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MASSACHUSETTS
Department of Elementary
and Secondary Education

Release of Spring 2023 MCAS Test Items

from the

Grade 8 Science and Technology/Engineering Paper-Based Test

Grade 8
Science and Technology/Engineering
## SESSION 1

This session contains 11 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 diagram shows the locations and relative sizes of several galaxies.
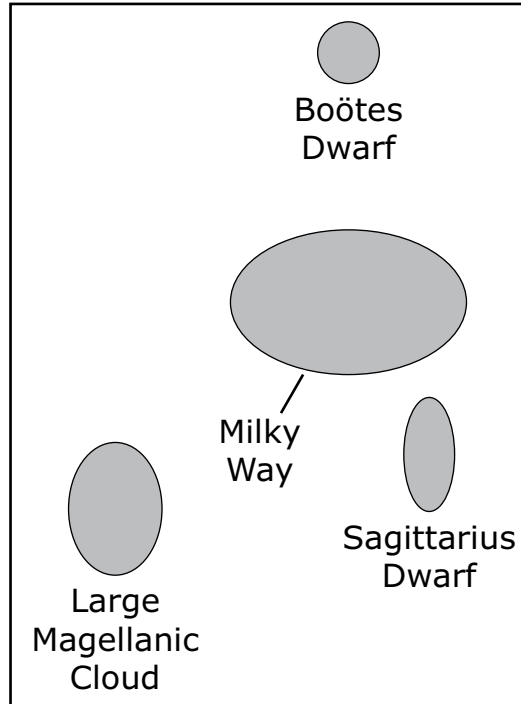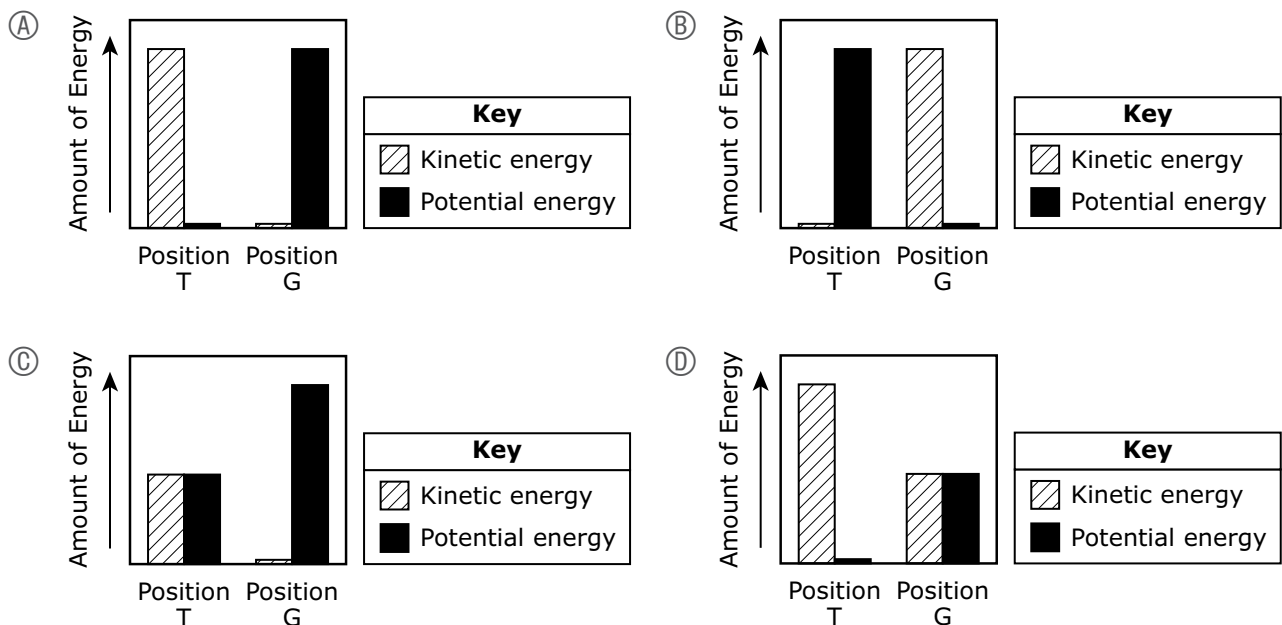

A student is asked to show the location of Earth's solar system on the diagram. Where should the student draw Earth's solar system on the diagram?

