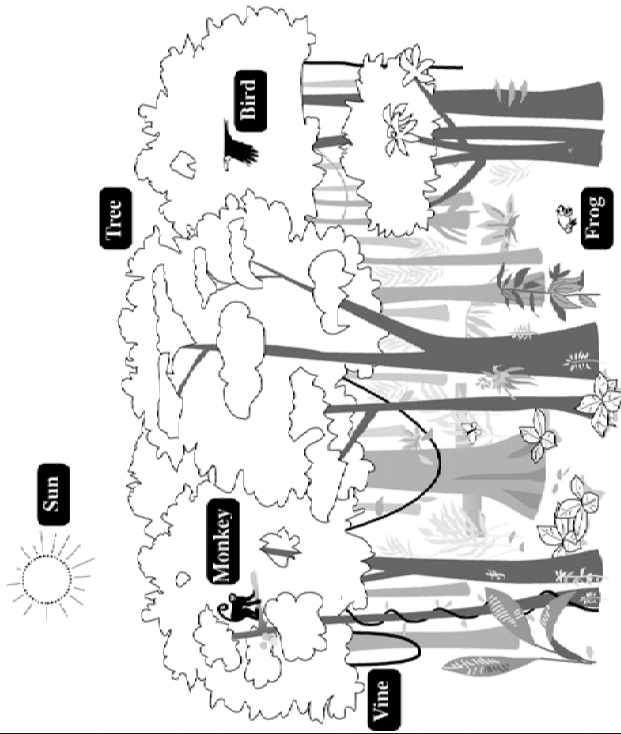
B. More severe earthquakes

C. Larger volcanic eruptions

D. Thinning ozone layer

Importance of trees/sun in rain forest				X02A
Content Category	Performance Expectation	Item Key	Score Points	International Average Percentage of 8th Grade Students Responding Correctly
Life Science	Theorizing, Analyzing and Solving Problems	Rubric	1	72
				Used in 1995
				N

In the picture of a rainforest, six objects have been labeled.



Explain why each of the following is important in maintaining the ecosystem in the rainforest.

A. The Tree

B. The Sun

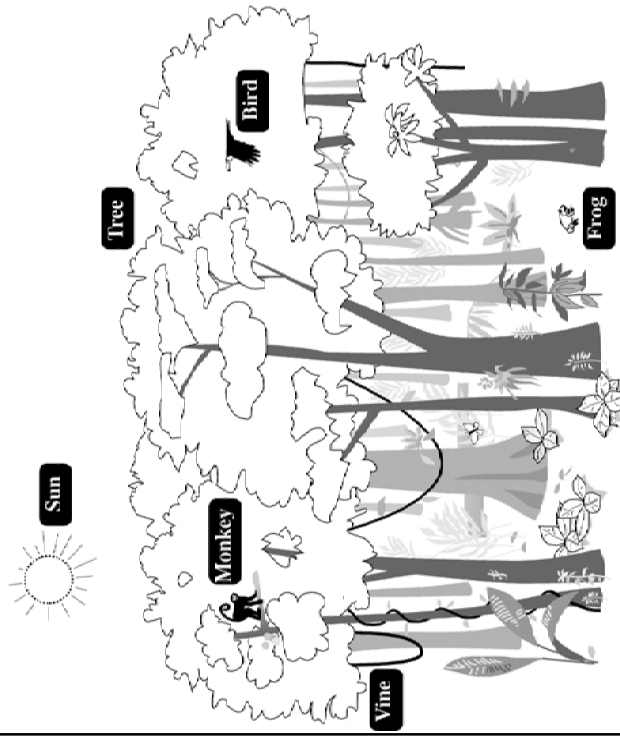
#### A: Codes for Trees

**Note:** If student response refers to oxygen/carbon dioxide cycle, use Code 10 even if other reasons are given. If more than one reason is given, assign the code corresponding to the first correct reason, giving priority to Code 10.

Code	Response	Item: S022172a
<b>Correct Response</b>		
10	Trees produce oxygen and/or use carbon dioxide. <i>Examples:</i> Trees provide oxygen. Trees are important because the ecosystem needs the oxygen they give off. The trees take in carbon dioxide and give off oxygen which animals need. The trees help the rainforest by turning the carbon dioxide into oxygen. The trees recycle carbon dioxide which animals give out.	
11	Trees provide food or energy. <i>Examples:</i> Food energy for Earth. Trees provide fruit for the animals. Animals eat leaves on trees. Trees provide energy for the ecosystem.	
12	Trees provide a place to hide/shelter. <i>Examples:</i> Trees are important because they give a home for the animals. The trees provide a habitat (for animals). Trees are where the monkeys and birds live.	
13	Trees provide shade or protection from the Sun. <i>Examples:</i> Trees block sunlight to protect animals. It would get too hot in the forest without shade from trees.	
19	Other correct.	
<b>Incorrect Response</b>		
70	Response too vague. <i>Examples:</i> You need trees for the animals. They are part of the whole ecosystem.	
79	Other incorrect (including crossed out/erased, stray marks, illegible, or off task).	
<b>Nonresponse</b>		
99	BLANK	

Importance of trees/sun in rain forest				X02B
Content Category	Performance Expectation	Item Key	Score Points	International Average Percentage of 8th Grade Students Responding Correctly
Life Science	Theorizing, Analyzing and Solving Problems	Rubric	1	68
				Used in 1995
				N

In the picture of a rainforest, six objects have been labeled.



Explain why each of the following is important in maintaining the ecosystem in the rainforest.

A. The Tree

B. The Sun

### B: Codes for Sun

**Note:** If response refers explicitly to **photosynthesis**, use Code 10 even if other reasons are given. If more than one reason is given, assign the code corresponding to the first correct reason, giving priority to Code 10 and then Code 11.

Code	Response	Item: S022172b
	<b>Correct Response</b>	
10	Sun is needed for <b>photosynthesis</b> (by plants). <i>Examples:</i> The Sun provides light energy for plants so they can grow using photosynthesis. The Sun gives energy to chlorophyll in plants to make photosynthesis.	
11	Sun is needed in order for <b>chlorophyll</b> in plants to produce food. (Does not explicitly mention <b>photosynthesis</b> ). <i>Examples:</i> The trees use chlorophyll and make their food from the Sun. Sun gives food to the trees through chlorophyll.	
12	Sun provides energy and/or is needed for plant growth. (No mention of <b>photosynthesis</b> or <b>chlorophyll</b> ). <i>Examples:</i> The Sun helps trees stay healthy and strong. The Sun helps things grow and it gives nutrients to the trees. The Sun keeps the trees and all plants living which give us oxygen. The Sun gives energy.	
13	Sun provides heat (warmth) or maintains the temperature. (No mention of <b>photosynthesis</b> or <b>chlorophyll</b> ). <i>Examples:</i> The Sun heats the Earth so the plants and animals will not freeze to death. The Sun creates heat that helps animals to grow and the trees to make their food.	
14	Sun provides light and/or enables animals to see. <i>Examples:</i> The Sun is the source of light for plants and animals. The animals need the light from the Sun in order to see.	
19	Other correct.	
	<b>Incorrect Response</b>	
70	Response too vague. <i>Examples:</i> Sun is needed by plants and animals. Everything needs the sun to survive. The Sun is probably the most important part of the ecosystem. It nourishes everything.	
79	Other incorrect (including crossed out/erased, stray marks, illegible, or off task).	
	<b>Nonresponse</b>	
99	BLANK	

Diagram of rain from sea					Z02
Content Category	Performance Expectation	Item Key	Score Points	International Average Percentage of 8th Grade Students Responding Correctly	Used in 1995
Earth Science	Theorizing, Analyzing and Solving Problems	Rubric	2	40	N

Draw a diagram to show how water from the sea can fall as rain on land.

