
XIV. Mathematics, Grade 8

Grade 8 Mathematics Test

The spring 2019 grade 8 Mathematics 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 8 Mathematics 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, multiple-select, or short-answer items that tested the same Mathematics 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.

Test Sessions and Content Overview

The grade 8 Mathematics test was made up of two separate test sessions. Each session included selected-response, short-answer, 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.

Standards and Reporting Categories

The grade 8 Mathematics test was based on standards in the five domains for grade 8 in the *Massachusetts Curriculum Framework for Mathematics* (2017). The five domains are listed below.

- The Number System
- Expressions and Equations
- Functions
- Geometry
- Statistics and Probability

The *Massachusetts Curriculum Framework for Mathematics* is available on the Department website at www.doe.mass.edu/frameworks/current.html.

Mathematics test results are reported under five MCAS reporting categories, which are identical to the five framework domains listed above.

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

Reference Materials and Tools

Each student taking the paper-based version of the grade 8 Mathematics test was provided with a plastic ruler and a grade 8 Mathematics Reference Sheet. A copy of the reference sheet follows the final question in this chapter. An image of the ruler is not reproduced in this publication.

During Session 2, each student had sole access to a calculator. Calculator use was not allowed during Session 1.

During both Mathematics test sessions, the use of bilingual word-to-word dictionaries was allowed for current and former English learner students only. No other reference tools or materials were allowed.

Grade 8 Mathematics

SESSION 1

This session contains 9 questions.

*You may use your reference sheet during this session.
You may **not** use a calculator during this session.*



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.

For other questions, you will need to fill in an answer grid. Directions for completing questions with answer grids are provided on the next page.

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 in this Test & Answer Booklet. Only responses written within the provided space will be scored.

Directions for Completing Questions with Answer Grids

1. Work the question and find an answer.
2. Enter your answer in the answer boxes at the top of the answer grid.
3. Print only one number or symbol in each box. Do not leave a blank box in the middle of an answer.
4. Under each answer box, fill in the circle that matches the number or symbol you wrote above. Make a solid mark that completely fills the circle.
5. Do not fill in a circle under an unused answer box.
6. Fractions cannot be entered into an answer grid and will not be scored. Enter fractions as decimals.
7. If you need to change an answer, be sure to erase your first answer completely.
8. See below for examples of how to correctly complete an answer grid.

EXAMPLES

-	1	4				
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4	4	●	4	4	4	4
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6	6	6	6	6	6	6
7	7	7	7	7	7	7
8	8	8	8	8	8	8
9	9	9	9	9	9	9

	4	8	3	1	6	
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4	●	4	4	4	4	4
5	5	5	5	5	5	5
6	6	6	6	6	●	6
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5	5	5	5	●	5	5
6	6	6	●	6	6	6
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8	8	8	8	8	8	8
9	9	9	9	9	9	9

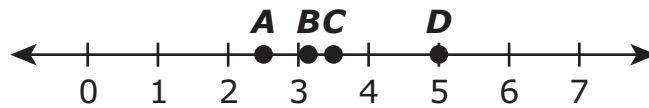
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5	5	5	●	●	●	●
6	6	6	6	6	6	6
7	7	7	7	7	7	7
8	8	8	8	8	8	8
9	●	9	9	9	9	9

1 What is 8.25×10^5 written in standard notation?

Enter your answer in the answer boxes at the top of the answer grid **and** completely fill the matching circles.

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1	1	1	1	1	1	1	1
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4	4	4	4	4	4	4	4
5	5	5	5	5	5	5	5
6	6	6	6	6	6	6	6
7	7	7	7	7	7	7	7
8	8	8	8	8	8	8	8
9	9	9	9	9	9	9	9

2 Which point on this number line best represents $\sqrt{10}$?



- (A) point A
- (B) point B
- (C) point C
- (D) point D

- 3 This expression represents the number of bacteria in a petri dish.

$$5(2^3)^2$$

What is the number of bacteria in the petri dish?