Ⓐ within the Milky Way galaxy

Ⓑ within the Sagittarius Dwarf galaxy

Ⓒ between the Milky Way galaxy and the Boötes Dwarf galaxy

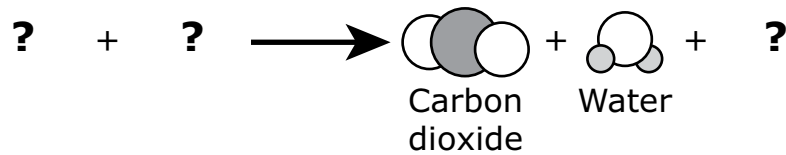Ⓓ between the Sagittarius Dwarf galaxy and the Large Magellanic Cloud galaxy

❷ As an apple falls from a tree, the apple's potential energy and kinetic energy change. The diagram shows the apple at two positions, T and G. At position T, the apple is about to fall. At position G, the apple is about to hit the ground.
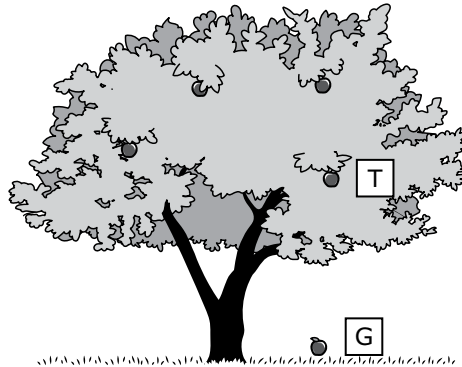
Which graph shows the apple's potential energy and kinetic energy at positions T and G?

Ⓐ

Amount of Energy

Position T   Position G

Key
▨ Kinetic energy
■ Potential energy

Ⓑ

Amount of Energy

Position T   Position G

Key
▨ Kinetic energy
■ Potential energy

Ⓒ

Amount of Energy

Position T   Position G

Key
▨ Kinetic energy
■ Potential energy

Ⓓ

Amount of Energy

Position T   Position G

Key
▨ Kinetic energy
■ Potential energy

3 Every morning a student eats a bowl of cereal with milk for breakfast. The cereal and the milk are broken down and used in the student's cells during cellular respiration. An incomplete model of cellular respiration is shown.

? + ? ⟶ Carbon dioxide + Water + ?

Which of the following models represents cellular respiration in the student's cells?

Ⓐ Food molecule + Oxygen ⟶ Carbon dioxide + Water + Energy

Ⓑ Oxygen + Energy ⟶ Carbon dioxide + Water + Food molecule

Ⓒ Energy + Food molecule ⟶ Carbon dioxide + Water + Oxygen

Ⓓ Food molecule + Energy ⟶ Carbon dioxide + Water + Energy
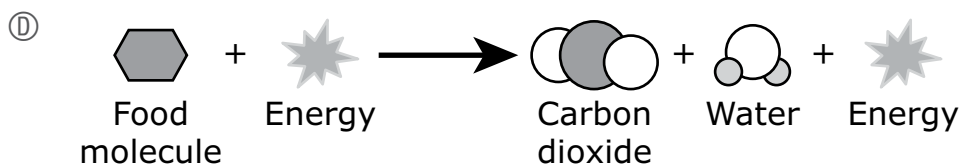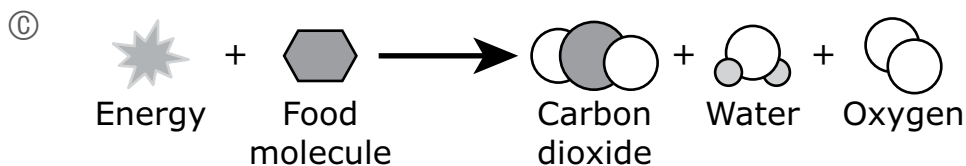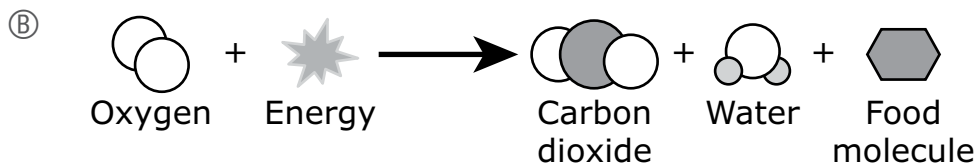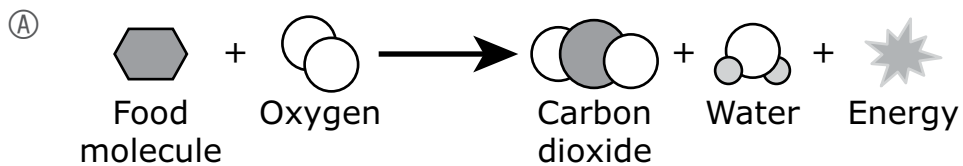
The following section focuses on an investigation of different substances that make icy sidewalks safer.

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

During winter, a class of students in Massachusetts completed an investigation to determine how to make icy sidewalks safer. They tested four substances to see whether the substances could melt ice. The information the students gathered about each substance is shown in Table 1.