**Note:** A fully correct response must show clear evidence of the following 4 steps:

- (i) Evaporation of water from the sea
- (ii) Condensation (as clouds)
- (iii) Transportation (from sea to land)
- (iv) Precipitation.

The steps do not have to be indicated on a labeled diagram for full credit, but the drawing and/or accompanying explanatory text must be clear with respect to the direction of water flow. Steps (ii) and (iii) may be clearly indicated as two steps (e.g. formation of clouds and transportation by wind) or as a single step showing a series of clouds extending over land and sea.

Code	Response	Item: S022090
	<b>Correct Response</b>	
20	Response includes a diagram indicating all 4 steps (i, ii, iii, and iv above) and direction of water flow.	
21	No diagram is shown, but response includes a complete and correct textual description of the water cycle. <i>Example: The water evaporates from the sea and forms clouds. Then, when the clouds are blown over the land, it rains.</i>	
29	Other fully correct.	
	<b>Partial Response</b>	
10	As in Code 20 or 21 but evaporation is unclear or omitted.	
11	As in Code 20 or 21 but condensation is unclear or omitted.	
12	As in Code 20 or 21 but transportation is unclear or omitted.	
13	As in Code 20 or 21 but precipitation is unclear or omitted.	
19	Other partially correct.	
	<b>Incorrect Response</b>	
70	Response clearly indicates evaporation and/or condensation only.	
71	Response clearly indicates precipitation only (may also show clouds).	
79	Other incorrect (including crossed out/erased, stray marks, illegible, or off task).	
	<b>Nonresponse</b>	
99	BLANK	

**TIMSS 2003**

Content Domain

**Environmental Science**

Main Topic

**Changes in environment**

Cognitive Domain

**Factual Knowledge**

Key

**A**

S012017

The burning of fossil fuels has increased the carbon dioxide content of the atmosphere. What is a possible effect that the increased amount of carbon dioxide is likely to have on our planet?

- Ⓐ A warmer climate
- Ⓑ A cooler climate
- Ⓒ Lower relative humidity
- Ⓓ More ozone in the atmosphere

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**TIMSS 2003**

Content Domain

**Life Science**

Main Topic

**Structure, function and life  
processes in organisms**

Cognitive Domain

**Conceptual Understanding**

Key

**See scoring guide**

What processes take place in the human body that prevent it from overheating during exercise?

S022152

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**Note:** Priority is given to Codes 10 and 11. If perspiration or sweating is mentioned, use Code 10 or 11, even if other correct responses such as increased blood flow to the skin are also included.

Code	Response	Item: S022152
	<b>Correct Response</b>	
10	Refers to perspiration (sweating) AND the cooling effect of evaporation. <i>Examples: When people sweat, it evaporates to cool them down.</i> <i>Sweating. When the sweat evaporates, it cools the skin.</i> <i>Perspiration cools you down when it evaporates.</i>	
11	Refers to perspiration (sweating), without explicitly mentioning the cooling effect of evaporation. <i>Examples: The body sweats.</i> <i>Perspiration keeps you from overheating.</i> <i>The perspiration cools you off and you don't stay hot.</i>	
12	Refers to increased blood flow to the skin. <i>Examples: The blood rushes to your face and cools you down.</i>	
19	Other correct	
	<b>Incorrect Response</b>	
70	Refers only to drinking water to cool down.	
71	Refers to an effect of exercise but does not specifically address overheating and/or cooling. <i>Examples: The blood pumps faster.</i> <i>Breathing increases.</i> <i>Your body is working hard and using up more food energy.</i>	
79	Other incorrect (including crossed out/erased, stray marks, illegible, or off task)	
	<b>Nonresponse</b>	
99	Blank	

## TIMSS 2003

Content Domain

Life Science

Main Topic

Cells and their functions

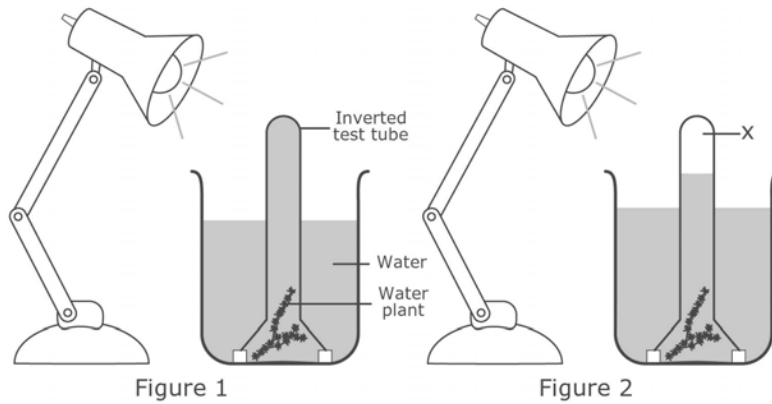
Cognitive Domain

Reasoning and Analysis

Key

See scoring guide

The picture shows how a student set up some apparatus in a laboratory for an investigation. The inverted test tube was completely filled with water at the beginning of the investigation as shown in Figure 1. After several hours, the level of water in the test tube had gone down as shown in Figure 2.



What is contained in the top part of the test tube labeled X in Figure 2?

(Check one box.)