- Ⓐ 60
- Ⓑ 160
- Ⓒ 320
- Ⓓ 800

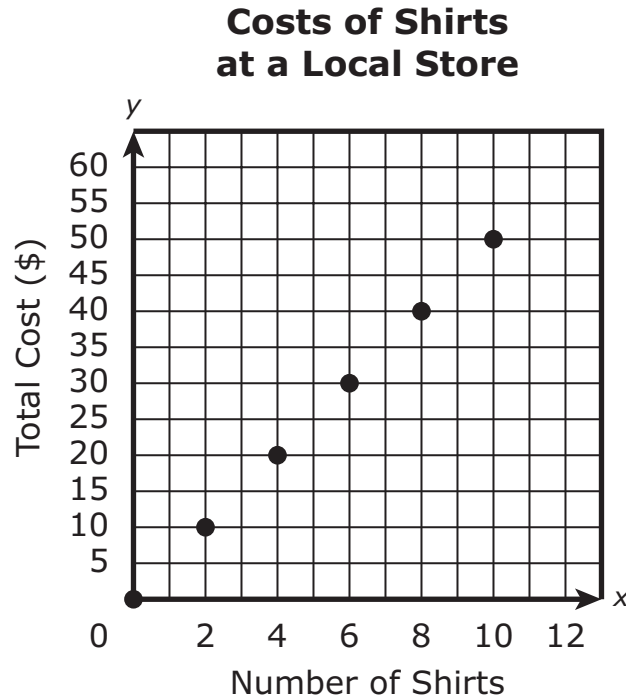
- 4 What value of w makes this equation true?

$$\frac{2}{3}(w + 3) = 7$$

- (A) $3\frac{1}{3}$
- (B) 4
- (C) 6
- (D) $7\frac{1}{2}$

This question has four parts. Be sure to label each part of your response.

- 5 An art teacher needs to buy 20 shirts for a class project. She can buy the shirts at a local store or online. This graph shows the costs, in dollars, for different numbers of shirts at a local store.



- A. Based on the graph, what is the cost, in dollars, for each shirt at the local store? Show or explain how you got your answer.
- B. Write a function that can be used to find y , the total cost, in dollars, of buying x shirts from the local store.
- C. The teacher could buy the shirts online for \$3.50 each. She would also pay a fee of \$9.50 for shipping the shirts. Write a function that can be used to find y , the total cost, in dollars, of buying x shirts online.
- D. The teacher wants to spend the least amount of money. Should she buy the 20 shirts from the local store or online? Show or explain how you got your answer.

5

- 6 Between which pair of numbers on a number line does $\sqrt{6}$ lie?
- Ⓐ 2.3 and 2.5
 - Ⓑ 2.5 and 2.7
 - Ⓒ 2.7 and 2.9
 - Ⓓ 2.9 and 3.1
- 7 The speed of light in cold air is approximately 3×10^8 meters per second. The speed of sound in cold air is approximately 3×10^2 meters per second. The speed of light in cold air is how many times the speed of sound in cold air?
- Ⓐ 1×10^4
 - Ⓑ 3×10^4
 - Ⓒ 1×10^6
 - Ⓓ 3×10^6

8 Consider this expression.

$$\frac{3^{-2} \cdot 3^3}{3^{-1}}$$

What is the value of the expression?

Enter your answer in the answer boxes at the top of the answer grid **and** completely fill the matching circles.

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6	6	6	6	6	6	6	6
7	7	7	7	7	7	7	7
8	8	8	8	8	8	8	8
9	9	9	9	9	9	9	9

- 9 A fruit stand sells apples, oranges, and bananas. The cost of 1 apple is \$0.50, and the cost of 1 orange is \$0.60.
- Ronald bought 4 apples and 1 banana.
 - Madison bought 2 oranges and 3 bananas.
 - The total cost of the fruit Ronald bought was the same as the total cost of the fruit Madison bought.

What is the cost of 1 banana at the fruit stand?

- Ⓐ \$0.20
- Ⓑ \$0.40
- Ⓒ \$0.55
- Ⓓ \$0.80

Grade 8 Mathematics

SESSION 2

This session contains 11 questions.

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EXAMPLES

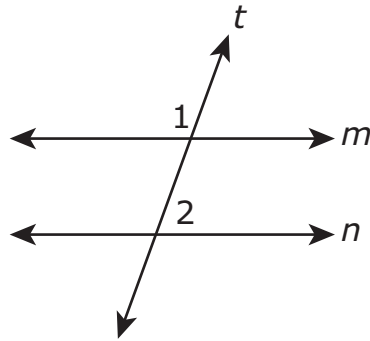
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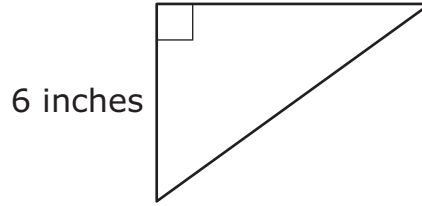
- 10 Lines m and n are parallel lines cut by transversal line t , as shown.



