MASSACHUSETTS DEPARTMENT OF
ELEMENTARY AND SECONDARY
EDUCATION

Release of Spring 2021 MCAS Test Items

from the

Grade 10 Mathematics Paper-Based Test

June 2021
Massachusetts Department of Elementary and Secondary Education

MASSACHUSETTS DEPARTMENT OF
ELEMENTARY AND SECONDARY
EDUCATION

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Grade 10 Mathematics Test

The spring 2021 grade 10 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 10 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 10 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 10 Mathematics test was based on high school standards in the *Massachusetts Curriculum Framework for Mathematics* (2017). The standards in the 2017 framework are organized under the five major conceptual categories listed below.

- Number and Quantity
- Algebra
- Functions
- Geometry
- Statistics and Probability

The grade 10 test assessed standards that overlap between the Model Algebra I/Model Geometry and Model Mathematics I/Model Mathematics II courses. The *Massachusetts Curriculum Framework for Mathematics* is available on the Department website at www.doe.mass.edu/frameworks/current.html.

Mathematics test results for grade 10 are reported under four MCAS reporting categories, which are based on the five framework conceptual categories listed above.

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

Reference Materials and Tools

Each student taking the grade 10 Mathematics test was provided with a grade 10 Mathematics Reference Sheet. A copy of the reference sheet follows the final question in this chapter.

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 10 Mathematics

SESSION 1

This session contains 21 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.

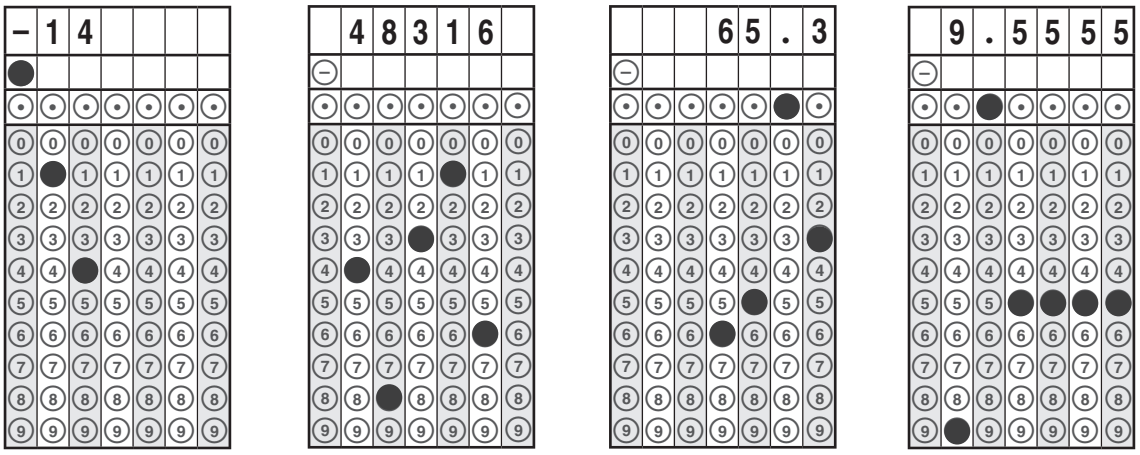
For other questions, you will need to fill in an answer grid. Directions for completing questions with answer grids are provided on the next page.

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. Only responses written within the provided space will be scored.

Directions for Completing Questions with Answer Grids

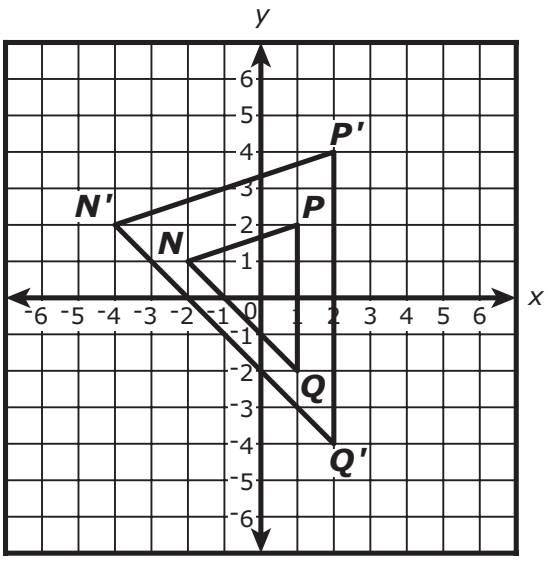
1. Work the question and find an answer.
2. Enter your answer in the answer boxes at the top of the answer grid.
3. Print only one number or symbol in each box. Do not leave a blank box in the middle of an answer.
4. Under each answer box, fill in the circle that matches the number or symbol you wrote 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

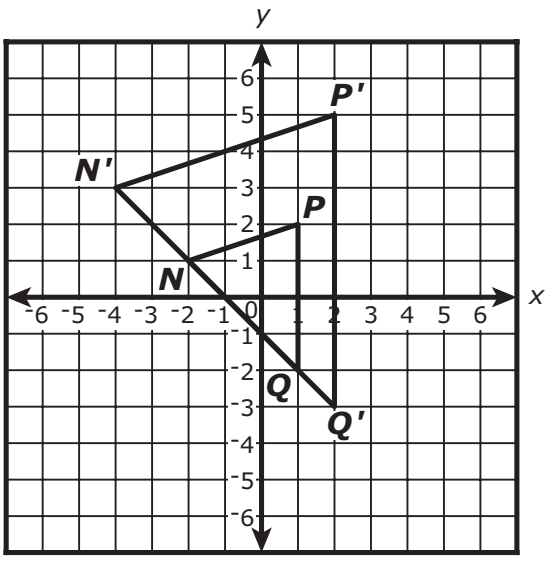


1 On a coordinate plane, $\triangle NPQ$ is dilated by a scale factor of 2 with respect to the origin to create its image, $\triangle N'P'Q'$. Which of the following shows possible locations of $\triangle NPQ$ and $\triangle N'P'Q'$?

