



MASSACHUSETTS DEPARTMENT OF  
ELEMENTARY AND SECONDARY  
**EDUCATION**

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*Release of Spring 2021*

*MCAS Test Items*

*from the*

*Grade 5 Science and  
Technology/Engineering*

*Paper-Based Test*

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**June 2021**

**Massachusetts Department of  
Elementary and Secondary Education**

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This document was prepared by the  
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# Overview of Grade 5 Science and Technology/Engineering Test

The spring 2021 grade 5 Science and Technology/Engineering (STE) test was a next-generation assessment that was administered in two primary formats: a computer-based version and a paper-based version. The vast majority of students took the computer-based test. The paper-based test was offered as an accommodation for students with disabilities who are unable to use a computer, as well as for English learners who are new to the country and are unfamiliar with technology.

Most of the operational items on the grade 5 STE test were the same, regardless of whether a student took the computer-based version or the paper-based version. In places where a technology-enhanced item was used on the computer-based test, an adapted version of the item was created for use on the paper test. These adapted paper items were multiple-choice or multiple-select items that tested the same STE content and assessed the same standard as the technology-enhanced item.

**This document displays released items from the paper-based test.** Released items from the computer-based test are available on the MCAS Resource Center website at [mcas.pearsonsupport.com/released-items](https://mcas.pearsonsupport.com/released-items).

## Test Sessions and Content Overview

The grade 5 STE test was made up of two separate test sessions. Each session included selected-response questions and constructed-response questions. On the paper-based test, the selected-response questions were multiple-choice items and multiple-select items, in which students select the correct answer(s) from among several answer options.

In 2021, due to the COVID-19 pandemic, the Department reduced testing time for students in grades 3–8 through a session sampling approach, in which each student took only a portion of each MCAS assessment. Instead of taking two sessions in each subject, individual students took one session each.

## Standards and Reporting Categories

The grade 5 STE test was based on learning standards in the four major content strands in the April 2016 version of the *Massachusetts Science and Technology/Engineering Curriculum Framework*. The four content strands are listed below.

- Earth and Space Science
- Life Science
- Physical Science
- Technology/Engineering

The 2016 *Massachusetts Science and Technology/Engineering Curriculum Framework* is available on the Department website at [www.doe.mass.edu/frameworks/current.html](http://www.doe.mass.edu/frameworks/current.html).

Science and Technology/Engineering test results are reported under four MCAS reporting categories, which are identical to the four framework content strands listed above.

The tables at the conclusion of this document provide the following information about each released and unreleased operational item: reporting category, standard covered, practice category covered (if any), item type, and item description. The correct answers for released selected-response questions are also displayed in the released item table.

## Reference Materials

Each student taking the paper-based version of the grade 5 STE test was provided with a plastic ruler. An image of the ruler is not reproduced in this document. Each student also had sole access to a calculator.

During both STE test sessions, the use of bilingual word-to-word dictionaries was allowed for current and former English learner students.

# Grade 5 Science and Technology/Engineering SESSION 1

This session contains 7 questions.

## **Directions**

Read each question carefully and then answer it as well as you can. You must record all answers in this Test & Answer Booklet.

For some questions, you will mark your answers by filling in the circles in your Test & Answer Booklet. Make sure you darken the circles completely. Do not make any marks outside of the circles. If you need to change an answer, be sure to erase your first answer completely.

If a question asks you to show or explain your work, you must do so to receive full credit. Write your response in the space provided. Only responses written within the provided space will be scored.

- 1 The picture below shows a river flowing through a canyon.

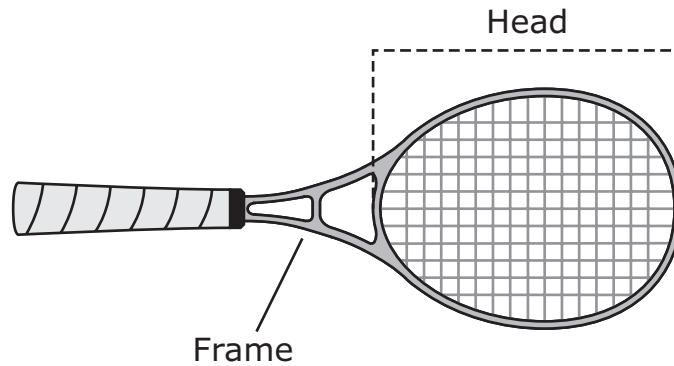


Courtesy of the National Park Service

Which of the following best explains how the canyon becomes wider and deeper over time?