The measure of $\angle 1$ is 120° . What is the measure of $\angle 2$?

- (A) 30°
- (B) 60°
- (C) 90°
- (D) 120°

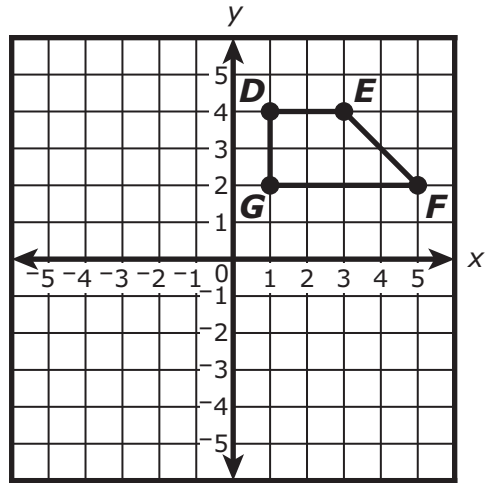
- 11 The length of one side of a right triangle is shown in this diagram.



What could be the lengths of the two remaining sides of the triangle?

- Ⓐ 2 inches and 8 inches
- Ⓑ 8 inches and 10 inches
- Ⓒ 8 inches and 14 inches
- Ⓓ 10 inches and 14 inches

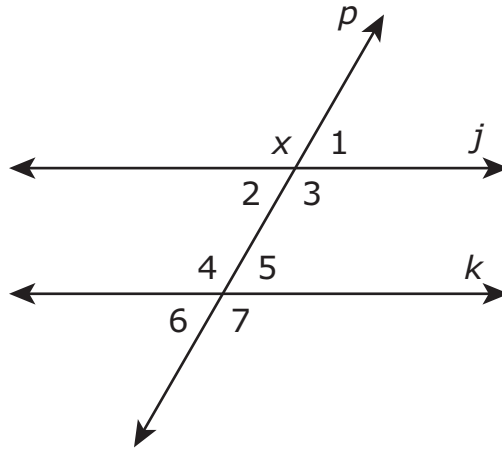
- 12 Trapezoid $DEFG$ is shown on this coordinate plane.



Trapezoid $DEFG$ will be reflected over the x -axis. What will be the coordinates of the image of point E ?

- Ⓐ $(3, -4)$
- Ⓑ $(4, -3)$
- Ⓒ $(-3, -4)$
- Ⓓ $(-4, -3)$

- 13 Parallel lines j and k are cut by transversal line p , creating the angles shown.

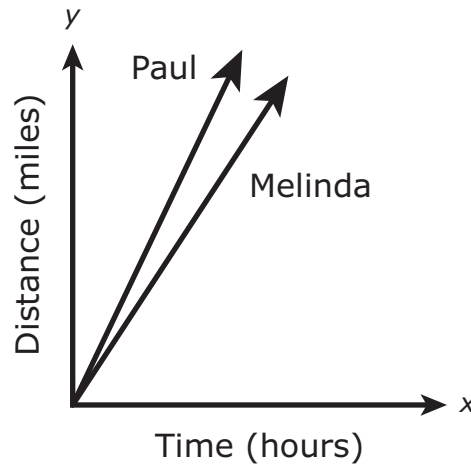


Determine which angles must be congruent to angle x .

Select **all** the angles that must be congruent to angle x .

- Ⓐ angle 1
- Ⓑ angle 2
- Ⓒ angle 3
- Ⓓ angle 4
- Ⓔ angle 5
- Ⓕ angle 6
- Ⓖ angle 7

- 14 Melinda and Paul ran in a marathon. This graph shows the relationship between the distance and the time they each ran.



Melinda ran at a constant speed of 5 miles per hour.

Which of the following is true?

- Ⓐ Paul ran at a slower constant speed than Melinda. An equation that could represent the relationship between Paul's distance and his time is $y = 1x$, where x is the time in hours, and y is the distance in miles Paul ran.
- Ⓑ Paul ran at a slower constant speed than Melinda. An equation that could represent the relationship between Paul's distance and his time is $y = 3x$, where x is the time in hours, and y is the distance in miles Paul ran.
- Ⓒ Paul ran at a faster constant speed than Melinda. An equation that could represent the relationship between Paul's distance and his time is $y = 5x$, where x is the time in hours, and y is the distance in miles Paul ran.
- Ⓓ Paul ran at a faster constant speed than Melinda. An equation that could represent the relationship between Paul's distance and his time is $y = 7x$, where x is the time in hours, and y is the distance in miles Paul ran.