Ⓐ



Ⓑ



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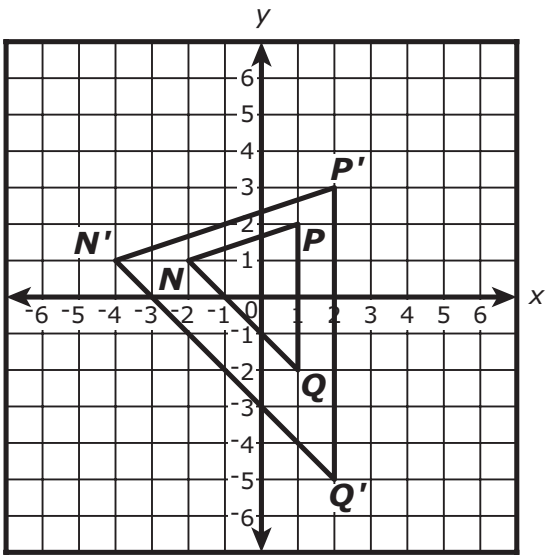

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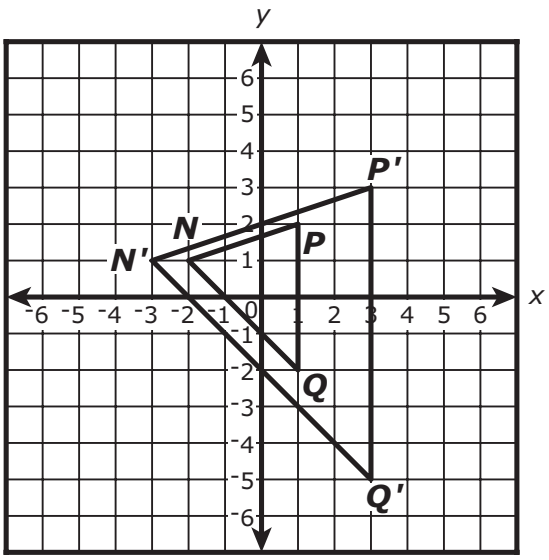


2 Silvia is planning to use a 4-year loan to purchase a car.

- The price of the car is $8,575.
- The amount of interest she will have to pay on the loan is $1,036.

Silvia will combine the price of the car and the amount of interest to determine how much she must repay. She will make 48 equal monthly payments.

Which of the following is the **best** estimate of each monthly payment Silvia will make?

Ⓐ $175

Ⓑ $200

Ⓒ $225

Ⓓ $250

3 Consider this equation.

$$5x - 1 = x^2 + 2x + 1$$

Which of the following values of x make the equation true?

Select the **two** correct values.

Ⓐ -2

Ⓑ -1

Ⓒ 0

Ⓓ 1

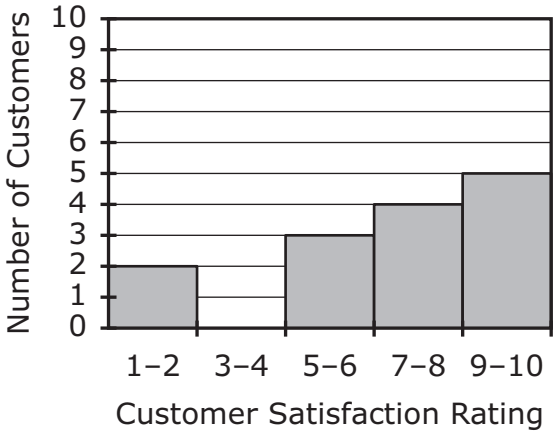
Ⓔ 2

4 A survey was given to fifteen customers at a store. The customers rated their satisfaction with the store on a scale from 1 to 10. The ratings from the survey are shown in this list.

8, 9, 2, 7, 10, 1, 7, 6, 9, 8, 5, 5, 9, 7, 10

Which histogram shows the correct distribution of customer satisfaction ratings?

Ⓐ



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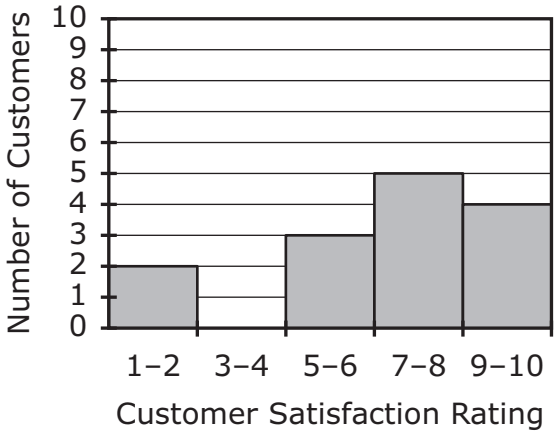

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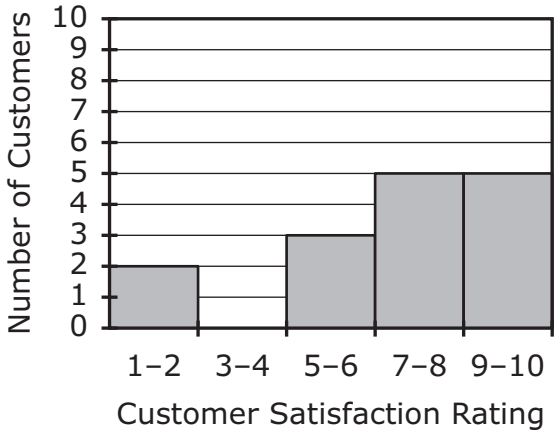

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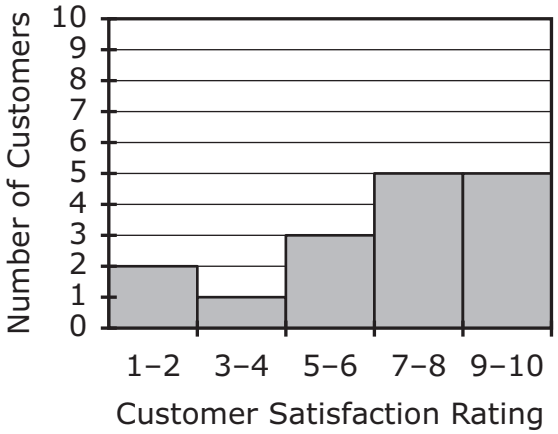


5 A system of equations is shown.

$$y = -\frac{1}{2}x$$
$$x^2 + y^2 = 20$$

Which of the following ordered pairs are solutions of the system of equations?

Select the **two** correct ordered pairs.