Table 1

	Substance			
	Sodium Chloride (NaCl)	Calcium Chloride (CaCl$_2$)	Urea (CH$_4$N$_2$O)	Sand
How It Works	melts ice	melts ice	melts ice	makes ice less slippery
Cost per 50 lb. Bag	$8	$20	$75	$4

The students measured how long it took each substance to melt a different icy area on each of three days. All the icy areas the students tested were the same size. The data the students collected are shown in Table 2.
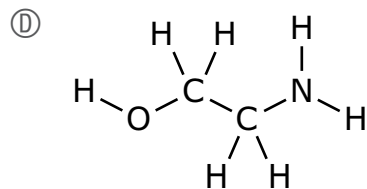
Table 2

Day	Temperature (°C)	Time for Ice to Melt (min)			
		Sodium Chloride	Calcium Chloride	Urea	Sand
1	−2	7	3	20	no melting
2	−10	50	5	no melting	no melting
3	−15	no melting	8	no melting	no melting

Sand made the icy areas less slippery, but it did not melt the ice.

Some of the substances harmed the grass. The following spring, the grass was brown and unhealthy next to the areas where sodium chloride and calcium chloride had been tested. However, the grass was green and healthy next to the areas where urea and sand had been tested.

4 The chemical formula for urea is CH_4N_2O. Which model represents a molecule of urea?

Ⓐ

$$\begin{array}{c} O \\ \| \\ H-N-C-N-H \\ | \quad\quad | \\ H \quad\quad H \end{array}$$

Ⓑ

$$\begin{array}{c} H \\ | \\ H-C-N \\ | \quad\ \ \backslash \\ H \quad\ H \\ | \\ H \end{array}$$

Ⓒ

$$\begin{array}{c} O \\ \| \\ H-C-C-N-H \\ | \quad\quad | \\ H \quad\quad H \\ | \\ H \end{array}$$

Ⓓ

$$\begin{array}{c} H \ \ H \quad H \\ \backslash \ / \quad | \\ H-O-C-C-N \\ / \backslash \quad \backslash \\ H \ H \quad H \end{array}$$
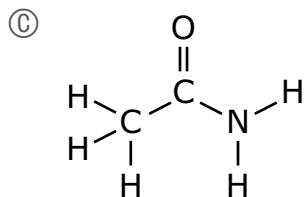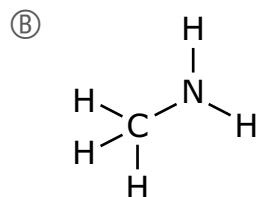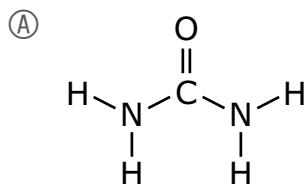
5 The students compared their results from using sodium chloride, calcium chloride, and urea to melt ice on the sidewalk. The students decided that calcium chloride was the best substance to apply to the ice.

Select the **two** criteria that were most important to the students when they evaluated the substances and decided calcium chloride was the best option.

Ⓐ cost of substance

Ⓑ time for ice to melt

Ⓒ works at lowest temperature

Ⓓ impact of substance on environment

6 The students want to spread one of the substances on a sidewalk near a garden the following winter. The substance needs to meet these criteria:

- melts ice at −2°C

- does not harm plants

Which substance should the students choose based on these criteria?

Ⓐ sodium chloride

Ⓑ calcium chloride

Ⓒ urea

Ⓓ sand

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

7   To better understand the effect of sand on icy sidewalks, a student completed an investigation with two identical 0.6 kg blocks, X and Y, and two icy areas. The student completed the following steps:

1. Add a thin layer of sand to the top of one icy area.

2. Place block X on the icy area without sand. Place block Y on the icy area with sand. Make sure blocks X and Y are not moving.

3. Push both blocks with the same amount of force for 3 seconds and then let go.

4. Observe the speed of each block after it is let go.

A. One block moved with less speed than the other. Identify which block had less speed. Explain your reasoning.

B. Determine which block, X or Y, had the greater kinetic energy just after the student's push. Explain your reasoning.

C. The student stacked another block on top of block Y. The student then pushed the two stacked blocks for 3 seconds with the same force as before.

 Compare the speed of the two stacked blocks to the speed of only block Y just after the blocks were pushed. Explain your reasoning.

7

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

8　A group of engineering students entered a competition to build a model of a two-story building. The model must support a large amount of weight. The students will use pieces of wood to construct the model and will also have the following equipment:

- drill
- dust masks
- earmuffs
- goggles
- hammer
- jigsaw

- nails
- sander
- screwdriver
- screws
- tape
- wrench

A. The students use a tool and a fastener to attach two pieces of wood together when building their model.

Identify one tool and one fastener the students should use from the equipment listed above.