- Ⓐ Water carries rock particles away from the canyon.
- Ⓑ Caves form in the canyon walls and rock particles move into them.
- Ⓒ Earthquakes cause the rocks of the canyon to move away from each other.
- Ⓓ Volcanic activity causes the rocks on each side of the canyon to become larger.

- 2 A diagram of a tennis racket is shown.



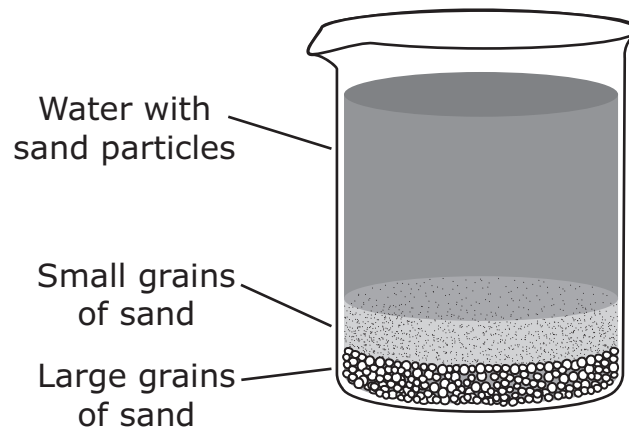
The design of tennis rackets has changed over time. Some changes to the design are shown in the table.

Design Year	Frame Material	Weight (g)	Size of Head (cm <sup>2</sup> )
1874	wood	370–400	419
1967	steel	350	626
1987	graphite	200–300	684

Which of the following best explains the difference in weight of the tennis rackets?

- (A) Over time, tennis rackets have become lighter in weight because of a change in the racket head size.
- (B) Over time, tennis rackets have become heavier in weight because of a change in the racket head size.
- (C) Over time, tennis rackets have become lighter in weight because of a change in the racket frame material.
- (D) Over time, tennis rackets have become heavier in weight because of a change in the racket frame material.

- 3 A group of students stirred sand into a beaker of water. The beaker was set on a table for 10 minutes. After 10 minutes, three layers formed in the beaker, as shown in the diagram.



The students made these observations after 10 minutes:

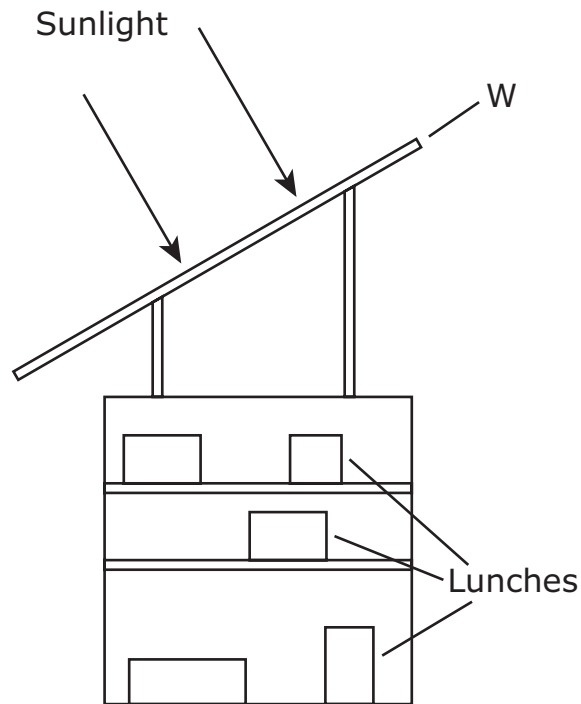
- The top layer was mostly water with some sand particles in it.
- The middle layer was mostly solid with small grains of sand.
- The bottom layer was mostly solid with large grains of sand.
- Each layer was at room temperature.

Some students claimed that a chemical reaction took place when the sand was stirred into the water. Other students claimed that a mixture was formed.

Which of the following is best supported by the students' observations?

- Ⓐ Claim: A chemical reaction took place.  
Evidence: Three layers formed.
- Ⓑ Claim: A chemical reaction took place.  
Evidence: The water had some sand particles in it.
- Ⓒ Claim: A mixture was formed.  
Evidence: Each layer was at room temperature.
- Ⓓ Claim: A mixture was formed.  
Evidence: The water and sand were mostly separated.

- 4 A group of students designed a box to keep their lunches cool during recess. Their design is shown.



Which of the following **best** describes the main purpose of the part labeled W in the design?

- Ⓐ It keeps the box from falling over.
- Ⓑ It gives support to the rest of the box.
- Ⓒ It stops warm air from blowing on the box.
- Ⓓ It blocks heat energy from entering the box.