Ⓐ (−8, −4)

Ⓑ (−4, 2)

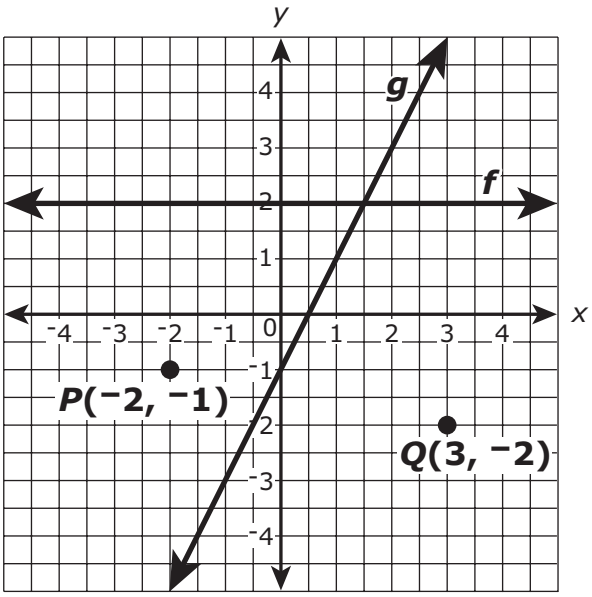
Ⓒ (0, 0)

Ⓓ (4, −2)

Ⓔ (8, −4)

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

6 Lines *f* and *g* and points *P* and *Q* are graphed on this coordinate plane.



- The equation of line *f* is $y = 2$.
- The equation of line *g* is $y = 2x - 1$.

A. Write an equation of the line that is parallel to line *f* and passes through point *P*. Show or explain how you got your answer.

B. Write an equation of the line that is parallel to line *g* and passes through point *P*. Show or explain how you got your answer.

C. Write an equation of the line that is **perpendicular** to line *f* and passes through point *Q*. Show or explain how you got your answer.

D. Write an equation of the line that is perpendicular to line *g* and passes through point *Q*. Show or explain how you got your answer.

6

7 Triangle *RST* is drawn on a coordinate plane.

Which of the following transformations, when performed on triangle *RST*, will **not** result in a congruent figure?

Ⓐ a dilation by a scale factor of 2 with respect to point *R*

Ⓑ a 540° counterclockwise rotation about point *S*

Ⓒ a translation 2 units to the right

Ⓓ a reflection over $\overline{ST}$

8 Which of the following has the same solution as this system of equations?

$$4x + 9y = 10$$
$$2x + 3y = 12$$

Ⓐ $4x + 9y = 10$
$4x + 3y = 24$

Ⓑ $4x + 9y = 10$
$2x + 9y = 36$

Ⓒ $4x + 9y = 10$
$4x + 6y = 24$

Ⓓ $4x + 9y = 10$
$2x + 9y = 12$

9 A data set with an outlier is shown.

20, 35, 40, 45, 45, 50, 75

Which of the following **best** describes the effect on the mean of the data if the outlier is removed?

Ⓐ The mean will increase.

Ⓑ The mean will decrease.

Ⓒ The mean will remain the same.

Ⓓ There is not enough information to make a conclusion.

10 An arithmetic sequence is represented by this function.

$$f(n) = 3 + 2n$$

What is the **fifth** term of the sequence?

Ⓐ 13

Ⓑ 17

Ⓒ 25

Ⓓ 35

This question has two parts.

11 **Part A**

An expression is shown.

$$\sqrt{9} + \sqrt{9}$$

What is the value of the expression?

Ⓐ 3

Ⓑ 6

Ⓒ 9

Ⓓ 18

Part B

A second expression is shown.

$$2\sqrt{3} \cdot 2\sqrt{4}$$

Which of the following is equivalent to the second expression?

Ⓐ $2\sqrt{6}$

Ⓑ $6\sqrt{3}$

Ⓒ $8\sqrt{3}$

Ⓓ $8\sqrt{4}$

12 For all real values of x and y, which of the following is equivalent to this expression?

$$-3x(-y + 4)$$

Ⓐ $12x - 3xy$

Ⓑ $12x + 3xy$

Ⓒ $-12x - 3xy$

Ⓓ $-12x + 3xy$

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

13 Nora, Owen, and Peyton are studying expressions.

A. Nora writes this expression.

$$(\sqrt{3})^2$$

What is the value of Nora's expression? Show or explain how you got your answer.

B. Owen writes this expression.

$$\sqrt[3]{2^6}$$

What is the value of Owen's expression? Show or explain how you got your answer.

C. Owen writes a second expression in this form.

$$\sqrt{x}$$

What value should Owen use for x to make his second expression equivalent to his first expression? Show or explain how you got your answer.

D. Peyton writes a different expression that contains a cube root and an exponent. Peyton's expression is equivalent to **Nora's** expression.

Write an expression that could be Peyton's expression. Show or explain how you got your answer.

13

This question has two parts.

14 This table shows some values of function $f(x)$.

x	0	3	5
$f(x)$	13	104	416

Part A

Which of the following **best** describes $f(x)$?

Ⓐ a linear decay function

Ⓑ a linear growth function

Ⓒ an exponential decay function

Ⓓ an exponential growth function

Part B

Which of the following equations models $f(x)$?

Ⓐ $f(x) = 2x + 13$

Ⓑ $f(x) = 13(2)^x$

Ⓒ $f(x) = 8x + 80$

Ⓓ $f(x) = 91(2)^{x-1}$

15 What are the solutions of this equation?

$$2x(3x - 4) = 0$$

Ⓐ $x = 0; x = \frac{3}{4}$

Ⓑ $x = 0; x = \frac{4}{3}$

Ⓒ $x = -2; x = 4$

Ⓓ $x = 2; x = -4$

16 In a geometric sequence, the second term is 15 and the fourth term is 135.

What is the first term in the sequence?

Ⓐ 3

Ⓑ 5

Ⓒ 7

Ⓓ 9

17 A candidate received 59% of the votes cast in an election. In the election, 76% of the 39,881 registered voters cast a vote.

Which of the following is closest to the total number of people who cast a vote for the candidate in the election?

Ⓐ 12,000

Ⓑ 14,000

Ⓒ 16,000

Ⓓ 18,000

This question has two parts.

18 Consider this system of linear equations.

$$x + 2y = 8$$
$$-2x + y = -6$$

Part A

What is the solution of the system of equations?