B. Describe how the students would use the tool and the fastener you identified in Part A to attach two pieces of wood together.

C. Identify one piece of safety equipment from the list that should be worn when building the model. Explain how this piece of safety equipment will keep a student safe when building the model.

8

A.　Tool: _____

　　　Fastener: _____

_____

_____

_____

_____

_____

_____

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Write your response to the following question on the next page.

9 The dark-shaded areas of the map show where fossils of *Cynognathus*, an extinct land reptile, were found on two continents.
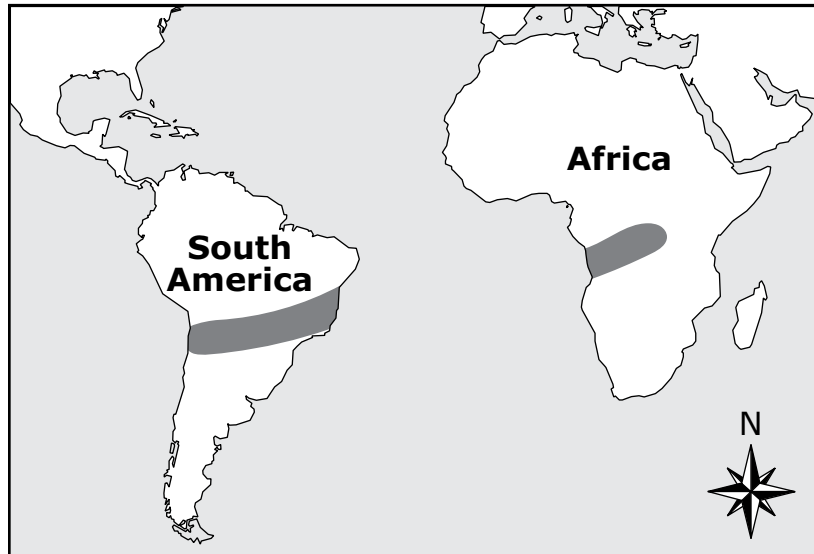
Based on the map, identify **two** pieces of evidence that support the claim that the two continents were once part of one large landmass. Explain how **each** piece of evidence supports the claim.

9

This question has two parts.

10   A certain chromosome in humans contains genes that affect eye color.

Part A

This chromosome is located in the

   Ⓐ   nucleus of all body cells.

   Ⓑ   membrane of all body cells.

   Ⓒ   cytoplasm of only hair and eye cells.

   Ⓓ   mitochondria of only hair and eye cells.

Part B

Two children from the same parents have different eye colors. One child has blue eyes, and the other has brown eyes.

Each child has a different eye color because each inherited

   Ⓐ   a different number of genes.

   Ⓑ   a different number of chromosomes.

   Ⓒ   chromosomes that produce different types of fat.

   Ⓓ   genes that cause different proteins to be produced.

11   Which of the following is the **best** example of thermal energy being transferred primarily through conduction?

   Ⓐ   when sunlight reflects off a lake

   Ⓑ   when magma touches surrounding rock

   Ⓒ   when warm air currents move over an air mass

   Ⓓ   when warm water near the equator flows north

Grade 8
Science and Technology/Engineering
SESSION 2

This session contains 9 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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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.

12 A group of students is learning about chemical reactions. They perform an investigation with four different setups. Only one of the setups is a closed system. The masses of the setups are measured and then a chemical reaction occurs in each setup. After the reactions occur, the masses are measured again. The results are shown in the table.

Setup	Mass before Reaction (g)	Mass after Reaction (g)
W	128.8	126.3
X	138.2	137.0
Y	127.0	127.7
Z	130.0	130.0

Based on the results, which setup is **most likely** the closed system?

Ⓐ setup W

Ⓑ setup X

Ⓒ setup Y

Ⓓ setup Z

13 A student is studying mitochondria in plant cells. Which of the following **best** describes the basic function of mitochondria in a plant cell?

Ⓐ to store water in the cell

Ⓑ to provide energy for the cell

Ⓒ to remove wastes from the cell

Ⓓ to provide carbon dioxide to the cell

14 Antibiotics are a type of medicine used to treat infections caused by bacteria. Bacteria that are killed by an antibiotic are said to be sensitive to that antibiotic. Sensitivity to antibiotics is an inherited trait in bacteria. The graph shows the change over time in the percentage of a certain species of bacteria that are sensitive to an antibiotic.