- 5 A scientist tested four objects: W, X, Y, and Z. Two of the objects were made of the same substance, and the other objects were made of different substances. The scientist collected the data in the table.

Object	Mass	Shape	Soluble in Water?	Conducts Electricity?
W	10 g	cube	yes	no
X	10 g	ball	yes	yes
Y	15 g	ball	yes	no
Z	15 g	cube	no	yes

Identify the two objects that were made of the same substance. Explain your reasoning **and** include data from the table to support your answer.

5 \_\_\_\_\_  
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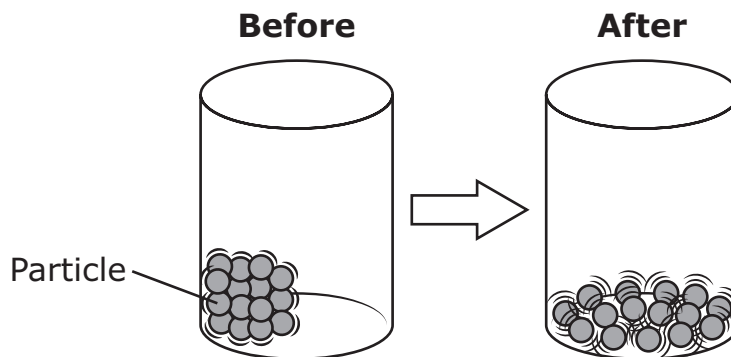
- 6 A software engineer designed a new version of a video game. The original version of the game and the new version are compared in the table.

Characteristic	Original Version	New Version
amount of time for engineer to develop	6 months	18 months
cost to make each unit	\$5.00	\$10.00
number of players	only 1 player	multiplayer, 1–4 players
levels of difficulty	medium only	easy, medium, and hard
number of levels of play	25 levels	45 levels

Select **three** design criteria the engineer most likely used in designing the new version of the game.

- Ⓐ must cost more to make than the original version
- Ⓑ must allow more players than the original version
- Ⓒ must take longer to design than the original version
- Ⓓ must have more levels of play than the original version
- Ⓔ must have more levels of difficulty than the original version

- 7 The model shown represents particles of a substance in a closed container before and after a phase change.



What state of matter was the substance before the phase change?

- Ⓐ solid
- Ⓑ liquid
- Ⓒ gas

What state of matter was the substance after the phase change?

- Ⓐ solid
- Ⓑ liquid
- Ⓒ gas

What type of phase change took place?

- Ⓐ condensation
- Ⓑ evaporation
- Ⓒ freezing
- Ⓓ melting

# Grade 5 Science and Technology/Engineering SESSION 2

This session contains 13 questions.

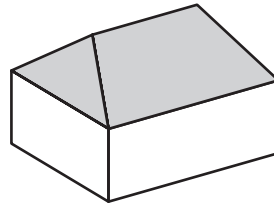
## **Directions**

Read each question carefully and then answer it as well as you can. You must record all answers in this Test & Answer Booklet.

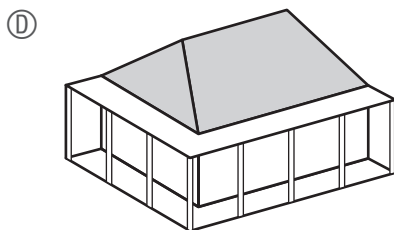
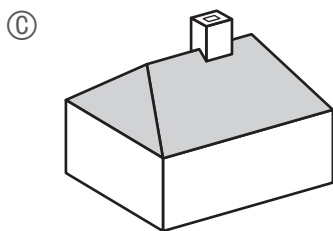
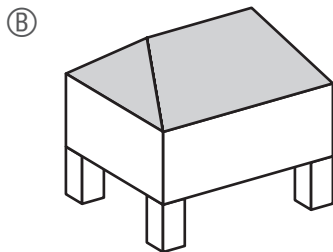
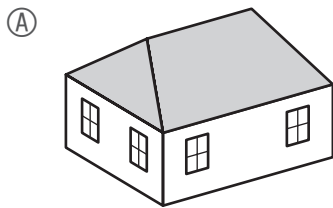
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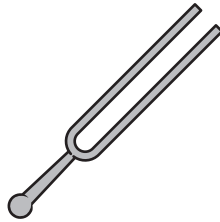
- 8 Houses built in places that have hurricanes need to be protected from strong winds and flooding. The design shown helps keep winds from blowing the roof off a house during a hurricane.



Which drawing represents the **best** way to modify the house so that it is also protected from flooding?



- 9 When a tuning fork is hit, it vibrates and makes a sound. A picture of a tuning fork is shown.