Ⓐ $(-1, 2)$

Ⓑ $(0, 4)$

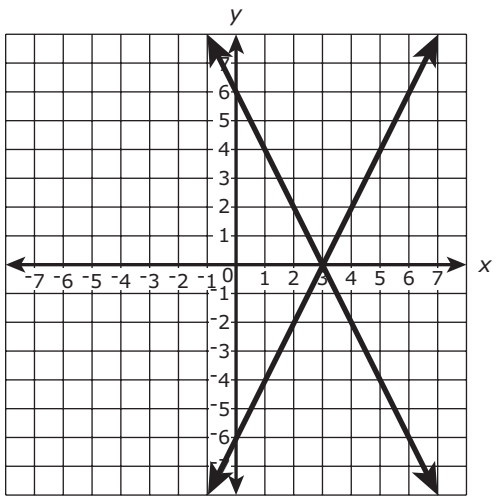
Ⓒ $(3, 0)$

Ⓓ $(4, 2)$

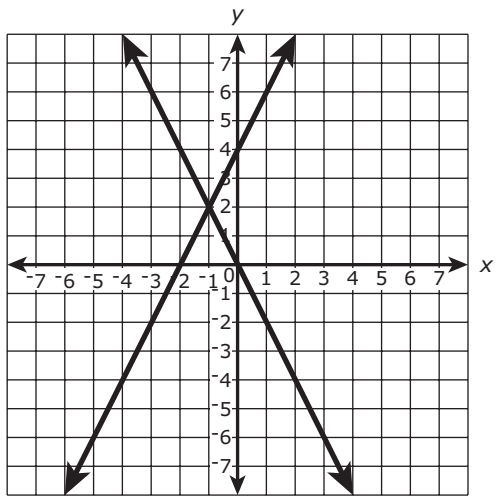
Part B

Which of the following graphs represents the system of equations?

Ⓐ



Ⓑ



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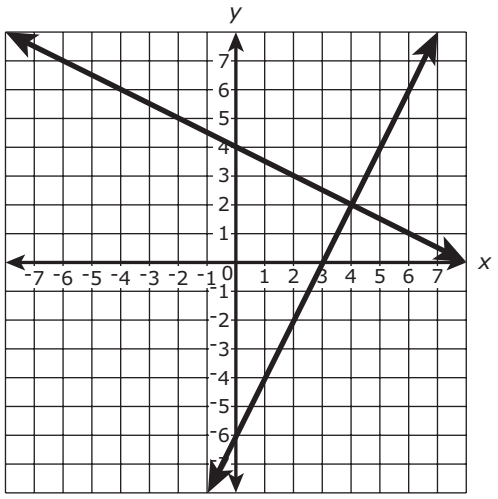

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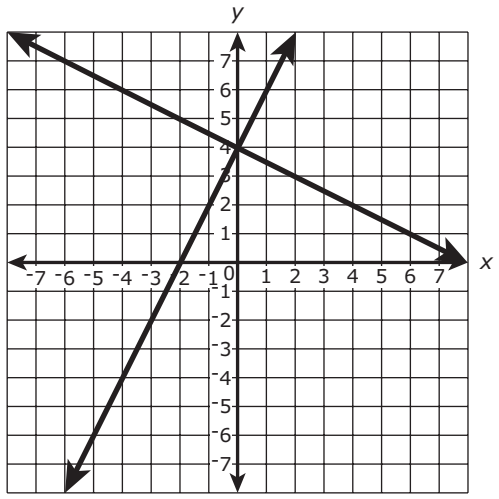
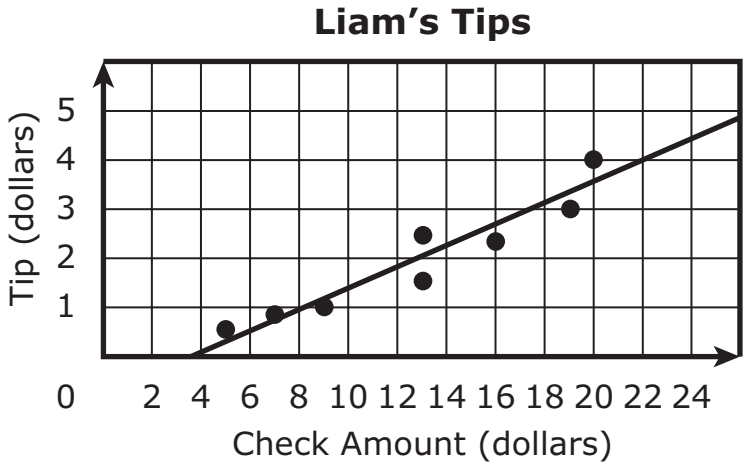


19 Liam is a waiter at a diner. This scatter plot shows the relationship between the amount, in dollars, of a customer's check and the tip, in dollars, that Liam receives on an average day of work.



Based on the line of best fit for the scatter plot, which of the following is **closest** to the tip that Liam should expect to receive for a $25 check?

Ⓐ $5.00

Ⓑ $4.50

Ⓒ $4.00

Ⓓ $3.75

20 An airplane reaches an altitude of 9000 meters and then begins to descend at a constant rate of 625 meters per minute. Which of the following equations can be used to determine y, the altitude of the airplane after x minutes?

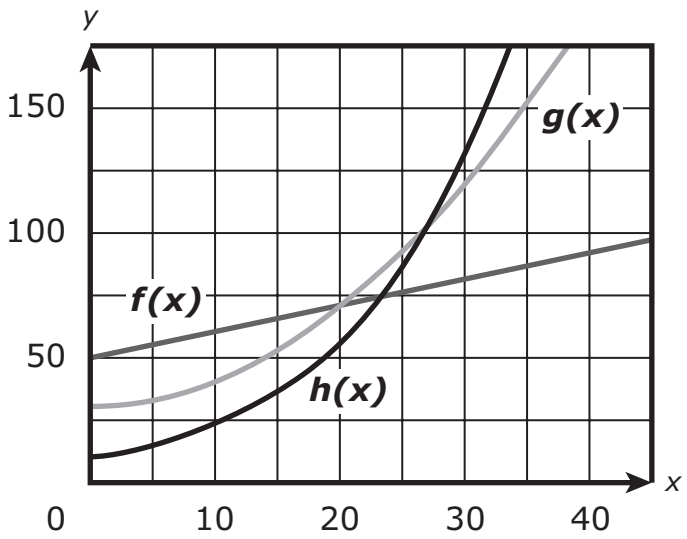
Ⓐ $y = -9000x + 625$

Ⓑ $y = -625x + 9000$

Ⓒ $y = 9000x - 625$

Ⓓ $y = 625x - 9000$

21 The graphs of three functions, linear function $f(x)$, quadratic function $g(x)$, and exponential function $h(x)$, are shown on this coordinate plane.