- ☐ air  
☐ oxygen  
☐ carbon dioxide  
☐ vacuum

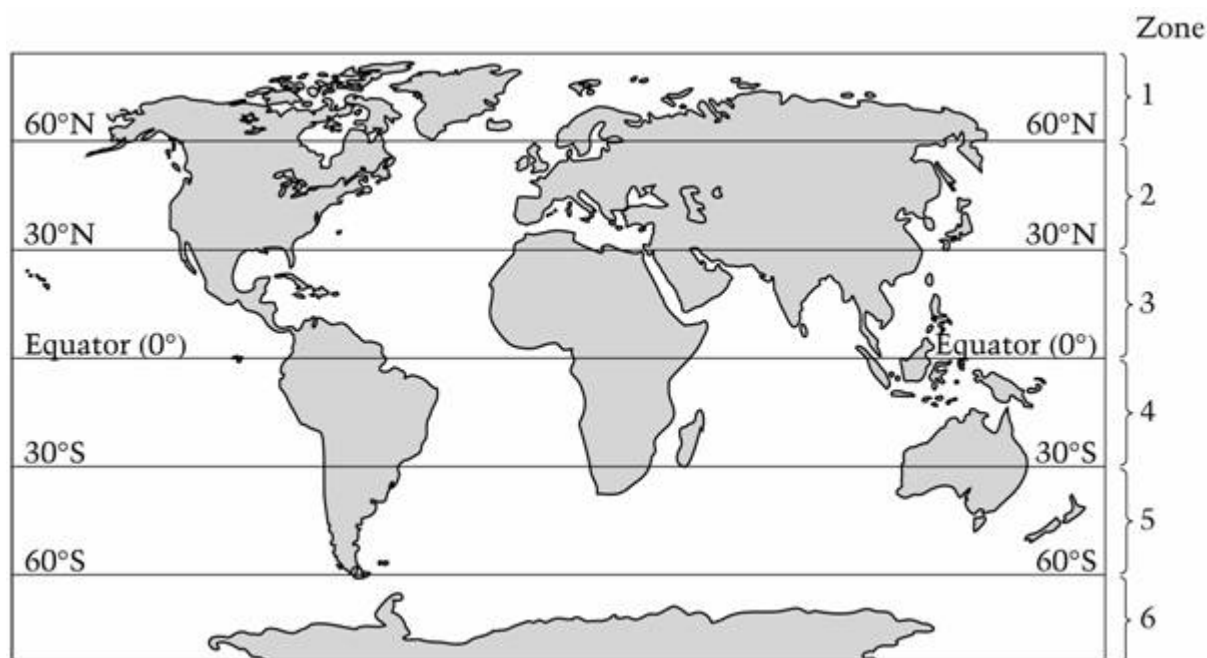
Explain your answer.

S032206

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Code	Response	Item: S032206
	<b>Correct Response</b>	
10	<b>OXYGEN</b> with an explanation that explicitly refers to <b>photosynthesis</b> (or equivalent). <i>Examples: Photosynthesis takes place. Plants use carbon dioxide from the water and give off oxygen.</i> <i>During photosynthesis, plants produce oxygen and glucose.</i>	
11	Gives an explanation that explicitly refers to <b>photosynthesis</b> , but checks <b>CARBON DIOXIDE</b> or <b>AIR</b> . <i>Examples: CARBON DIOXIDE. The plant undergoes photosynthesis.</i> <i>AIR. When the plant photosynthesizes it takes in carbon dioxide and gives off air.</i>	
12	<b>OXYGEN</b> with a minimal explanation based on carbon dioxide/oxygen exchange involving plants. [No explicit mention of photosynthesis.] <i>Examples: Plants take in carbon dioxide and give off oxygen.</i> <i>Plants give off oxygen.</i>	
19	Other correct	
	<b>Incorrect Response</b>	
70	<b>OXYGEN</b> with no explanation or an incorrect explanation not related to plant processes. <i>Examples: Because the heat has evaporated the water and the oxygen pressure is too great.</i> <i>Because water is made up of 2 parts hydrogen and 1 part oxygen. Some hydrogen has detached from the oxygen, leaving the oxygen in the top of the tube.</i>	
71	<b>CARBON DIOXIDE</b> with no explanation or an incorrect explanation (not based on photosynthesis). <i>Examples: There is carbon dioxide in the water and it bubbles up when it is heated by the light.</i>	
72	<b>AIR</b> with no explanation or an incorrect explanation (not based on photosynthesis). <i>Examples: The plant has dissolved half the water and there is nothing in the tube left but air.</i> <i>When the water gets warm enough it will start to evaporate into air.</i>	
73	<b>VACUUM</b> with no explanation or an incorrect explanation. <i>Examples: The plant has taken in the oxygen from the water and left a vacuum at the top.</i>	
79	Other incorrect (including crossed out/erased, stray marks, illegible or off task)	
	<b>Nonresponse</b>	
99	Blank	

\* : Revised following data collection.



1. Which zones in the map above are most likely to have a temperate climate (warm summers and cold winters) ?

- A) 1 and 6
- B) 2 and 5
- C) 3 and 4
- D) 1, 2, and 3

2. When you exercise strenuously, your body produces excess heat. Describe what your body does to help prevent your temperature from rising excessively, and explain why the body's response is effective.

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Some scientists think that the Earth's climate is getting warmer.

3. If these scientists are correct and the Earth keeps getting warmer for the next 50 years, what will happen to the oceans? Explain why this would happen.

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If these scientists are correct, what things about the Earth's weather will change? Explain why this would happen.

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If these scientists are correct, what will happen to plants? Explain why this would happen.

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4. The Earth's climate may be getting warmer because of some things that people do. List two human activities that may contribute to warming of the Earth's climate.

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5. Air in the atmosphere continuously moves by convection. At the equator, air rises; at the poles, it sinks. This occurs because

- A) the Earth's ozone layer is thinner at the equator than at the poles
- B) the Earth's magnetic field is stronger at the poles than at the equator
- C) warm air can hold less water vapor than can cold air
- D) warm air is less dense than cold air

Question 1**Key**

1. Which zones in the map above are most likely to have a temperate climate (warm summers and cold winters) ?

-  A) 1 and 6  
B) 2 and 5  
C) 3 and 4  
D) 1, 2, and 3

Question 2**Scoring Guide**

Score & Description
<b>Complete</b> Student indicates that the body keeps its temperature from rising through sweating or by blood vessels dilating and states how these are effective.
<b>Partial</b> Student indicates that the body keeps its temperature from rising through sweating or by blood vessels dilating but does not explain fully how the mechanism works.
<b>Unsatisfactory/Incorrect</b> Student provides little or no evidence of knowledge of any mechanism for losing heat during exercise.

Question 3**Scoring Guide**

<b>Score &amp; Description</b>
<b>Complete</b> Student predicts the effects on oceans, weather, and plants and explains why each predicted event might occur. Response consists of six correct parts: a prediction and an explanation for each of oceans, weather, and plants.
<b>Essential</b> Student response consists of three to five correct parts.
<b>Partial</b> Student response consists of one or two correct parts.
<b>Unsatisfactory/Incorrect</b> Student response does not include any predictions of the effects of global warming.

Question 4**Scoring Guide**

<b>Score &amp; Description</b>
<b>Complete</b> Student lists two human activities that are thought to contribute to global warming.
<b>Partial</b> Student lists one activity that may contribute to global warming.
<b>Unsatisfactory/Incorrect</b> Student response does not indicate an understanding of the relationship of humans to global warming.

Question 5**Key**

5. Air in the atmosphere continuously moves by convection. At the equator, air rises; at the poles, it sinks. This occurs because
- A) the Earth's ozone layer is thinner at the equator than at the poles
  - B) the Earth's magnetic field is stronger at the poles than at the equator
  - C) warm air can hold less water vapor than can cold air
  - D) warm air is less dense than cold air

G2. When a small volume of water is boiled, a large volume of steam is produced. Why?