Which of the following happens when a tuning fork is hit?

- Ⓐ The tuning fork creates sound waves that carry kinetic energy.
- Ⓑ The tuning fork creates sound waves that carry electrical energy.
- Ⓒ The tuning fork creates sound waves that carry magnetic energy.

Which of the following would happen if a tuning fork is hit and then placed in water?

- Ⓐ The sound waves will move the water.
- Ⓑ The sound waves will immediately stop moving.

The following section focuses on organisms in a garden.

Read the information below and use it to answer the three selected-response questions and one constructed-response question that follow.

A science class investigated how sunlight and fertilizer affect the total mass of vegetables produced in a garden. The students filled four planting boxes with equal amounts of soil. They put two boxes in a very sunny area and two boxes in a shaded area. The students added fertilizer to one box in each area. The table below shows the conditions that were different for each box. All other conditions were the same for each box.

**Table 1: Conditions for Growing Plants**

Condition	Box W	Box X	Box Y	Box Z
sunlight	sunny	sunny	shaded	shaded
fertilizer	no	yes	no	yes

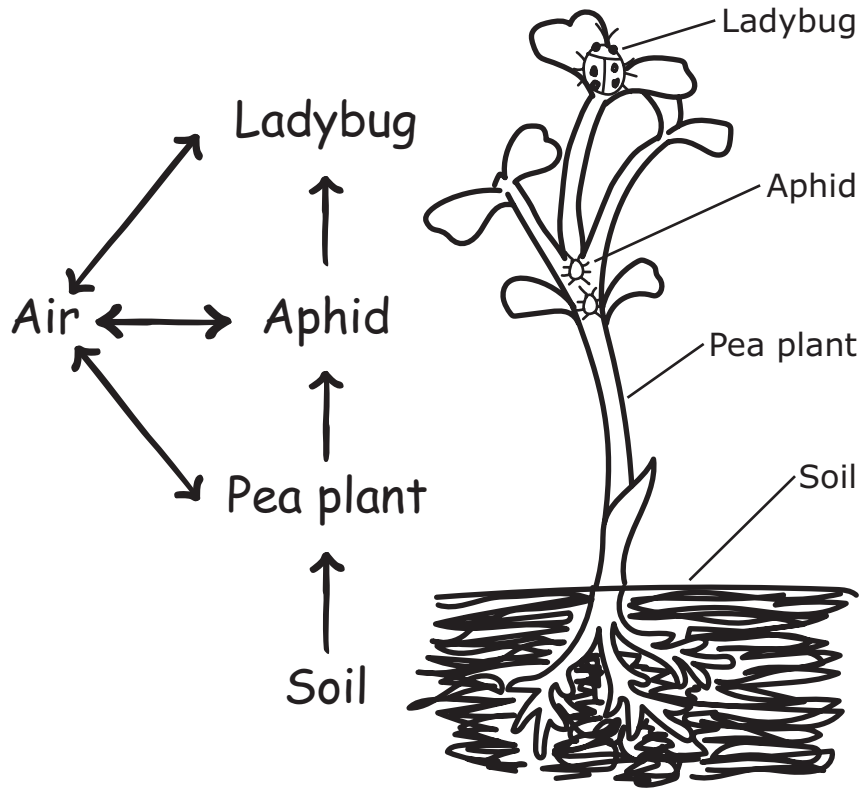
The students planted four identical pea plants and four identical lettuce plants in each box. After six weeks, the students measured the mass of the vegetables produced in each box. The table below shows the students' data.

**Table 2: Student Data**

Vegetable	Box W	Box X	Box Y	Box Z
peas	363 g	454 g	227 g	318 g
lettuce	1089 g	1452 g	816 g	907 g
total	1452 g	1906 g	1043 g	1225 g

The students observed small insects called aphids eating some parts of the plants. The students also observed ladybugs eating the aphids. The students made the model below to show how matter moves in the garden. The students forgot to add decomposers.

**Movement of Matter Model**





- 10** The students also studied how pea plants use energy.
- Which of the following best describes how pea plants use energy?
- Ⓐ Pea plants use energy from soil to break down food.
  - Ⓑ Pea plants use energy from sunlight to break down food.
  - Ⓒ Pea plants use energy from water to make their own food.
  - Ⓓ Pea plants use energy from sunlight to make their own food.

- 11 A student is classifying some organisms from the garden into these three groups: producer, consumer, and decomposer.

Which of the following tables correctly classifies each organism?