Which of the following statements about the functions is true?

Ⓐ Function $f(x)$ has the greatest initial value, and function $h(x)$ has the greatest value when $x = 50$.

Ⓑ Function $g(x)$ has the greatest initial value, and function $f(x)$ has the greatest value when $x = 50$.

Ⓒ Function $f(x)$ has the greatest initial value, and function $g(x)$ has the greatest value when $x = 50$.

Ⓓ Function $g(x)$ has the greatest initial value, and function $h(x)$ has the greatest value when $x = 50$.

Grade 10 Mathematics
SESSION 2

This session contains 21 questions.

You may use your reference sheet during this session.
You may 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.

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Directions for Completing Questions with Answer Grids

1. Work the question and find an answer.
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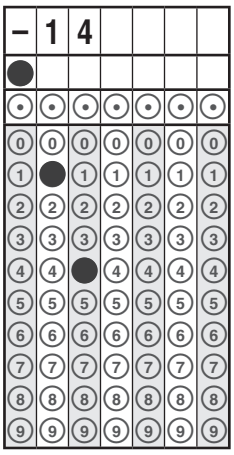
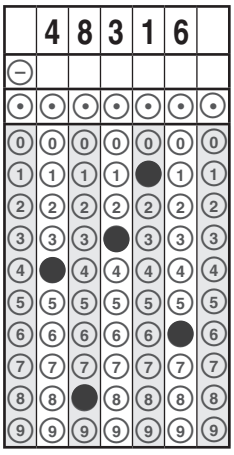
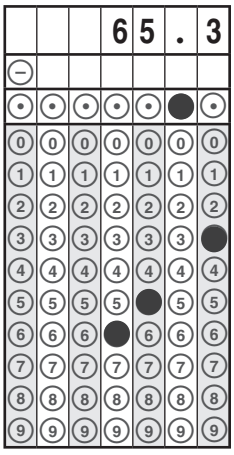
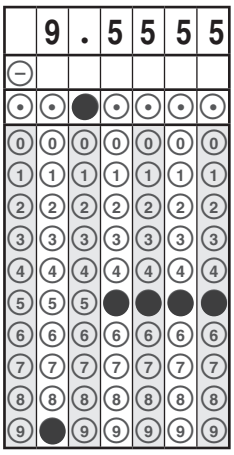
8. See below for examples of how to correctly complete an answer grid.

EXAMPLES

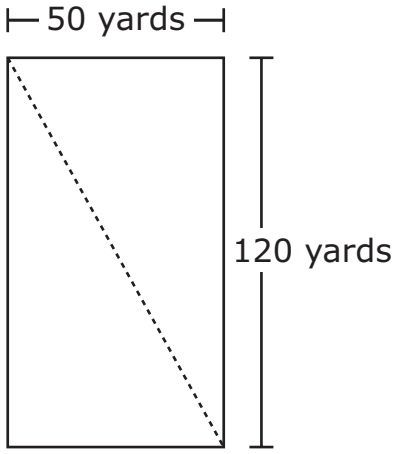








22 Julio walked from one corner of a rectangular field to the opposite corner along a diagonal of the field. This diagram represents the field and the path Julio walked.



Based on the dimensions in the diagram, what is the distance that Julio walked?

Ⓐ 130 yards

Ⓑ 140 yards

Ⓒ 160 yards

Ⓓ 170 yards

23 A worker at the Rainbow Garden Center planted multiple rows of flowers.

- There are 3 flowers in the first row.
- Each of the remaining rows has 4 more flowers than the previous row.

How many flowers do rows 20 and 35 each have?

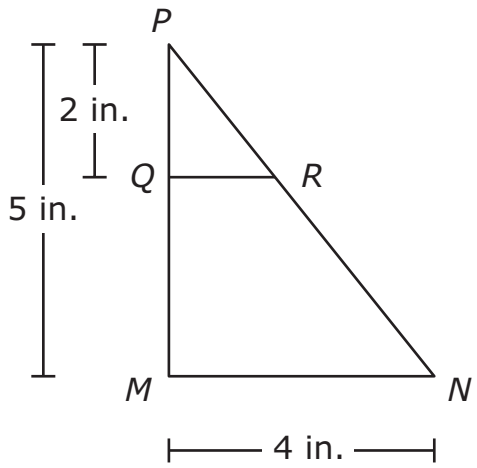
Ⓐ Row 20 has 83 flowers and row 35 has 143 flowers.

Ⓑ Row 20 has 83 flowers and row 35 has 106 flowers.

Ⓒ Row 20 has 79 flowers and row 35 has 139 flowers.

Ⓓ Row 20 has 79 flowers and row 35 has 83 flowers.

24 In this diagram, $\triangle MNP \sim \triangle QRP$.



Based on the dimensions in the diagram, what is the length of $\overline{QR}$?

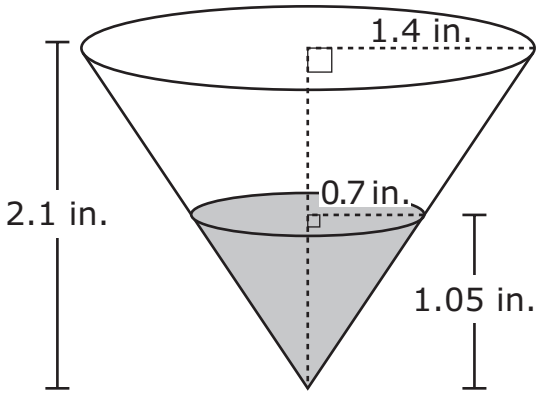
Ⓐ 1 in.

Ⓑ 1.6 in.

Ⓒ 2 in.

Ⓓ 2.4 in.

25 A cup is in the shape of a right circular cone. The cup is filled with water to half its height, as shown.



Based on the measurements shown, which of the following expressions represents the volume, in cubic inches, of the empty part of the cup?