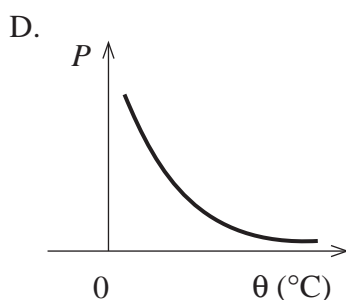
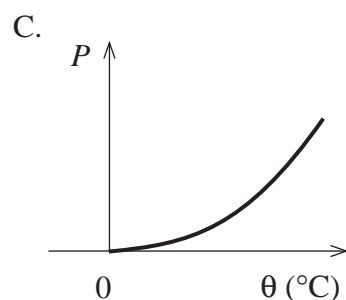
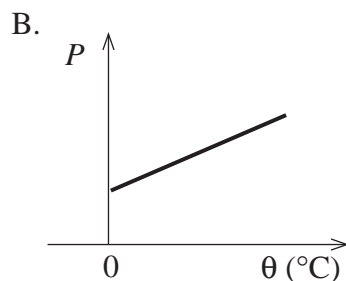
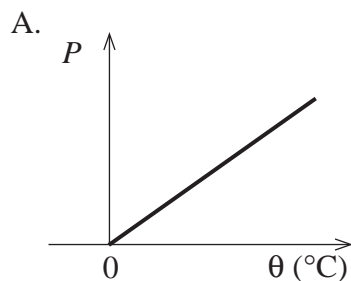
- A. The molecules are further apart in steam than in water.
- B. Water molecules expand when heated.
- C. The change from water to steam causes the number of molecules to increase.
- D. Atmospheric pressure works more on water molecules than on steam molecules.
- E. Water molecules repel each other when heated.

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Subject	Item Key	Content Category	Performance Expectation	International Average Percent of Students Responding Correctly	International Difficulty Index
Physics	A	Heat	Theorizing, Analyzing, and Solving Problems	65%	502

H7. A fixed mass of gas is heated at constant volume.

Which one of the following diagrams best shows the correct shape of the graph of pressure ( $P$ ) against temperature ( $\theta$ ) for the gas? Temperature is measured in degrees Celsius ( $^{\circ}\text{C}$ ).

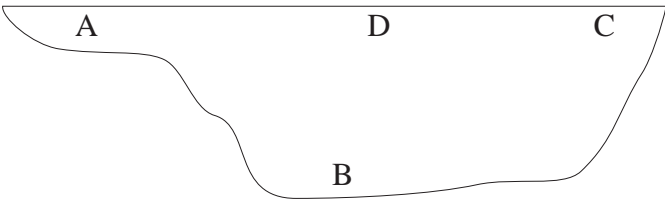


H-7

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Subject	Item Key	Content Category	Performance Expectation	International Average Percent of Students Responding Correctly	International Difficulty Index
Physics	B	Heat	Using Tools, Routine Procedures, and Science Processes	41%	650

H14. Here is a cross-section of a lake in the mountains. The air temperature gets below freezing in the winter and stays below freezing for 3 months.



Not all of the water in the lake freezes. Which part of the lake will remain the warmest? Explain.

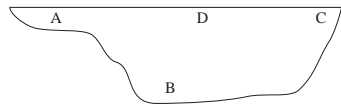
H-14

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Subject	Item Key	Content Category	Performance Expectation	International Average Percent of Students Responding Correctly	International Difficulty Index
Physics	next page	Heat	Understanding	13%	804

## H-14 Coding Guide

H14. Here is a cross-section of a lake in the mountains. The air temperature gets below freezing in the winter and stays below freezing for 3 months.



Not all of the water in the lake freezes. Which part of the lake will remain the warmest? Explain.

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Code	Response
	<b>Correct Response</b>
20	B. Response refers to the maximum density of water (or the water is heaviest) at 4 degrees Celsius. <i>Example: Warmest at B because water has greatest density at 4° C so this water will stay there.</i>
29	Other acceptable responses.
	<b>Partial Response</b>
10	B. Refers to the fact that the water is 4 degrees Celsius at B without mentioning density.
11	B. Refers to the fact that ice will insulate this part of the water and/or that water is a bad heat conductor. <i>Examples: a) The surface will freeze first and then downwards. b) It takes time for heat and cold to get there.</i>
19	Other partially correct responses.
	<b>Incorrect Response</b>
70	B. No explanation.
71	B. Incorrect explanation referring to the heat from the earth (closer to the earth's center). <i>Example: The heat from the Earth will give heat to the water.</i>
72	B. Refers to the fact that hot water is heavier than cold water.
73	A/D/C with or without explanation.
76	Merely repeats information in the stem. <i>Example: B is the deepest point of the lake.</i>
79	Other unacceptable responses.
	<b>Nonresponse</b>
90	Crossed-out/erased, illegible, or impossible to interpret.
99	BLANK

- J4. Which is an example of a chemical reaction?
- A. The melting of ice
  - B. The grinding of salt crystals to powder
  - C. The burning of wood
  - D. The evaporation of water from a puddle

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Subject	Item Key	Content Category	Performance Expectation	International Average Percent of Students Responding Correctly		International Difficulty Index
				Upper Grade	Lower Grade	
Science	C	Chemistry	Understanding Simple Information	47%	35%	635

- L6. On cold days, snakes usually lie very still and eat little or nothing, while birds usually move around and eat a lot of food. Which statement best explains this?
- A. Both animals are cold-blooded, but without feathers to keep warm, snakes get too cold to move.
  - B. Unlike birds, snakes are warm-blooded; they must hibernate during cold weather.
  - C. Unlike snakes, birds are cold-blooded; they are less affected by the cold than snakes.
  - D. Unlike snakes, birds are warm-blooded; they must eat food to maintain a constant temperature.

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Subject	Item Key	Content Category	Performance Expectation	International Average Percent of Students Responding Correctly		International Difficulty Index
				Upper Grade	Lower Grade	
Science	D	Life Science	Theorizing, Analyzing, and Solving Problems	54%	50%	571

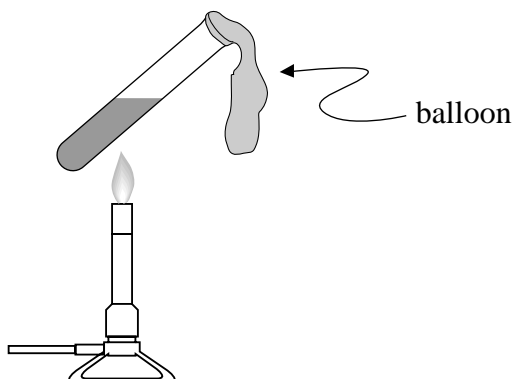
M13. When oil is burning, the reaction will

- A. only release energy
- B. only absorb energy
- C. neither absorb nor release energy
- D. sometimes release and sometimes absorb energy depending on the oil

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Subject	Item Key	Content Category	Performance Expectation	International Average Percent of Students Responding Correctly		International Difficulty Index
				Upper Grade	Lower Grade	
Science	A	Chemistry	Understanding Simple Information	51%	41%	604

- P5. The water in a tube is heated, as shown in the diagram. As the water is heated, the balloon increases in size. Explain why.