This question has four parts. Be sure to label each part of your response.

- 15 Ethan asked a random sample of students the two questions below.
- Do you have brothers or sisters?
 - Does your family have a dog?

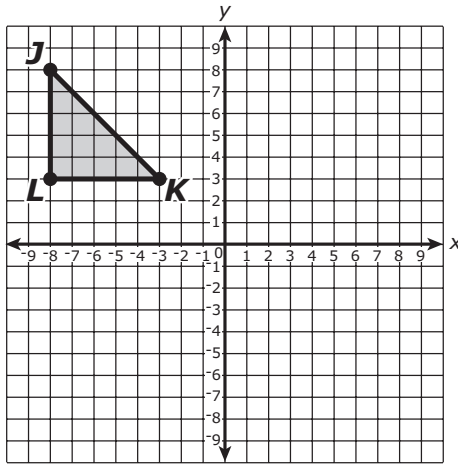
Ethan created this table to display the data he collected.

Ethan's Data

	Have No Dog	Have a Dog
Have No Brothers or Sisters	15	25
Have Brothers or Sisters	80	60

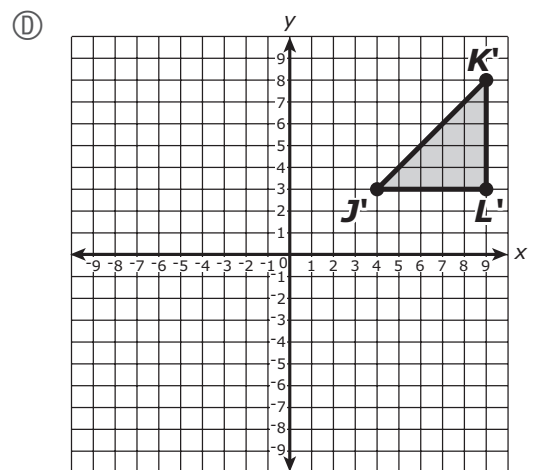
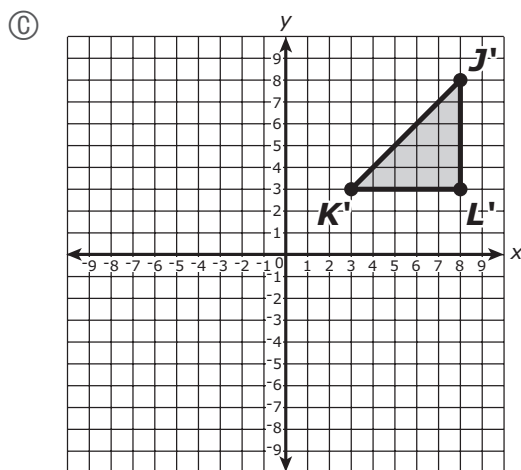
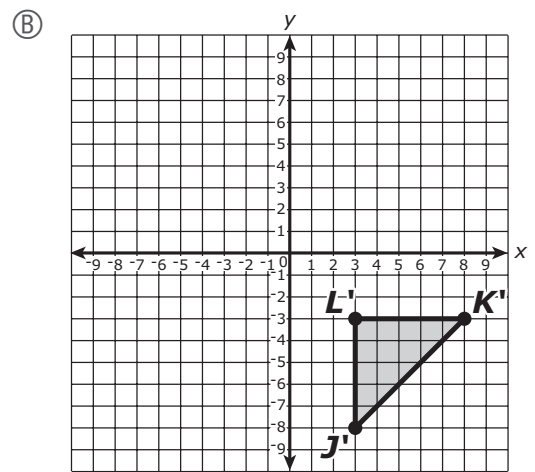
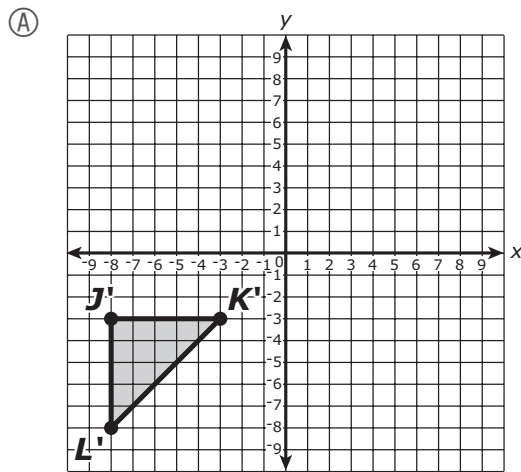
- A. Based on the table, what is the total number of students that have no brothers or sisters? Show or explain how you got your answer.
- B. Based on the table, what percentage of students that have no brothers or sisters have a dog? Show or explain how you got your answer.
- C. Of the students represented in the table that have no dog, what is the ratio of students that have brothers or sisters to students that have no brothers or sisters? Show or explain how you got your answer.
- D. Ethan believes that students that have no brothers or sisters are more likely to have a dog than are students that have brothers or sisters. Does the data support Ethan's belief? Explain your reasoning.