**Change in Sensitivity
to an Antibiotic over Time**
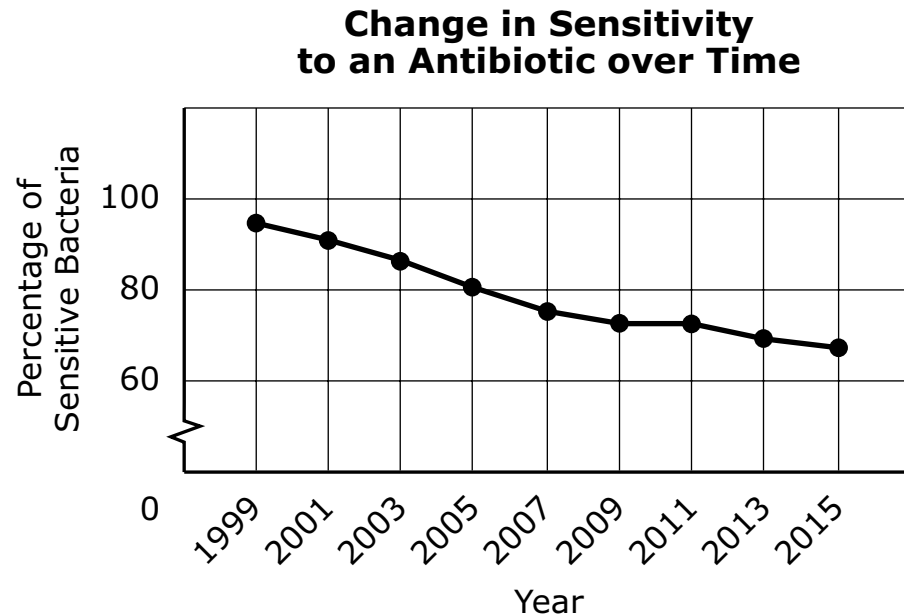
Which of the following best explains the change in the sensitivity of the bacteria to the antibiotic?

Ⓐ The bacteria are becoming more sensitive to the antibiotic because bacteria were killed each time they were exposed to the antibiotic.

Ⓑ The bacteria are becoming more sensitive to the antibiotic because the bacteria changed their genes to protect themselves from the antibiotic.

Ⓒ The bacteria are becoming less sensitive to the antibiotic because some bacteria were able to survive and pass on traits that protect them from the antibiotic.

Ⓓ The bacteria are becoming less sensitive to the antibiotic because some bacteria reproduced very rapidly when they were aware of the antibiotic in their environment.

15 The diagram shows two tectonic plates at a mid-ocean ridge.

Mid-ocean ridge
Tectonic plate 1
Tectonic plate 2

Mantle
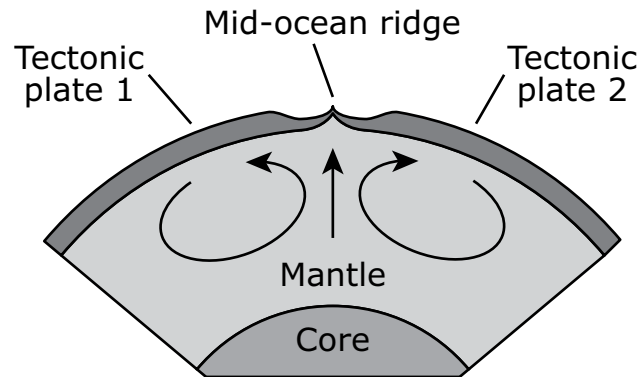
Core

Based on the diagram, which of the following best describes how the plates are moving?

Ⓐ The plates are being pushed toward each other by the cycling of materials in the core.

Ⓑ The plates are being pushed toward each other by the waves of heat traveling through the mantle.

Ⓒ The plates are being pushed away from each other by convection currents in the mantle.

Ⓓ The plates are being pushed away from each other by the eruption of hot magma from the core.

16   Different types of cell phone signals can provide different download speeds. The graph shows the download speeds of two types of cell phone signals, X and Y, based on how close the cell phones are to an antenna.

**Download Speed vs.
Distance from Antenna**
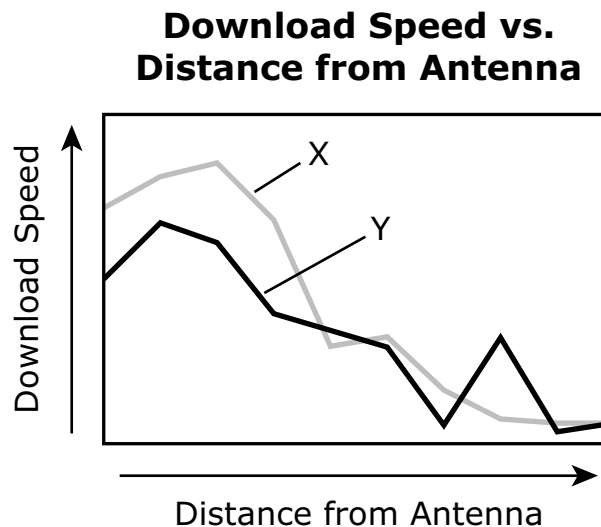
The bar graph below shows how the download speeds of the two cell phone signals were affected as they traveled through air, glass, and stone.