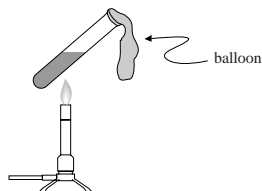
P-5

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Subject	Item Key	Content Category	Performance Expectation	International Average Percent of Students Responding Correctly		International Difficulty Index
				Upper Grade	Lower Grade	
Science	next page	Physics	Theorizing, Analyzing, and Solving Problems	58%	52%	549

## P-5 Coding Guide

P5. The water in a tube is heated, as shown in the diagram. As the water is heated, the balloon increases in size. Explain why.



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Code	Response
<b>Correct Response</b>	
<b>10</b>	Mentions explicitly that expansion is due to increased pressure of air/gas/water vapor when tube is heated.
<b>11</b>	States that the water evaporates.
<b>19</b>	Other correct.
<b>Incorrect Response</b>	
<b>70</b>	Mentions that hot air[or gas] always rises.
<b>71</b>	Mentions that air particles [or molecules] expand when heated.
<b>76</b>	Merely repeats information in the stem. <i>Example: Because it is heated.</i>
<b>79</b>	Other incorrect.
<b>Nonresponse</b>	
<b>90</b>	Crossed out/erased, illegible, or impossible to interpret.
<b>99</b>	BLANK

Y2. One day when the temperature was just below 0°C, Peter and Ann made snowballs. They put a thermometer into one of the snowballs and it showed 0°C. They tried to make the snowball warmer by holding it in their hands. What do you think the thermometer showed after two minutes? Explain your answer.

Y-2

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Subject	Item Key	Content Category	Performance Expectation	International Average Percent of Students Responding Correctly		International Difficulty Index
				Upper Grade	Lower Grade	
Science	next page	Physics	Theorizing, Analyzing, and Solving Problems	13%	10%	792

## Y-2 Coding Guide

Y2. One day when the temperature was just below 0°C, Peter and Ann made snowballs. They put a thermometer into one of the snowballs and it showed 0°C. They tried to make the snowball warmer by holding it in their hands. What do you think the thermometer showed after two minutes? Explain your answer.

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Code	Response
<b>Correct Response</b>	
<b>20</b>	Reports 0 degrees or mentions "the same temperature". The explanation includes: Snow cannot be warmer than 0 degrees. <i>Example: The melting point of snow is 0 degrees.</i>
<b>29</b>	Other correct.
<b>Partial Response</b>	
<b>10</b>	0 degrees or "the same temperature". No explanation or an <u>incorrect explanation</u> .
<b>19</b>	0 degrees or "the same temperature" <i>Example: Some snow melts, but it will not be warmer.</i> Other partially correct.
<b>Incorrect Response</b>	
<b>70</b>	Above 0 degrees, because the hands are warm.
<b>71</b>	Above 0 degrees, because the snow melts.
<b>72</b>	Above 0 degrees: No explanation.
<b>79</b>	Other incorrect.
<b>Nonresponse</b>	
<b>90</b>	Crossed out/erased, illegible, or impossible to interpret.
<b>99</b>	BLANK

Burning wood absorbs/releases energy						H06
Content Category	Performance Expectation	Item Key	Score Points	International Average Percentage of 8th Grade Students Responding Correctly	Used in 1995	
Chemistry	Understanding Simple Information	A	1	55	Y	

If you are burning wood, the reaction will

A. release energy

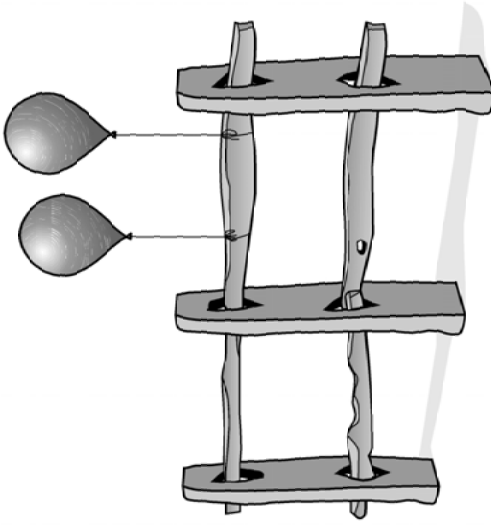
B. absorb energy

C. neither absorb nor release energy

D. sometimes release and sometimes absorb energy, depending on the kind of wood

Heat expansion of balloons					Z03
Content Category	Performance Expectation	Item Key	Score Points	International Average Percentage of 8th Grade Students Responding Correctly	Used in 1995
Physics	Theorizing, Analyzing and Solving Problems	Rubric	1	26	N

Balloons filled with helium gas are taken outside on a hot, sunny day and tied to a fence as shown in the diagram.



Over a period of a few hours, the balloons increase in size. Explain why.

**Note:** A correct response is based on an increase in gas volume (or internal gas pressure) as a result of increased temperature. Credit is given for both higher-level responses relating to the increased kinetic energy of helium atoms as a function of temperature (Code 10) as well as more general responses relating to increased internal gas pressure and/or gas volume (Code 11). An increase in temperature does not have to be explicitly mentioned in order to receive credit. Responses referring ONLY to the **balloon** expanding or to the effect of temperature on the **balloon** without further explanation of the gas behavior are scored as incorrect.

Code	Response	Item: S022048
<b>Correct Response</b>		
10	Mentions explicitly that (as the gas in the balloon heats up), the helium (gas) <b>atoms</b> (particles, molecules) move faster (collide more frequently) causing the pressure inside the balloon to increase and/or the volume to increase (expand). <i>Examples: As helium is heated the particles move around faster and make the balloon expand. The gas molecules bounce around a lot more when heated, so the volume increases.</i>	
11	Mentions that the pressure of the gas inside the balloon increases and/or the volume of the gas increases (expands). (No mention of gas <b>atoms/molecules</b> ). <i>Examples: The balloon expands because of the pressure building up inside. When the heat is added, the gas expands and the balloon stretches. As the temperature goes up, the pressure in the balloon becomes greater than the atmospheric pressure. The volume of gas goes up as the temperature goes up.</i>	
19	Other correct.	
<b>Incorrect Response</b>		
70	Mentions <b>only</b> that the sun heats the helium (gas) and/or causes the <b>balloon</b> to expand. [No reference to the pressure/volume changes in the gas.] <i>Examples: The heat caused the balloon to expand. The sun heats up the helium and the rubber expands.</i>	
71	Mentions pressure and/or volume with inadequate explanation. <i>Examples: It is because of the great pressure. The volume changes.</i>	
72	Mentions <b>only</b> the effect of heat (from Sun) on the balloon material (rubber, latex). <i>Examples: The heat makes the rubber weaker. The rubber is melted by the sun.</i>	
73	Refers to (individual) <b>atoms or molecules</b> expanding (or growing). <i>Examples: The helium particles grow when they heat up. Because the gas atoms expanded.</i>	
79	Other incorrect (including crossed out/erased, stray marks, illegible, or off task).	
<b>Nonresponse</b>		
99	BLANK	

**TIMSS 2003**

Content Domain

**Chemistry**

Main Topic

**Chemical change**

Cognitive Domain

**Conceptual Understanding**

Key

**C**

Some chemical reactions absorb energy, while others release energy. Of the chemical reactions in burning coal and exploding fireworks, which will release energy?