- 16 Triangle JKL is shown on this coordinate plane.



A student will reflect triangle JKL across the y -axis.

Which coordinate plane shows triangle $J'K'L'$, the image of triangle JKL after the reflection?



- 17 A student bought a piece of hard candy that is in the shape of a sphere. The candy has a radius of 3 centimeters.

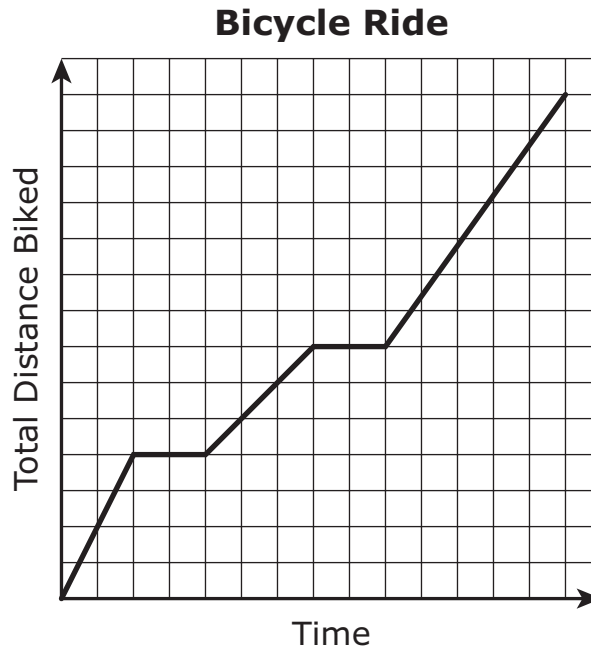
Which of the following is **closest** to the volume of the piece of candy?
(Use 3.14 for π .)

- Ⓐ 14.13 cubic centimeters
- Ⓑ 37.68 cubic centimeters
- Ⓒ 113.04 cubic centimeters
- Ⓓ 904.32 cubic centimeters

This question has two parts.

- 18 A student rode his bicycle from his home to a park.
- He rode home from the park following the same route.
 - He took two rest breaks during his ride, including one at the park.

This graph shows the relationship between the time and the total distance the student rode his bicycle.



Part A

Based on the graph, which statement about the student’s bicycle ride is true?

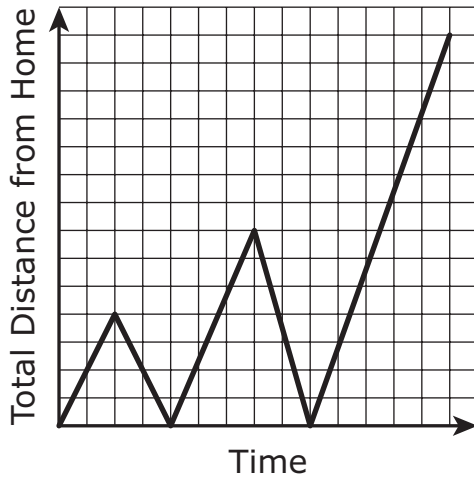
- Ⓐ The student stopped for a rest break on his way to the park.
- Ⓑ The student stopped for a rest break on his way home from the park.
- Ⓒ The student’s rest break at the park lasted longer than the other rest break he took.
- Ⓓ The student reached his fastest speed on his way home from the park.

Part B

Which graph shows how the student's distance from home changed over time?