Ⓐ

Group	Organism
producer	aphid
consumer	fungus
decomposer	lettuce plant

Ⓑ

Group	Organism
producer	fungus
consumer	aphid
decomposer	lettuce plant

Ⓒ

Group	Organism
producer	lettuce plant
consumer	aphid
decomposer	fungus

Ⓓ

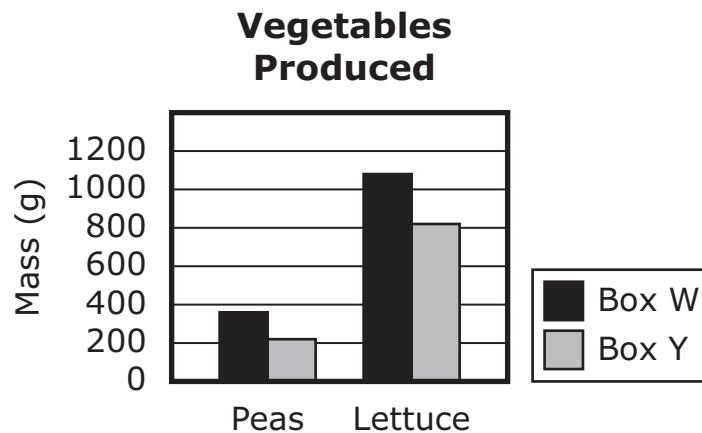
Group	Organism
producer	lettuce plant
consumer	fungus
decomposer	aphid

- 12 A student noticed that the small aphids in the garden grew larger over time. Which of the following best describes what the aphids must have done to grow larger?

- Ⓐ ate more of the plant for food
- Ⓑ used more matter from the soil
- Ⓒ absorbed more sunlight for food
- Ⓓ received more energy from the air

This question has three parts. Write your response on the next page. Be sure to label each part of your response.

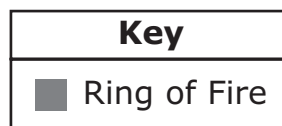
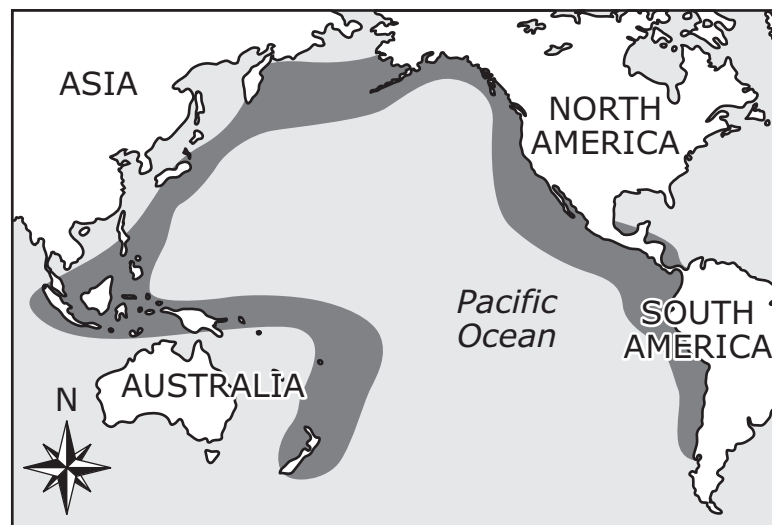
- 13 A student is investigating the process of photosynthesis.
- Identify the part of the pea and lettuce plants where most photosynthesis takes place.
  - What must the pea and lettuce plants take up through their roots to perform photosynthesis?
  - The student is also investigating the effect of sunlight on the total mass of the vegetables produced in the garden. The student graphs the data from box W and box Y, as shown.



Explain why the student compared the data from boxes W and Y instead of the data from boxes W and Z to determine the effect of sunlight.



- 14 The Ring of Fire is a region around the Pacific Ocean that has many volcanoes. The area shaded gray on the map is where the Ring of Fire is located.

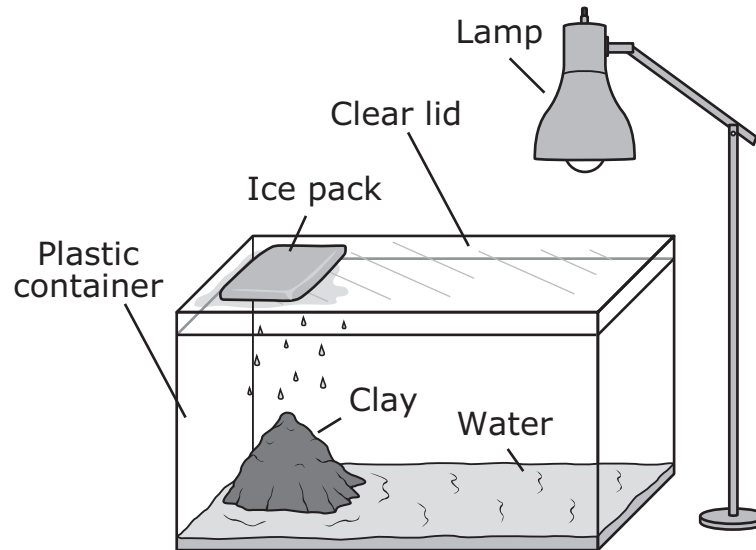


Which of the following best explains why there are many volcanoes in this region?