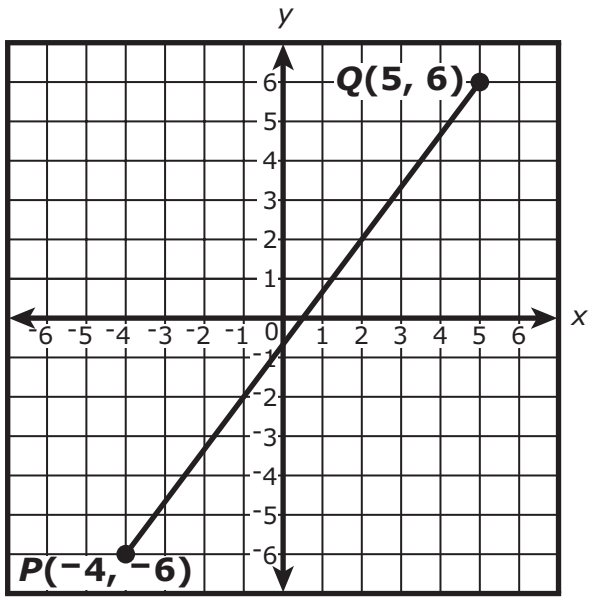
Ⓐ $\frac{1}{3}\pi(2.8)^2(2.1) - \frac{1}{3}\pi(1.4)^2(1.05)$

Ⓑ $\frac{1}{3}\pi(1.4)^2(2.1) - \frac{1}{3}\pi(0.7)^2(1.05)$

Ⓒ $\frac{1}{3}\pi(1.4)^2(1.05)$

Ⓓ $\frac{1}{3}\pi(0.7)^2(1.5)$

26 A student graphed $\overline{PQ}$ on a coordinate plane, as shown.



The student will plot point S on $\overline{PQ}$ such that the length of $\overline{SQ}$ is twice the length of $\overline{SP}$. What will be the coordinates of point S?

Ⓐ $(-1, -2)$

Ⓑ $(0, -\frac{1}{2})$

Ⓒ $(\frac{1}{2}, 0)$

Ⓓ $(2, 2)$

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

27 The types and colors of the vehicles for sale at a dealership are shown in this table.

Vehicles for Sale

	Red	Blue	Green	Total
Vans	53	127	51	231
Trucks	62	78	49	189
Total	115	205	100	420

A. Based on the table, what percentage of the vehicles for sale at the dealership are trucks? Show or explain how you got your answer.

B. What **fraction** of the vans for sale at the dealership are blue? Show or explain how you got your answer.

C. What fraction of the vehicles for sale at the dealership are red **or** are vans? Show or explain how you got your answer.

D. How many of the vehicles for sale at the dealership are vans **and** are either red **or** green? Show or explain how you got your answer.

27

28 Two students calculated the area of a circular skating rink that has a radius of 20 yards.

- The first student calculated the area using 3 as an estimate for π.
- The second student calculated the area using 3.14 as an estimate for π.

Which of the following statements correctly compares the students' calculations?

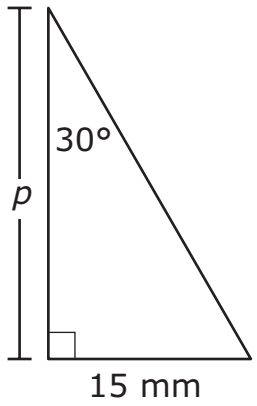
Ⓐ The first student's calculation is more accurate by about 3 square yards.

Ⓑ The first student's calculation is more accurate by about 56 square yards.

Ⓒ The second student's calculation is more accurate by about 3 square yards.

Ⓓ The second student's calculation is more accurate by about 56 square yards.

29 A triangle and some of its measurements are shown in this diagram.



Based on the diagram, what is the value of p?

Ⓐ 15 mm

Ⓑ $15\sqrt{3}$ mm

Ⓒ 30 mm

Ⓓ $30\sqrt{3}$ mm

30 Which of the following statements correctly define a geometric term?

Select the **three** correct answers.

Ⓐ An angle is defined as lines in a plane that do not intersect.

Ⓑ An angle is defined as two rays that have the same endpoint.

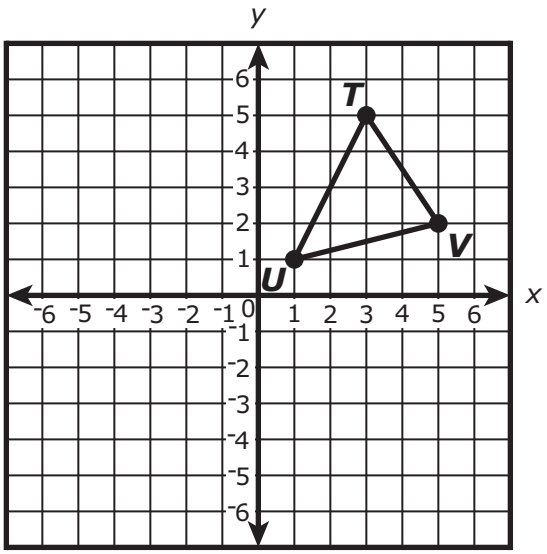
Ⓒ A circle is defined as the set of all points equidistant from a point in a plane.

Ⓓ A circle is defined as part of a line that contains two endpoints and all the points between them.

Ⓔ Parallel lines are defined as the set of all points equidistant from a point in a plane.

Ⓕ Parallel lines are defined as lines in a plane that do not intersect.

31 Triangle *TUV* is shown on this coordinate plane.



- Triangle *TUV* will be reflected over the *x*-axis.
- The image of triangle *TUV* will then be translated 2 units up and 1 unit left.

What will be the coordinates of the **final** image of point *V* after the two transformations?

Ⓐ (0, 4)

Ⓑ (4, 0)

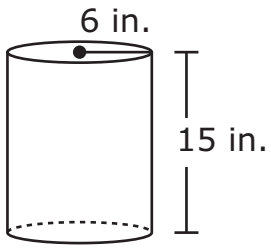
Ⓒ (4, −6)

Ⓓ (−6, 4)

This question has two parts.

32 **Part A**

Circular cylinder W and some of its dimensions are shown in this diagram.



Cylinder W

Which of the following is **closest** to the volume of cylinder W?