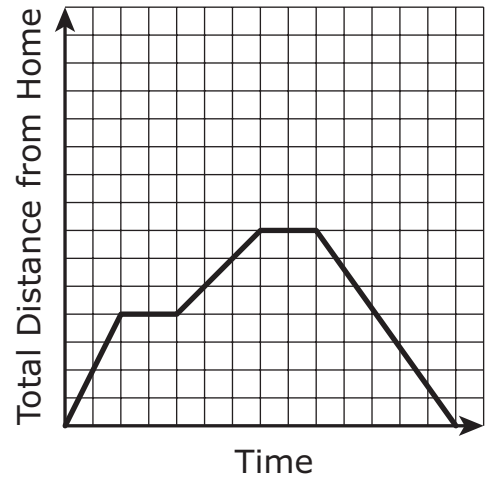
Ⓐ

Bicycle Ride



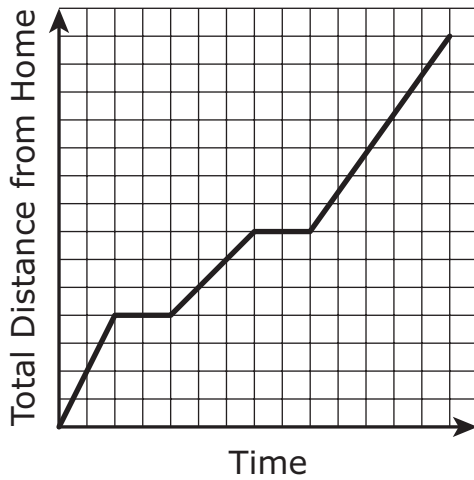
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Bicycle Ride



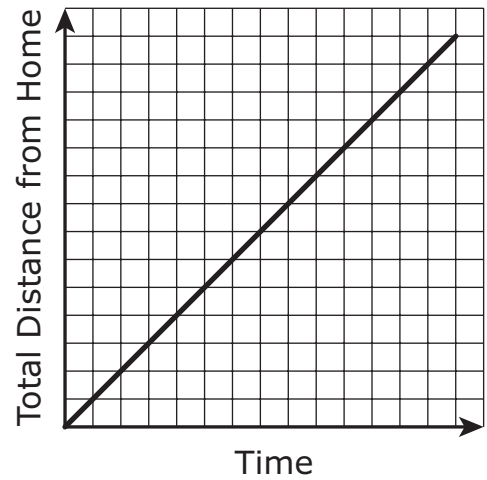
Ⓒ

Bicycle Ride

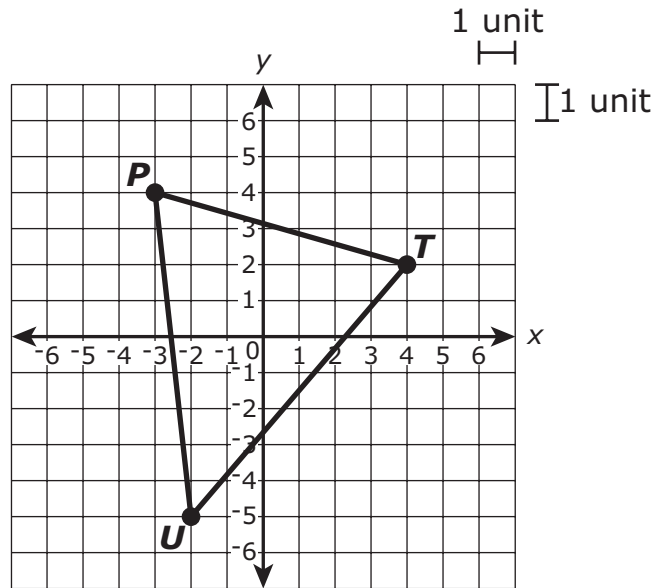


Ⓓ

Bicycle Ride



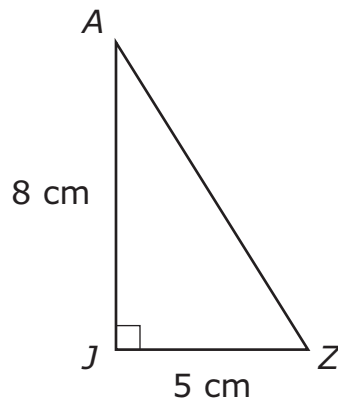
- 19 Triangle PTU is shown on this coordinate plane.



What is the length, to the nearest unit, of \overline{TU} ?

- (A) 6
- (B) 7
- (C) 9
- (D) 13

- 20 Right triangle JAZ has a base of 5 centimeters and a height of 8 centimeters, as shown.