- Ⓐ There is an ocean in this region.
- Ⓑ There are plate boundaries in this region.
- Ⓒ There are only four continents in this region.
- Ⓓ There is always a warm climate in this region.

This question has three parts. Write your response on the next page. Be sure to label each part of your response.

- 15 A student used a model to show how fresh water cycles in Massachusetts. The model is shown.

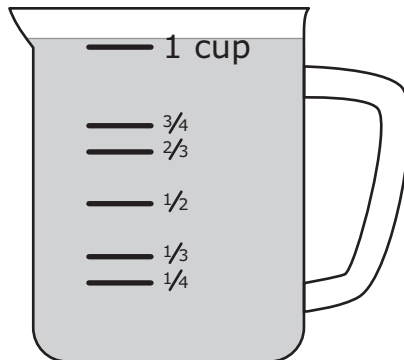


In the model, the water represented a lake and the clay represented land. A lamp shined through the lid and onto the water. The student placed an ice pack on top of the clear lid. Water droplets formed under the ice pack and dripped onto the clay.

- Identify what the lamp represented in this model.
- Describe the part of the water cycle that was represented by the lamp shining on the water in the container. In your answer, be sure to describe what happened to the water.
- Identify the part of the water cycle that was represented by the droplets of water forming on the bottom of the lid under the ice pack. Explain your reasoning.



- 16 A student adds liquid water to a measuring cup and freezes it. The surface of the ice that forms is above the 1-cup measurement line, as shown.



The ice then melts and the student observes that the surface of the liquid water is below the 1-cup measurement line. The student claims the number of water particles in the ice and in the liquid water was the same.

To provide evidence for this claim, what did the student most likely do before and after the ice melted?

- Ⓐ measured the level of the water using a ruler
- Ⓑ measured the mass of the water using a scale
- Ⓒ measured the temperature of the water using a thermometer
- Ⓓ measured the circumference of the measuring cup using a tape measure



**This question has two parts.**

- 17** A teacher played a game with a class of students. During the game, the teacher gave hand signals. The students watched the teacher and then moved a game piece on a board based on the teacher's hand signals. The move required by each hand signal is shown.

- closed fist: move up one space
- one thumb up: move down one space
- two thumbs up: move left one space
- open hand: move right one space

The teacher gave several hand signals and the students moved their game pieces.

**Part A**

Which of the following best describes how information was transferred as the teacher gave the hand signals?

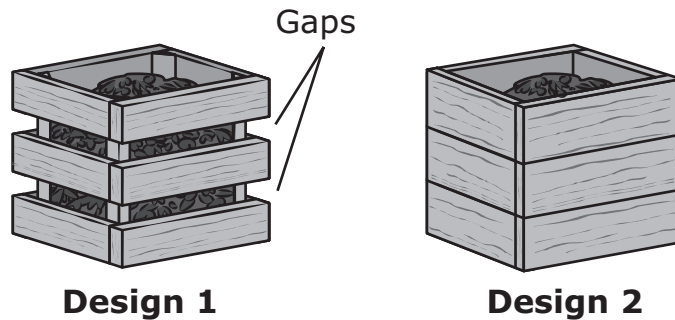
- Ⓐ The teacher encoded a message and then sent it to the students.
- Ⓑ The teacher decoded a message and then sent it to the students.
- Ⓒ The teacher decoded a message and then received it from the students.
- Ⓓ The teacher encoded a message and then received it from the students.

**Part B**

Which of the following best describes how information was transferred after the teacher gave the hand signals?

- Ⓐ The students sent a message and then encoded it.
- Ⓑ The students decoded a message and then sent it.
- Ⓒ The students received a message and then decoded it.
- Ⓓ The students encoded a message and then received it.

- 18 Students are testing two designs of a compost bin. One bin has gaps in its sides, while the other does not. Each design is shown.



Each bin contains the same amount of materials that will be composted. One student claims that the gaps in design 1 will allow the materials to break down faster than in design 2.