Ⓐ 565.5 cubic inches

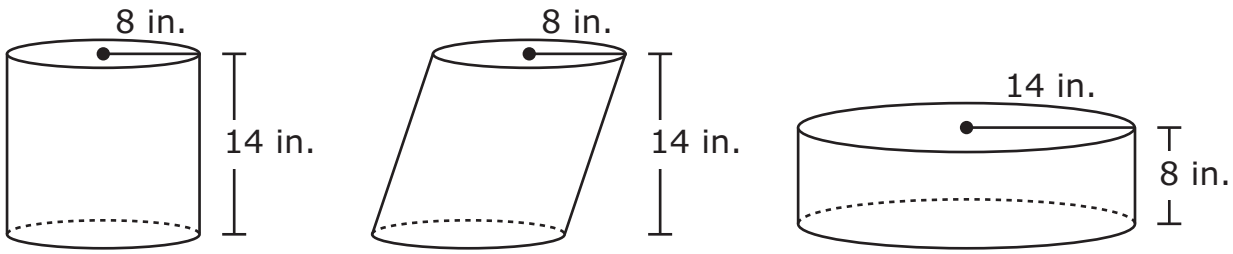
Ⓑ 1,696.5 cubic inches

Ⓒ 4,241.2 cubic inches

Ⓓ 6,785.8 cubic inches

Part B

This diagram shows circular cylinders X, Y, and Z and the measures of their heights and radii.



Cylinder X Cylinder Y Cylinder Z

Which of the following statements correctly compare the volumes of cylinders X, Y, and Z?

Select the **two** correct answers.

Ⓐ The volume of cylinder Y is less than the volume of cylinder X.

Ⓑ The volume of cylinder Y is equal to the volume of cylinder X.

Ⓒ The volume of cylinder Y is greater than the volume of cylinder X.

Ⓓ The volume of cylinder Z is less than the volume of cylinder X.

Ⓔ The volume of cylinder Z is equal to the volume of cylinder X.

Ⓕ The volume of cylinder Z is greater than the volume of cylinder X.

33 This compound inequality can be used to determine X, the approximate range of temperatures, in degrees Fahrenheit, at which zinc is a liquid.

$$419.5 \leq \frac{5}{9}(X - 32) \leq 907$$

What is the **approximate** range of temperatures, in degrees Fahrenheit, at which zinc is a liquid?

Ⓐ 250.8 to 521.7

Ⓑ 265.1 to 535.9

Ⓒ 787.1 to 1664.6

Ⓓ 812.7 to 1690.2

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

34 Mikaila is saving money to purchase a laptop computer. She already has saved $150 in her savings account. Next week Mikaila will begin a tutoring job that pays $10 per hour. All the money she earns tutoring will be added to her savings account.

A. What is the **total** amount of money Mikaila will have saved in her account after tutoring for 12 hours? Show or explain how you got your answer.

B. Write an expression to represent the **total** amount of money Mikaila will have saved in her account after tutoring for x hours.

C. The least expensive laptop that Mikaila is considering purchasing costs $550, including tax.

Write and solve an inequality to determine the minimum number of hours Mikaila needs to tutor to have enough money in her savings account to purchase a laptop that costs $550 or more. Show or explain how you got your answer.

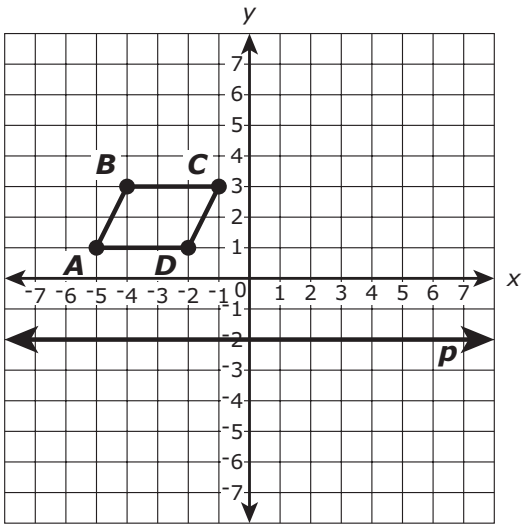
D. The most expensive laptop that Mikaila is considering purchasing costs $1,150, including tax.

Write and solve a **compound** inequality to determine the number of hours Mikaila needs to tutor to have enough money in her savings account to purchase a laptop that costs at least $550 but not more than $1,150. Show or explain how you got your answer.

34

This question has two parts.

35 A student graphed parallelogram *ABCD* and line *p* on a coordinate plane, as shown.



Part A

The student will reflect parallelogram *ABCD* over line *p* to create its image, parallelogram *EFGH*. Which of the following will be the coordinates of point *H*?

Ⓐ (−2, −5)

Ⓑ (−2, −1)

Ⓒ (2, 1)

Ⓓ (5, 1)

Part B

Which sequence of transformations can be performed to map *ABCD* onto itself?

Ⓐ a reflection over the *y*-axis followed by a reflection over the *x*-axis

Ⓑ a clockwise rotation of 180° about the origin followed by a counterclockwise rotation of 180° about the origin

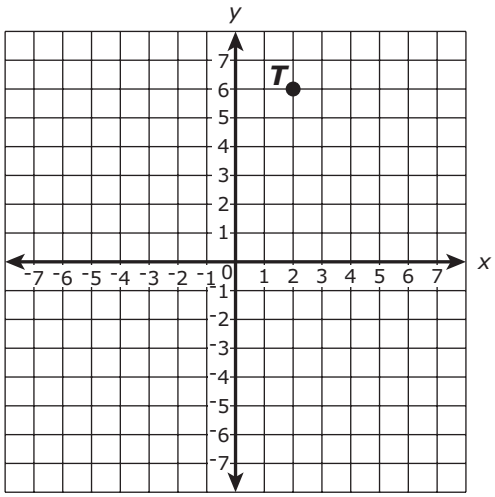
Ⓒ a reflection over the *y*-axis followed by a clockwise rotation of 180° about the origin

Ⓓ a dilation by a scale factor of 5 with respect to the origin followed by a dilation by a scale factor of −5 with respect to the origin

36 Line q is represented by this equation.

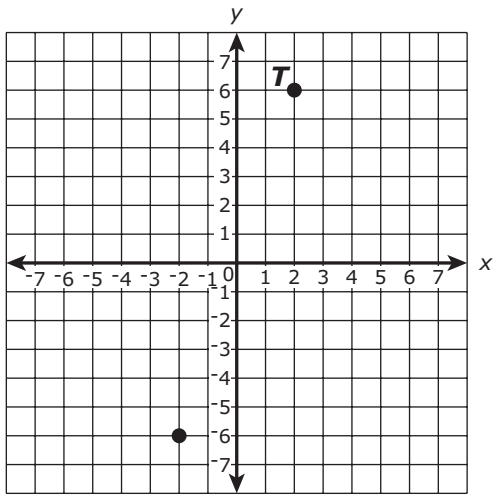
$$y = x$$

Point T (shown) will be reflected over line q to create its image.