Which of the following pairs of dimensions could represent a triangle that is similar to triangle JAZ ?

- Ⓐ base = 9 cm
height = 12 cm
- Ⓑ base = 8 cm
height = 11 cm
- Ⓒ base = 10 cm
height = 8 cm
- Ⓓ base = 15 cm
height = 24 cm

Massachusetts Comprehensive Assessment System Grade 8 Mathematics Reference Sheet

CONVERSIONS

1 cup = 8 fluid ounces	1 inch = 2.54 centimeters	1 pound = 16 ounces
1 pint = 2 cups	1 meter \approx 39.37 inches	1 pound \approx 0.454 kilogram
1 quart = 2 pints	1 mile = 5280 feet	1 kilogram \approx 2.2 pounds
1 gallon = 4 quarts	1 mile = 1760 yards	1 ton = 2000 pounds
1 gallon \approx 3.785 liters	1 mile \approx 1.609 kilometers	
1 liter \approx 0.264 gallon	1 kilometer \approx 0.62 mile	
1 liter = 1000 cubic centimeters		

AREA (A) FORMULAS

square	$A = s^2$
rectangle	$A = bh$
	OR
	$A = lw$
parallelogram	$A = bh$
triangle	$A = \frac{1}{2}bh$
trapezoid	$A = \frac{1}{2}h(b_1 + b_2)$
circle	$A = \pi r^2$

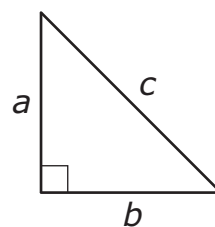
CIRCLE FORMULAS

area.	$A = \pi r^2$
circumference.	$C = 2\pi r$
	OR
	$C = \pi d$

VOLUME (V) FORMULAS

cube	$V = s^3$
	(s = length of an edge)
sphere	$V = \frac{4}{3}\pi r^3$
cone	$V = \frac{1}{3}\pi r^2 h$
right circular cylinder	$V = \pi r^2 h$
right prism	$V = Bh$

PYTHAGOREAN THEOREM



$$a^2 + b^2 = c^2$$

Grade 8 Mathematics
Spring 2019 Released Operational Items

PBT Item No.	Page No.	Reporting Category	Standard	Item Type*	Item Description	Correct Answer**
1	324	<i>The Number System and Expressions and Equations</i>	8.EE.A.4	SA	Convert a number given in scientific notation to a number in standard notation.	825,000
2	324	<i>The Number System and Expressions and Equations</i>	8.NS.A.2	SR	Identify a point on a number line that corresponds to the approximate location of an irrational number.	B
3	325	<i>The Number System and Expressions and Equations</i>	8.EE.A.1	SR	Use the properties of integer exponents to determine an expression equivalent to a given expression.	C
4	326	<i>The Number System and Expressions and Equations</i>	8.EE.C.7	SR	Determine the solution to a linear equation by using the distributive property.	D
5	327	<i>Functions</i>	8.F.A.2	CR	Compare properties of two different functions, representing real-world contexts, graphically and verbally; write equations that represent functions.	
6	329	<i>The Number System and Expressions and Equations</i>	8.NS.A.2	SR	Determine the location of an irrational number between two rational numbers on a number line.	A
7	329	<i>The Number System and Expressions and Equations</i>	8.EE.A.3	SR	Determine how many times greater one number is than another when both are expressed as single digits multiplied by integer powers of ten.	C
8	330	<i>The Number System and Expressions and Equations</i>	8.EE.A.1	SA	Apply the properties of integer exponents to simplify a given expression.	9
9	331	<i>The Number System and Expressions and Equations</i>	8.EE.C.7	SR	Solve a pair of linear equations expressed as verbal descriptions.	B
10	334	<i>Geometry</i>	8.G.A.5	SR	Determine the measure of an unknown angle in a figure containing two parallel lines cut by a transversal.	B
11	335	<i>Geometry</i>	8.G.B.7	SR	Choose side lengths to create a right triangle.	B
12	336	<i>Geometry</i>	8.G.A.3	SR	Determine the coordinates of the image of a vertex of a polygon after the polygon has been reflected over the x-axis.	A
13	337	<i>Geometry</i>	8.G.A.5	SR	Given parallel lines cut by a transversal, select all angles that must be congruent to one of the angles.	C,D,G
14	338	<i>The Number System and Expressions and Equations</i>	8.EE.B.5	SR	Interpret and compare proportional relationships on a graph, and identify an equation to represent the relationship.	D
15	339	<i>Statistics and Probability</i>	8.SP.A.4	CR	Interpret a two-way table to answer statistical questions about categorical data collected from the same subjects.	
16	341	<i>Geometry</i>	8.G.A.3	SR	Choose a graph that represents a given transformation of a two-dimensional figure on a coordinate plane.	C
17	342	<i>Geometry</i>	8.G.C.9	SR	Determine the volume of a sphere.	C
18	343–344	<i>Functions</i>	8.F.B.5	SR	Analyze a graph of a functional relationship to determine which statement about the relationship is true; then select another graph that exhibits a different qualitative feature of the functional relationship.	A;B
19	345	<i>Geometry</i>	8.G.B.8	SR	Determine the length of a side of a right triangle graphed on the coordinate plane by using the Pythagorean Theorem.	C
20	346	<i>Geometry</i>	8.G.A.4	SR	Determine which measurements belong to a triangle similar to a given triangle.	D