- Ⓐ Burning coal only
- Ⓑ Exploding fireworks only
- Ⓒ Both burning coal and exploding fireworks
- Ⓓ Neither burning coal nor exploding fireworks

S022188

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**TIMSS 2003**

Content Domain

**Chemistry**

Main Topic

**Chemical change**

Cognitive Domain

**Conceptual Understanding**

Key

**B**

S012003

Fanning can make a wood fire burn hotter because the fanning

- Ⓐ makes the wood hot enough to burn
- Ⓑ adds more oxygen needed for burning
- Ⓒ increases the amount of wood there is to burn
- Ⓓ provides the energy needed to keep the fire going

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**TIMSS 2003**

Content Domain

**Physics**

Main Topic

**Physical states and changes  
in matter**

Cognitive Domain

**Factual Knowledge**

Key

**D**

A wet towel will dry when it is left in the Sun. Which process occurs to make this happen?

- (A) melting
- (B) boiling
- (C) condensation
- (D) evaporation

S032055

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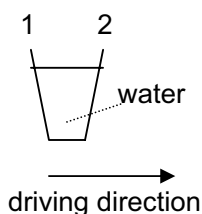
## S127: Buses

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### Question 1: BUSES

S127Q01

A bus is driving along a straight stretch of road. The bus driver, named Ray, has a cup of water resting on the dashboard:



Suddenly Ray has to slam on the brakes.

What is most likely to happen to the water in the cup?

- A The water will stay horizontal.
- B The water will spill over side 1.
- C The water will spill over side 2.
- D The water will spill but you cannot tell if it will spill at side 1 or side 2.

### BUSES SCORING 1

QUESTION INTENT: Process: Demonstrating knowledge and understanding  
Theme: Forces and movement  
Area: Science in technologies

#### ***Full credit***

Code 1: C. The water will spill over side 2.

#### ***No credit***

Code 0: Other responses.

Code 9: Missing.

---

**Question 4: BUSES**

S127Q04- 0 1 8 9

Ray's bus is, like most buses, powered by a petrol engine. These buses contribute to environmental pollution.

Some cities have trolley buses: they are powered by an electric engine. The voltage needed for such an electric engine is provided by overhead lines (like electric trains).

The electricity is supplied by a power station using fossil fuels.

Supporters for the use of trolley buses in a city say that these buses don't contribute to environmental pollution.

Are these supporters right? Explain your answer. ....

.....

.....

.....

**BUSES SCORING 4**

QUESTION INTENT: Process: Demonstrating knowledge and understanding

Theme: Energy transformations

Area: Science in Earth and environment

**Full credit**

Code1: Gives an answer in which it is stated that the power station also contributes to environmental pollution:

- No, because the power station causes environmental pollution as well.
- Yes, but this is only true for the city itself; the power station however causes environmental pollution.

**No credit**

Code 0: No or yes, without a correct explanation.

Code 8: Off task.

Code 9: Missing.

**Example responses**

Code 1:

- Yes and No. The buses don't pollute the city which is good, but the power station does pollute and that's not very good.
- The buses do contribute to the environmental pollution by using fossil fuels but they're not as harmful as normal buses with all their gases. *[Note: This answer can be given the benefit of the doubt.]*

Code 0:

- Well they have no outlet so no harmful smoke goes into the air which can damage the O-zone layer, and having electricity created by fossil fuels is also more environmental friendly.
- Yes, they are. Because electricity isn't harmful for the environment we only use up our Earth's gas.

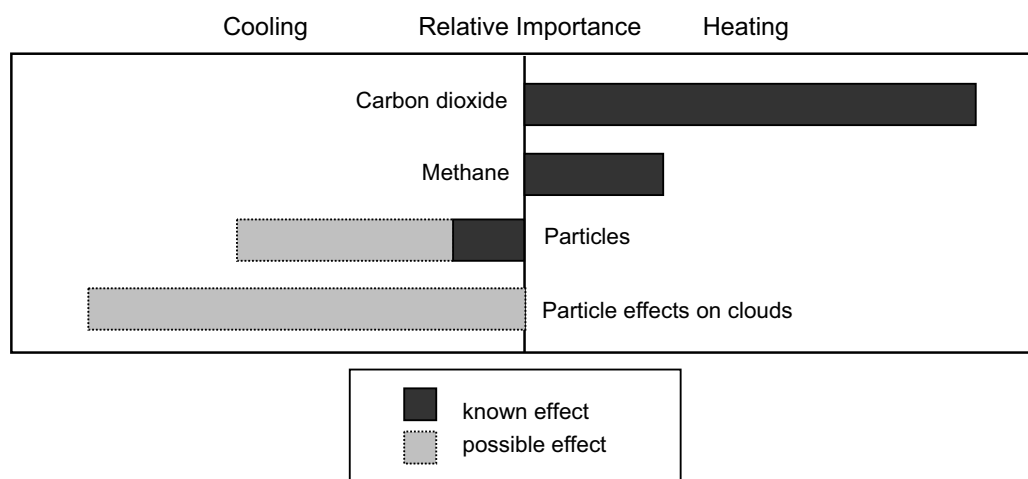
## S210: Climate Change

### Climate Change Text 1

Read the following information and answer the questions which follow.

#### WHAT HUMAN ACTIVITIES CONTRIBUTE TO CLIMATE CHANGE?

The burning of coal, oil and natural gas, as well as deforestation and various agricultural and industrial practices, are altering the composition of the atmosphere and contributing to climate change. These human activities have led to increased concentrations of particles and greenhouse gases in the atmosphere. The relative importance of the main contributors to temperature change is shown in Figure 1. Increased concentrations of carbon dioxide and methane have a heating effect. Increased concentrations of particles have a cooling effect in two ways, labelled 'Particles' and 'Particle effects on clouds'.



**Figure 1: Relative importance of the main contributors to change in temperature of the atmosphere.**

Bars extending to the right of the centre line indicate a heating effect. Bars extending to the left of the centre line indicate a cooling effect. The relative effect of 'Particles' and 'Particle effects on clouds' are quite uncertain: in each case the possible effect is somewhere in the range shown by the light grey bar.

Source: adapted from <http://www.gcric.org/ipcc/qa/04.html>

---

**Question 1: CLIMATE CHANGE**

S210Q01- 0 1 2 8 9

Use the information in Figure 1 to develop an argument in support of reducing the emission of carbon dioxide from the human activities mentioned.

.....

.....

.....

**CLIMATE CHANGE SCORING 1**

QUESTION INTENT: Process: Communicating  
Theme: The Earth and its place in the universe  
Area: Science in Earth and environment

**Full credit**

Code 2: Carbon dioxide is the main factor causing an increase in atmospheric temperature/causing climatic change, so reducing the amount emitted will have the greatest effect in reducing the impact of human activities.

**Partial credit**

Code 1: Carbon dioxide is causing an increase in atmospheric temperature/causing climatic change.

**No credit**

Code 0: Other responses, including that an increase in temperature will have a bad effect on the Earth.

Code 8: Off task.

Code 9: Missing.