Download Speed vs. Material
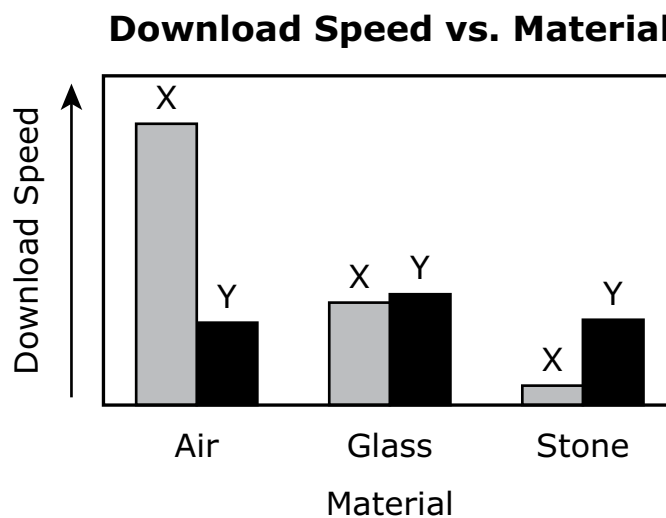
Based on the graphs, which of the following best compares the two types of cell phone signals?

Ⓐ Through each of the materials, signal X has a faster download speed than signal Y has.

Ⓑ At any distance from an antenna, signal X has a faster download speed than signal Y has.

Ⓒ When traveling close to an antenna, signal X has faster download speeds through air than signal Y has.

Ⓓ When traveling far away from an antenna, signal X has faster download speeds through stone than signal Y has.

17 The map shows two cities in the United States, Los Angeles and Oklahoma City.
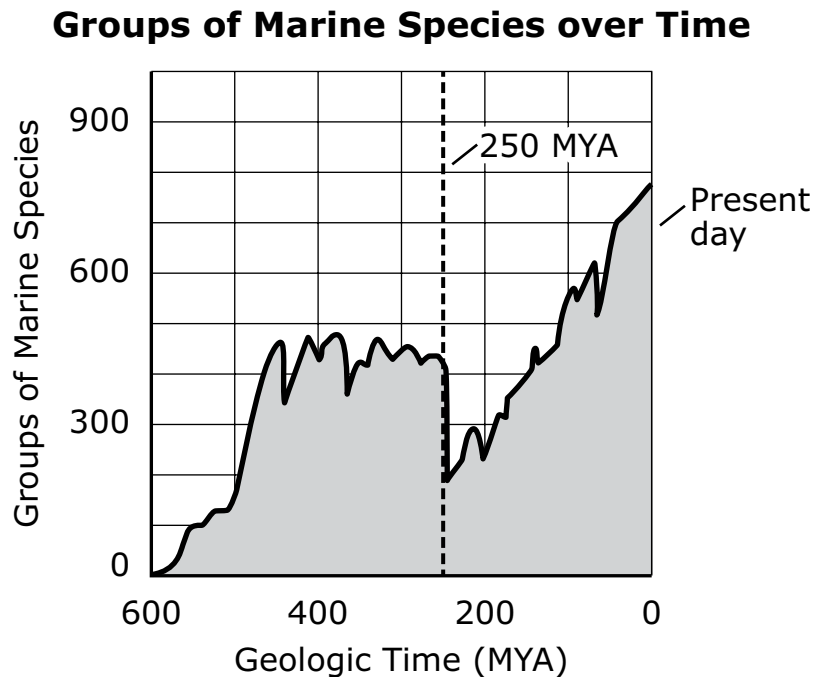

Compared to Oklahoma City, Los Angeles is expected to have

Ⓐ cooler summers.

Ⓑ warmer summers.

This is due to the difference in

Ⓐ latitude.

Ⓑ distance from the ocean.

18   The graph shows the number of groups of marine species from 600 million years ago (MYA) to the present.

Groups of Marine Species over Time

Which of the following claims can be supported by the change in the graph that occurred 250 MYA?

  Ⓐ   New species of marine organisms evolved 250 MYA.

  Ⓑ   Biodiversity of marine organisms decreased 250 MYA.

  Ⓒ   Many marine organisms migrated to live on land 250 MYA.

  Ⓓ   Many species of marine organisms adapted to environmental changes 250 MYA.

19   Which of the following provides the **best** evidence that the climate of Massachusetts has changed over geologic time?