Which of the following best supports the student's claim?

- Ⓐ The gaps in design 1 allow air to flow into the bin.
- Ⓑ The gaps in design 1 allow the materials to dry out.
- Ⓒ The gaps in design 1 allow heat to escape from the bin.
- Ⓓ The gaps in design 1 allow light to shine on the materials.

- 19 The table shows weather data collected over a three-day period.

Day	Temperature (°F)	Wind Speed (mph)	Wind Direction	Humidity
1	31	15	west	67%
2	34	6	north	98%
3	42	5	west	92%

Which of the following **best** explains why there was a greater chance of precipitation on day 2 than on day 1?

- Ⓐ Day 1 had stronger winds.
- Ⓑ Day 2 had higher humidity.
- Ⓒ Day 1 had colder temperatures.
- Ⓓ Day 2 had more wind from the north.

- 20** The people in a town want to help the environment. Which of the following is one way the people in the town can reduce human impact on the environment?
- Ⓐ heat town buildings using oil and propane gas
  - Ⓑ build a housing development in a forested area
  - Ⓒ install street lights throughout the town so people can see at night
  - Ⓓ build a water-treatment plant that cleans and recycles wastewater

**Grade 5 Science and Technology/Engineering  
Spring 2021 Released Operational Items**

PBT Item No.	Page No.	Reporting Category	Standard	Practice Category	Item Type*	Item Description	Correct Answer**
1	3	<i>Earth and Space Science</i>	4.ESS.1.1	C. Evidence, Reasoning, and Modeling	SR	Use evidence from a picture to describe the role of erosion in the formation of a landform over time.	A
2	4	<i>Technology/Engineering</i>	5.ETS.3.1	B. Mathematics and Data	SR	Evaluate data in a table to explain how an existing technology was improved over time.	C
3	5	<i>Physical Science</i>	5.PS.1.4	C. Evidence, Reasoning, and Modeling	SR	Use evidence from a diagram to support a claim that a mixture formed.	D
4	6	<i>Technology/Engineering</i>	5.ETS.3.2	C. Evidence, Reasoning, and Modeling	SR	Analyze a sketch of a design to determine the purpose of one part of the design.	D
5	7	<i>Physical Science</i>	5.PS.1.3	B. Mathematics and Data	CR	Use data to determine which objects were made from the same substance based on their characteristic properties and explain the reasoning using evidence.	
6	8	<i>Technology/Engineering</i>	3.ETS.1.1	B. Mathematics and Data	SR	Analyze information to determine the design criteria an engineer most likely used to redesign a game.	B,D,E
7	9	<i>Physical Science</i>	5.PS.1.1	C. Evidence, Reasoning, and Modeling	SR	Interpret a particle model of a phase change and determine the phases of the substance and the phase change that took place.	A;B;D
8	11	<i>Technology/Engineering</i>	3.ESS.3.1	C. Evidence, Reasoning, and Modeling	SR	Determine which design solution will best protect a structure from flooding.	B
9	12	<i>Physical Science</i>	4.PS.4.1	None	SR	Determine the type of energy carried by sound waves and what will happen to water when the sound waves enter the water.	A;A
10	15	<i>Life Science</i>	5.LS.1.1	None	SR	Describe how plants use energy from sunlight to make their own food.	D
11	16	<i>Life Science</i>	5.LS.2.1	None	SR	Classify organisms from a model as producers, consumers, or decomposers.	C
12	16	<i>Life Science</i>	5.PS.3.1	None	SR	Describe how animals must use food for growth.	A
13	17	<i>Life Science</i>	5.LS.1.1	A. Investigations and Questioning	CR	Identify a part of a plant where photosynthesis takes place, identify water as what is taken up through roots for photosynthesis, and evaluate a student's investigation of how different amounts of sunlight affect photosynthesis.	
14	19	<i>Earth and Space Science</i>	4.ESS.2.2	C. Evidence, Reasoning, and Modeling	SR	Analyze a map to explain why there are volcanoes in a region.	B
15	20	<i>Earth and Space Science</i>	5.ESS.2.1	C. Evidence, Reasoning, and Modeling	CR	Identify, describe, and explain different parts of the water cycle in a student's model.	
16	22	<i>Physical Science</i>	5.PS.1.2	A. Investigations and Questioning	SR	Identify evidence from an investigation that supports the claim that matter is conserved before and after a phase change.	B
17	23	<i>Technology/Engineering</i>	4.PS.4.3	C. Evidence, Reasoning, and Modeling	SR	Analyze a situation to determine how a message was encoded, sent, received, and decoded.	A;C
18	24	<i>Life Science</i>	5.LS.2.2	C. Evidence, Reasoning, and Modeling	SR	Use evidence to support a claim about compost bin designs.	A
19	25	<i>Earth and Space Science</i>	3.ESS.2.1	B. Mathematics and Data	SR	Use weather data to explain why there was a greater chance of precipitation on a particular day.	B
20	26	<i>Earth and Space Science</i>	5.ESS.3.1	None	SR	Identify one way people in a town can reduce human impact on the environment.	D

\* Science and Technology/Engineering item types are: selected-response (SR) and constructed-response (CR).