**Example responses**

Code 2:

- The emission of CO<sub>2</sub> causes significant heating to the atmosphere and therefore should be lessened. [Note: The term “significant” can be considered as equivalent to “most”.]
- According to figure 1 reduction in the emission of carbon dioxide is necessary because it considerably heats the earth. [Note: The term “considerable” can be considered as equivalent to “most”.]

Code 1:

- The burning of fossil fuel such as oil, gas and coal are contributing to the build up of gases in the atmosphere, one of which is carbon dioxide (CO<sub>2</sub>). This gas affects the temperature of the earth which increases causing a greenhouse effect.

Code 0:

- The way that humans could help control carbon dioxide levels to drop would be by not driving a car, don't burn coal and don't chop down forests. [Note: No consideration given to the effect of carbon dioxide on temperature.]

## S307: Corn

---

*Consider the following newspaper report.*

### **DUTCHMAN USES CORN AS FUEL**

Auke Ferwerda's stove contains a few logs burning quietly with low flames. From a paper bag next to the stove he takes a handful of corn and puts it onto the flames. Immediately the fire flares up brightly. "Look here," Ferwerda says, "The window of the stove stays clean and transparent. Combustion is complete." Ferwerda talks about the fact that corn can be used as fuel as well as cattle food. As far as he is concerned, this is the future.

---

Ferwerda points out that corn, in the form of cattle food, is in fact a type of fuel too. Cows eat corn to get energy out of it. But, Ferwerda explains, the sale of corn for fuel instead of for cattle food might be much more profitable for farmers.

Ferwerda has become convinced that, in the long run, corn will be widely used as fuel. He imagines what it will be like harvesting, storing, drying and packing the grains in bags for sale.

Ferwerda is currently investigating whether the whole corn plant could be used as fuel, but this research has not been completed yet.

What Ferwerda also needs to consider is the amount of attention being focused on carbon dioxide. Carbon

dioxide is regarded as the main cause of the increase of the Greenhouse effect. The increase of the Greenhouse effect is said to be the cause of the increasing average temperature of the Earth's atmosphere.

In Ferwerda's view, however, there is nothing wrong with carbon dioxide. On the contrary, he argues, plants absorb it and convert it into oxygen for human beings.

However, Ferwerda's plans may clash with those of the government, which is actually trying to reduce the emission of carbon dioxide. Ferwerda says, "There are many scientists who say that carbon dioxide is not the main cause of the Greenhouse effect."

---

**Question 2: CORN**

S307Q02

Ferwerda compares corn used as fuel to corn used as food.

The first column of the table below contains a list of things that happen when corn burns.

Do these things also happen when corn works as a fuel in an animal body?

Circle Yes or No for each.

When corn burns:	Does this also happen when corn works as a fuel in an animal body?
Oxygen is consumed.	Yes / No
Carbon dioxide is produced.	Yes / No
Energy is produced.	Yes / No

**CORN SCORING 2****Full credit**

Code 1: Yes, Yes, Yes.

**No credit**

Code 0: Other responses.

Code 9: Missing.

---

**Question 5: CORN**

S307Q05 - 0 1 9

In the article a conversion of carbon dioxide is described: "...plants absorb it and convert it into oxygen ...".

There are more substances involved in this conversion than carbon dioxide and oxygen only. The conversion can be represented in the following way:

carbon dioxide + water → oxygen +

Write in the box the name of the missing substance.

**CORN SCORING 5****Full credit**

Code 1: One of the following names:

- glucose

- sugar(s)
- carbohydrate(s)
- saccharide(s)
- starch

**No credit**

Code 0: Other responses.

Code 9: Missing.

### Question 7: CORN

S307Q07

At the end of the article Ferwerda refers to scientists who say that carbon dioxide is not the main cause of the Greenhouse effect.

Karin finds the following table showing the relative Greenhouse effect caused by four gases:

Relative Greenhouse effect per molecule of gas			
Carbon dioxide	Methane	Nitrous oxide	Chlorofluorocarbons
1	30	160	17 000

From this table Karin cannot conclude which gas is the main cause of the increase of the Greenhouse effect. The data in the table need to be combined with other data for Karin to conclude which gas is the main cause of the increase of the Greenhouse effect.

Which other data does Karin need to collect?

- A Data about the origin of the four gases.
- B Data about the absorption of the four gases by plants.
- C Data about the size of each of the four types of molecules.
- D Data about the amounts of each of the four gases in the atmosphere.

### CORN SCORING 7

**Full credit**

Score 1: D. Data about the amounts of each of the four gases in the atmosphere.

**No credit**

Score 0: Other responses.

Code 9: Missing.

## S420: Hot Work

---

### Question 1: HOT WORK

S420Q01

Peter is working on repairs to an old house. He has left a bottle of water, some metal nails, and a piece of timber inside the boot of his car. After the car has been out in the sun for three hours, the temperature inside the car reaches about 40 °C.

What happens to the objects in the car? Circle “Yes” or “No” for each statement.

Does this happen to the object(s)?	Yes or No?
They all have the same temperature.	Yes / No
After some time the water begins to boil.	Yes / No
After some time the metal nails begin to glow red.	Yes / No

### HOT WORK SCORING 1

#### **Full credit**

Code 1: All three correct: Yes, No, No, in that order.

#### **No credit**

Code 0: Other responses.

Code 9: Missing.

---

### Question 3: HOT WORK

S420Q03

For drinks during the day, Peter has a cup of hot coffee, at a temperature of about 90 °C, and a cup of cold mineral water, with a temperature of about 5 °C. The cups are of identical type and size and the volume of each drink is the same. Peter leaves the cups sitting in a room where the temperature is about 20 °C.

What are the temperatures of the **coffee** and the **mineral water** likely to be after 10 minutes?

- A 70 °C and 10 °C
- B 90 °C and 5 °C
- C 70 °C and 25 °C
- D 20 °C and 20 °C

### HOT WORK SCORING 3

#### **Full credit**

Code 1: A. 70 °C and 10 °C

#### **No credit**

Code 0: Other responses.

Code 9: Missing.

#### **Question 10N: HOT WORK**

S420Q10N

How much interest do you have in the following information?

*Tick only one box in each row.*

	<i>High Interest</i>	<i>Medium Interest</i>	<i>Low Interest</i>	<i>No Interest</i>
a) Understanding how the shape of the cup influences the speed at which coffee cools	<input type="checkbox"/> <sub>1</sub>	<input type="checkbox"/> <sub>2</sub>	<input type="checkbox"/> <sub>3</sub>	<input type="checkbox"/> <sub>4</sub>
b) Learning about the different arrangements of atoms in wood, water and steel	<input type="checkbox"/> <sub>1</sub>	<input type="checkbox"/> <sub>2</sub>	<input type="checkbox"/> <sub>3</sub>	<input type="checkbox"/> <sub>4</sub>
c) Knowing why different solids conduct heat differently	<input type="checkbox"/> <sub>1</sub>	<input type="checkbox"/> <sub>2</sub>	<input type="checkbox"/> <sub>3</sub>	<input type="checkbox"/> <sub>4</sub>

## S529: Wind Farms

Many people believe that wind should replace oil and coal as a source of energy for producing electricity. The structures in the picture are windmills with blades that are rotated by the wind. These rotations cause electricity to be produced by generators that are turned by the windmills.