  Ⓐ   mountains

  Ⓑ   river valleys

  Ⓒ   glacial deposits

  Ⓓ   igneous rock formations

20   The pictures show the bone structure of the front limbs of three animals.

Lion   Human   Frog

(not to scale)
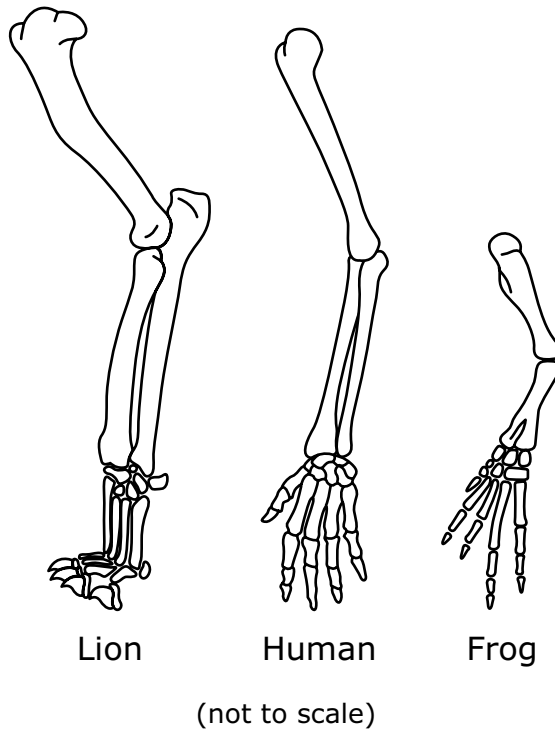
Which of the following **best** describes how the front limbs support the theory of evolution?

Ⓐ   The bone structure of the animals has not changed over time.

Ⓑ   The bone structure of the animals is getting more complex over time.

Ⓒ   The bone structure of the animals was inherited from a common ancestor.

Ⓓ   The bone structure of the animals evolved independently from different ancestors.

Grade 8 Science and Technology/Engineering
Spring 2023 Released Operational Items

PBT Item No.	Page No.	Reporting Category	Standard	Science and Engineering Practice Category	Item Type*	Item Description	Correct Answer**
1	3	*Earth and Space Science*	6.ESS.1.5	C. Evidence, Reasoning, and Modeling	SR	Determine the location of Earth's solar system when given a diagram of several galaxies.	A
2	4	*Physical Science*	7.PS.3.7	B. Mathematics and Data	SR	Analyze graphs to determine the amounts of kinetic and potential energy an object has at two different heights.	B
3	5	*Life Science*	8.LS.1.7	C. Evidence, Reasoning, and Modeling	SR	Complete a model that shows food molecules and oxygen combining to release energy during cellular respiration.	A
4	8	*Physical Science*	8.PS.1.1	C. Evidence, Reasoning, and Modeling	SR	Identify the model that represents a molecule when given the chemical formula.	A
5	8	*Technology/ Engineering*	6.ETS.1.1	B. Mathematics and Data	SR	Interpret data from an investigation to identify the criteria used to select a solution.	B,C
6	9	*Technology/ Engineering*	7.ETS.1.2	B. Mathematics and Data	SR	Use data to determine which solution meets the given criteria to solve a problem.	C
7	10	*Physical Science*	8.PS.2.2	C. Evidence, Reasoning, and Modeling	CR	Analyze steps of an investigation to determine how forces on objects and the masses of objects will affect the speed and kinetic energy of the objects and explain the reasoning.	
8	12	*Technology/ Engineering*	6.ETS.2.3	A. Investigations and Questioning	CR	Identify an appropriate tool and fastener and describe how to use them; identify a piece of safety equipment and explain how it can keep a person safe.	
9	14	*Earth and Space Science*	6.ESS.2.3	C. Evidence, Reasoning, and Modeling	CR	Identify pieces of evidence supporting the claim that two continents were once one landmass and explain the reasoning.	
10	16	*Life Science*	8.LS.3.3	None	SR	Describe the location of chromosomes in cells and describe how genes cause specific proteins to be produced, resulting in the inheritance of different traits.	A;D
11	16	*Physical Science*	7.PS.3.6	None	SR	Identify an example of thermal energy being transferred primarily by conduction.	B
12	18	*Physical Science*	8.PS.1.5	B. Mathematics and Data	SR	Use a data table to compare masses before and after chemical reactions to determine which reaction took place in a closed system.	D
13	18	*Life Science*	6.LS.1.2	None	SR	Describe the function of mitochondria in plant cells.	B
14	19	*Life Science*	8.LS.4.4	B. Mathematics and Data	SR	Analyze a graph of a population changing over time to explain the likelihood of surviving and reproducing to pass on a trait.	C