\*\* Answers are provided here for selected-response items only. Sample responses and scoring guidelines for constructed-response items will be posted to the Department's website later this year.

**Grade 5 Science and Technology/Engineering  
Spring 2021 Unreleased Operational Items**

<b>PBT Item No.</b>	<b>Reporting Category</b>	<b>Standard</b>	<b>Practice Category</b>	<b>Item Type*</b>	<b>Item Description</b>
21	<i>Physical Science</i>	3.PS.2.3	None	SR	Determine which pair of magnets has the strongest attraction between them.
22	<i>Earth and Space Science</i>	5.ESS.3.2	C. Evidence, Reasoning, and Modeling	SR	Describe an improvement to increase the effectiveness of a water filter.
23	<i>Physical Science</i>	4.PS.3.4	None	SR	Describe the energy that an object had at a certain position on a ramp.
24	<i>Physical Science</i>	5.PS.2.1	C. Evidence, Reasoning, and Modeling	SR	Identify the direction of the gravitational force that acted on a moving object.
25	<i>Physical Science</i>	4.PS.3.4	C. Evidence, Reasoning, and Modeling	SR	Describe how a change in design would affect the stored energy and speed of an object.
26	<i>Physical Science</i>	4.PS.3.1	C. Evidence, Reasoning, and Modeling	CR	Explain how surface material would affect the force of friction acting on an object, the speed of the object, and the kinetic energy of the object.
27	<i>Technology/Engineering</i>	4.ETS.1.5	C. Evidence, Reasoning, and Modeling	CR	Describe changes that could be made to the design of a structure to meet specific criteria and describe a possible tradeoff to one of the changes.
28	<i>Physical Science</i>	3.PS.2.1	C. Evidence, Reasoning, and Modeling	SR	Analyze a diagram and determine the effect of unbalanced forces on an object.
29	<i>Earth and Space Science</i>	5.ESS.1.2	C. Evidence, Reasoning, and Modeling	SR	Identify a model that shows the cause of day and night and explain why people on Earth experience this change.
30	<i>Life Science</i>	3.LS.4.1	None	SR	Describe how scientists use fossil evidence to make comparisons between a modern-day organism and one that lived long ago.
31	<i>Life Science</i>	3.LS.3.2	C. Evidence, Reasoning, and Modeling	SR	Analyze information to determine a characteristic of a plant that was affected by the environment.
32	<i>Earth and Space Science</i>	3.ESS.2.2	B. Mathematics and Data	SR	Use precipitation and temperature data to describe the climate of a region.
33	<i>Life Science</i>	3.LS.1.1	C. Evidence, Reasoning, and Modeling	SR	Describe a similarity between the life stages of plants and animals.
34	<i>Earth and Space Science</i>	5.ESS.2.2	B. Mathematics and Data	SR	Interpret a circle graph to explain why there is a limited amount of fresh water available for human use.
35	<i>Life Science</i>	3.LS.4.4	None	SR	Describe how an environmental change is likely to affect an organism's survival.
36	<i>Technology/Engineering</i>	3.ETS.1.2	C. Evidence, Reasoning, and Modeling	SR	Compare design solutions to determine why one design cooks food faster.
37	<i>Life Science</i>	4.LS.1.1	None	SR	Describe how plant roots support the survival of plants during winter.
38	<i>Technology/Engineering</i>	3.ETS.1.4	None	CR	Compare different representations of a design solution and describe an advantage of each representation.
39	<i>Earth and Space Science</i>	4.ESS.2.1	C. Evidence, Reasoning, and Modeling	SR	Describe how the loss of trees affects the soil in an area.
40	<i>Earth and Space Science</i>	4.ESS.3.1	None	SR	Determine whether energy resources are renewable or nonrenewable.
41	<i>Life Science</i>	3.LS.4.2	None	SR	Describe how some individuals within a population have an advantage in survival and reproduction because of variations of a characteristic.

\* Science and Technology/Engineering item types are: selected-response (SR) and constructed-response (CR).