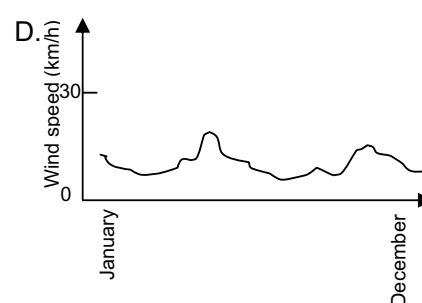
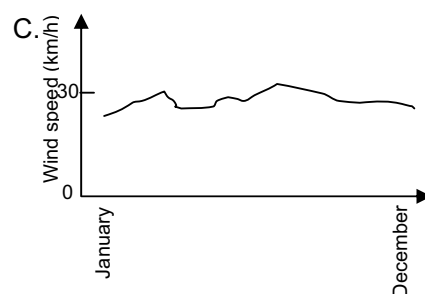
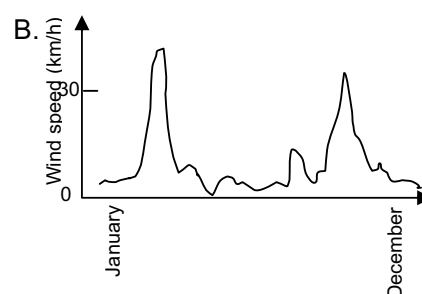
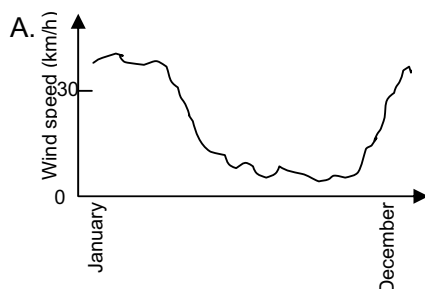


A wind farm

### Question 1: WIND FARMS

S529Q01

The graphs below show the average wind speeds in four different places throughout a year. Which one of the graphs indicates the most appropriate place to establish a wind farm for generating electricity?



### WIND FARMS SCORING 1

#### **Full credit**

Code 1: C

#### **No credit**

Code 0: Other responses.

Code 9: Missing.

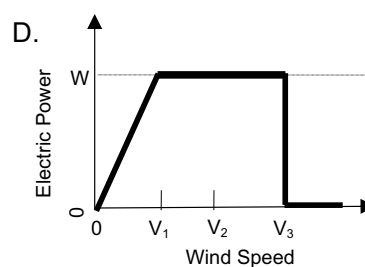
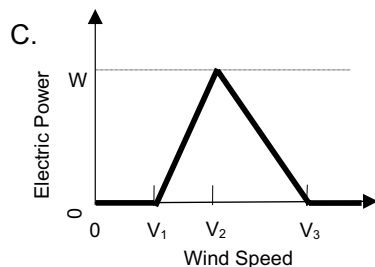
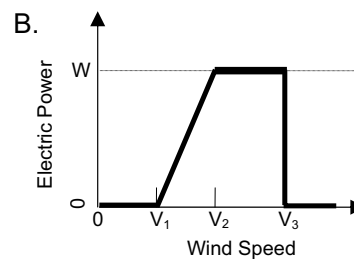
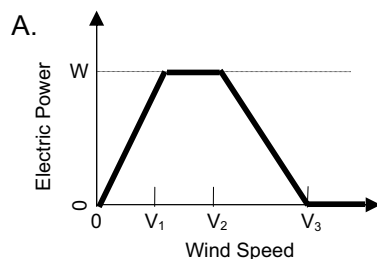
## Question 2: WIND FARMS

S529Q02

The stronger the wind, the faster the windmill blades rotate and the greater the electric power output. However, there is not a direct relationship between wind speed and electric power in a real setting. Below are four working conditions of electricity generation in a real wind farm.

- The windmill blades start rotating when the wind speed reaches  $V_1$ .
- The electric power output reaches a maximum ( $W$ ) when the wind speed is  $V_2$ .
- For safety reasons, the blades are prevented from rotating faster than they do when the wind speed is  $V_2$ .
- The blades stop rotating when the wind speed reaches  $V_3$ .

Which one of the following graphs best represents the relationship between wind speed and electric power output under these working conditions?



### WIND FARMS SCORING 2

**Full credit**

Code 1: B

**No credit**

Code 0: Other responses

Code 9: Missing

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**Question 3: WIND FARMS**

S529Q03

The higher the altitude the more slowly windmills rotate at the same wind speed.

Which one of the following is the best reason why the blades of windmills rotate more slowly in higher places at the same wind speed?

- A The air is less dense as altitude increases.
- B The temperature is lower as altitude increases.
- C Gravity becomes less as altitude increases.
- D It rains more often as altitude increases.

**WIND FARMS SCORING 3*****Full credit***

Code 1: A. The air is less dense as altitude increases.

***No credit***

Code 0: Other responses

Code 9: Missing

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**Question 4: WIND FARMS**

S529Q04 – 0 1 2 9

Describe one specific advantage, and one specific disadvantage, of using wind to generate electricity compared with using fossil fuels like coal and oil.

An advantage .....

.....

A disadvantage .....

.....

**WIND FARMS SCORING 4*****Full credit***

Code 2: One **specific** advantage and one **specific** disadvantage are described.

**Scoring Comment:** It is possible for the cost of wind farms to be seen as an advantage or disadvantage depending on what aspect is considered (e.g., establishment costs or running costs). Hence, mentioning “the cost” involved, without further explanation, is not sufficient to gain credit as either an advantage or a disadvantage.

[Advantage]

- Do not discharge carbon dioxide (CO<sub>2</sub>).
- Do not consume fossil fuels.
- The wind resource will not be used up.
- After the wind generator is established, the cost for electric generation is cheap.
- No waste and/or no toxic substance will be emitted.
- Using natural forces or clean energy.
- Environmentally friendly and will last for a very long time.

[Disadvantage]

- Generation on demand is not possible. *[Because the wind speed cannot be controlled.]*
- Good places for windmills are limited.
- The windmill could be damaged by too strong wind.
- The amount of power generated by each windmill is relatively small.
- Noise pollution occurs in some cases.
- Birds are sometimes killed when they crash into the rotors.
- Natural views are altered *[Visual pollution]*.
- Expensive to set up

**Partial credit**

Code 1: Either a correct advantage or a correct disadvantage is described (as shown in the full credit examples) but not both

**No credit**

Code 0: No correct advantage or correct disadvantage is described. Individual examples of unacceptable advantages or disadvantages are given below.

- Good for the environment or nature. *[This answer is a general value statement.]*
- Bad for the environment or nature
- It costs less to build a wind power generator than to build a fossil fuel power plant. *[This ignores the fact that a great number of wind power generators would be needed to produce the same amount of power as a fossil fuel power plant.]*
- It wouldn't cost as much.

Code 9: Missing.