PBT Item No.	Page No.	Reporting Category	Standard	Science and Engineering Practice Category	Item Type*	Item Description	Correct Answer**
15	20	*Earth and Space Science*	8.ESS.2.1	C. Evidence, Reasoning, and Modeling	SR	Use a diagram to describe the cause of plate motion near a mid-ocean ridge.	C
16	21–22	*Technology/ Engineering*	7.ETS.3.2	B. Mathematics and Data	SR	Analyze graphs to determine the benefits and drawbacks of different communication systems.	C
17	23	*Earth and Space Science*	8.ESS.2.6	C. Evidence, Reasoning, and Modeling	SR	Use the location of two cities shown on a map to describe how distance from the ocean affects climate.	A;B
18	24	*Life Science*	6.LS.4.1	B. Mathematics and Data	SR	Analyze a graph of groups of species over time showing an extinction event to determine what claim can be supported by the graph.	B
19	24	*Earth and Space Science*	7.ESS.2.2	None	SR	Identify evidence that the climate of Massachusetts has changed over geologic time.	C
20	25	*Life Science*	6.LS.4.2	None	SR	Compare the bone structures of different organisms to describe their evolutionary relationships to a common ancestor.	C

 * 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 8 Science and Technology/Engineering
Spring 2023 Unreleased Operational Items

PBT Item No.	Reporting Category	Standard	Science and Engineering Practice Category	Item Type*	Item Description
21	*Earth and Space Science*	8.ESS.3.1	C. Evidence, Reasoning, and Modeling	SR	Explain why two locations can have different amounts of fossil fuel resources.
22	*Life Science*	8.LS.3.4	C. Evidence, Reasoning, and Modeling	SR	Analyze Punnett squares to identify which one can be used to determine the probability of a trait for a given cross.
23	*Life Science*	8.LS.4.5	None	SR	Identify selective breeding as a method people use to develop different types of plants.
24	*Technology/ Engineering*	6.ETS.2.2	A. Investigations and Questioning	SR	Describe the properties of materials needed for a design solution.
25	*Life Science*	7.LS.2.3	None	SR	Describe some of the reactants and products of photosynthesis.
26	*Life Science*	6.LS.1.3	C. Evidence, Reasoning, and Modeling	SR	Describe how organs shown in a diagram work together as a body system.
27	*Technology/ Engineering*	7.ETS.3.5	A. Investigations and Questioning	SR	Use the concept of systems engineering to describe how data can be used to modify a part of a transportation system.
28	*Earth and Space Science*	8.ESS.3.5	B. Mathematics and Data	SR	Use a graph to determine changes in carbon dioxide levels in the atmosphere and identify several activities that have contributed to these changes.
29	*Technology/ Engineering*	6.ETS.1.5	B. Mathematics and Data	SR	Use a ruler to measure the dimensions of a scale drawing and calculate the dimensions of the actual object.
30	*Technology/ Engineering*	7.ETS.3.1	None	SR	Identify the encoder and receiver in a communication system.
31	*Earth and Space Science*	6.ESS.1.1	C. Evidence, Reasoning, and Modeling	SR	Explain why the appearance of the Moon changes over time.
32	*Physical Science*	6.PS.2.4	None	SR	Identify that very massive objects have noticeable gravitational forces between them and those forces are attractive.
33	*Earth and Space Science*	8.ESS.1.1	C. Evidence, Reasoning, and Modeling	SR	Explain the reason for a pattern of increasing daylight hours in a given area.
34	*Earth and Space Science*	8.ESS.1.2	C. Evidence, Reasoning, and Modeling	CR	Analyze a data table to complete a model showing the positions of the Moon, the Sun, and Earth on a certain date; analyze data to determine a tide height and use evidence to support the answer.
35	*Earth and Space Science*	7.ESS.2.4	C. Evidence, Reasoning, and Modeling	SR	Use a model to describe the role of gravity in the water cycle.
36	*Life Science*	8.LS.3.2	C. Evidence, Reasoning, and Modeling	CR	Describe differences between sexual and asexual reproduction and explain how sexual reproduction benefits a population.
37	*Physical Science*	7.PS.3.3	B. Mathematics and Data	CR	Use data to determine a design that minimizes thermal energy transfer, describe how the speed of air molecules inside the design changes, and explain the reasoning.
38	*Technology/ Engineering*	8.ETS.2.5	C. Evidence, Reasoning, and Modeling	SR	Describe assembling, quality control, and safety processes used in the manufacturing of an object.
39	*Physical Science*	6.PS.4.1	C. Evidence, Reasoning, and Modeling	SR	Analyze wave models to determine relative wavelengths, amplitudes, and energies of the waves.

PBT Item No.	Reporting Category	Standard	Science and Engineering Practice Category	Item Type*	Item Description
40	*Technology/ Engineering*	6.ETS.1.1	A. Investigations and Questioning	SR	Determine the design problem given a design solution.
41	*Physical Science*	8.PS.1.2	None	SR	Compare results of investigations to determine which result describes the separation of a compound rather than the separation of a mixture.

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