* Mathematics item types are: selected-response (SR), short-answer (SA), and constructed-response (CR).

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

Grade 8 Mathematics
Spring 2019 Unreleased Operational Items

PBT Item No.	Reporting Category	Standard	Item Type*	Item Description
21	<i>Statistics and Probability</i>	8.SPA.1	SR	Determine which scatter plot matches a given description that includes information about linearity and direction of correlation.
22	<i>The Number System and Expressions and Equations</i>	8.EE.A.1	SR	Determine which expression with an exponent is equivalent to a given expression featuring multiplication of two numbers with the same base but different exponents.
23	<i>The Number System and Expressions and Equations</i>	8.NS.A.2	SR	Determine between which pair of integers a square root of a given number lies.
24	<i>The Number System and Expressions and Equations</i>	8.EE.C.8	CR	Given the graph of a system of linear equations, solve the system, write the equation of a graphed line, and determine whether a third line passing through two given points will intersect the line.
25	<i>The Number System and Expressions and Equations</i>	8.NS.A.1	SA	Convert a fraction to a decimal.
26	<i>The Number System and Expressions and Equations</i>	8.EE.A.1	SR	Apply the properties of integer exponents to choose an equivalent expression when one exponent is positive and the other exponent is negative.
27	<i>Functions</i>	8.F.B.4	SR	Determine the rate of change from a verbal description of a proportional relationship, and use that rate of change to solve a real-world problem.
28	<i>The Number System and Expressions and Equations</i>	8.EE.A.1	SR	Use the properties of integer exponents to determine an expression equivalent to a given expression.
29	<i>The Number System and Expressions and Equations</i>	8.EE.B.5	SR	Choose the graph of a real-world proportional relationship and identify an equation to represent a related relationship.
30	<i>Functions</i>	8.F.B.5	SR	Analyze a graph where a function is increasing and decreasing.
31	<i>The Number System and Expressions and Equations</i>	8.EE.A.3	SR	Given two quantities, each expressed as a single digit multiplied by an integer power of ten, choose which statement expresses how many times as much one quantity is than the other.
32	<i>Statistics and Probability</i>	8.SPA.3	SR	Interpret the meaning of the slope in a linear equation.
33	<i>Geometry</i>	8.G.A.3	SR	Determine the coordinates of the image of a vertex of a polygon after the polygon has been reflected over the y-axis.
34	<i>Functions</i>	8.F.A.2	SR	Compare properties of two functions represented algebraically and in a table and choose a correct statement interpreting each function's rate of change and initial value.
35	<i>Geometry</i>	8.G.A.1	CR	Given a polygon and its image after a transformation, verify congruence by analyzing properties of both; describe a series of transformations that would result in the same image of the polygon.
36	<i>Functions</i>	8.F.B.4	SR	Determine which graph has a given slope.
37	<i>Geometry</i>	8.G.B.7	SR	Use the Pythagorean Theorem to solve a problem with real-world context.
38	<i>Geometry</i>	8.G.A.2	SA	Determine the measure of an unknown angle in a figure by using facts about similarity.
39	<i>Functions</i>	8.F.A.1	SR	Identify y as a function of x from given input/output tables.
40	<i>Geometry</i>	8.G.A.5	SR	Determine which angles are congruent when two parallel lines are intersected by a transversal.

* Mathematics item types are: selected-response (SR), short-answer (SA), and constructed-response (CR).