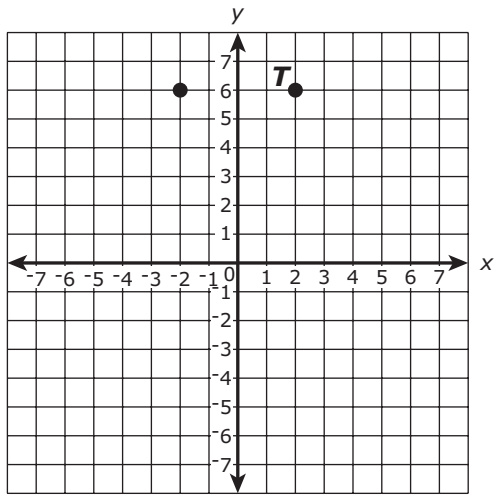


Which of the following graphs shows point *T* and its image after the reflection?

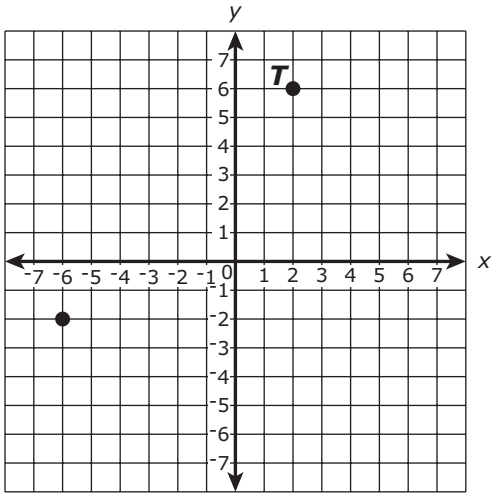
Ⓐ



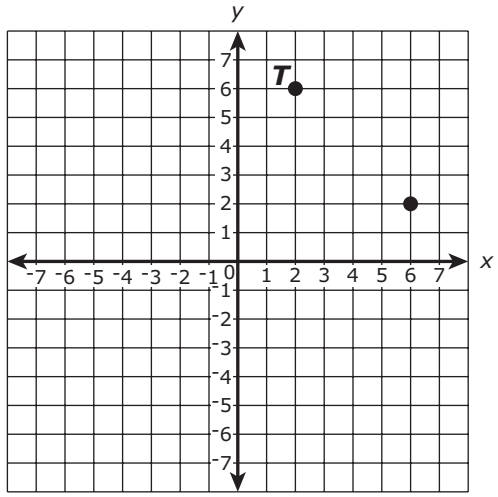
Ⓑ



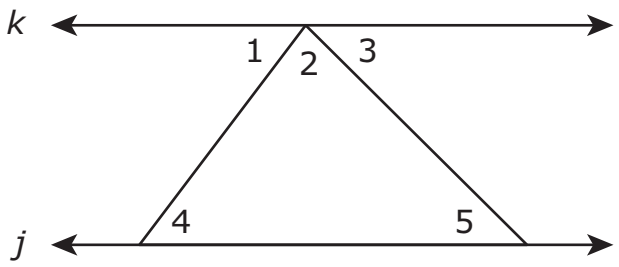
Ⓒ



Ⓓ



37 In this diagram, lines *k* and *j* are parallel.



Which statement proves that $\angle 1 \cong \angle 4$ **and** $\angle 3 \cong \angle 5$?

Ⓐ The vertical angles formed by the intersection of two lines are congruent.

Ⓑ The corresponding angles formed by the intersection of a transversal and two parallel lines are congruent.

Ⓒ The alternate interior angles formed by the intersection of a transversal and two parallel lines are congruent.

Ⓓ The measure of an exterior angle of a triangle is equal to the sum of the measures of the two opposite interior angles.

38 Some students are raising money by selling T-shirts.

- They ordered 100 T-shirts to sell.
- They will sell the T-shirts for $20 each.

This equation models P, the amount of money the students will earn, as a function of n, the number of T-shirts they sell.

$$P(n) = 20n - 500$$

What is the domain of this function, where n is a whole number?

Ⓐ $0 \leq n \leq 20$

Ⓑ $0 \leq n \leq 100$

Ⓒ $20 \leq n \leq 100$

Ⓓ $20 \leq n \leq 500$

This question has two parts.

39 A teacher surveyed all of the students at a school about whether they participate in a sport and whether they play sports-related video games. This table shows some of the results of the survey.

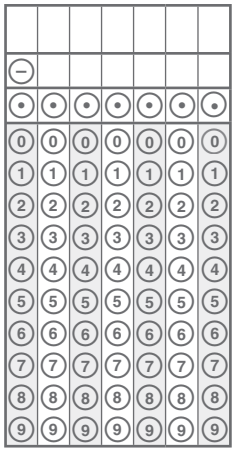
Teacher's Survey

	Participate in a Sport	Do Not Participate in a Sport	Total
Play Sports-Related Video Games	110		294
Do Not Play Sports-Related Video Games	165	278	443
Total	275	462	737

Part A

Based on the table, how many students at the school play sports-related video games but do not participate in a sport?

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



Part B

Given that a randomly selected student from the school participates in a sport, what is the probability that the student also plays sports-related video games?

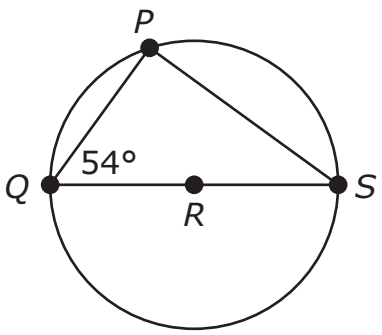
Ⓐ $\frac{110}{737}$

Ⓑ $\frac{110}{275}$

Ⓒ $\frac{275}{737}$

Ⓓ $\frac{275}{462}$

40 In this diagram, points *P*, *Q*, and *S* lie on circle *R*. Line segment *QS* is a diameter of the circle.



The measure of $\angle Q$ is 54°. What is the measure of $\angle S$?

Ⓐ 27°

Ⓑ 36°

Ⓒ 54°

Ⓓ 63°

41 This table lists some input and output values for a function, $f(x)$.

x	$f(x)$
−1	8.1
0	2.5
1	−1.1
2	−2.7

Which of the following statements correctly describes this function?

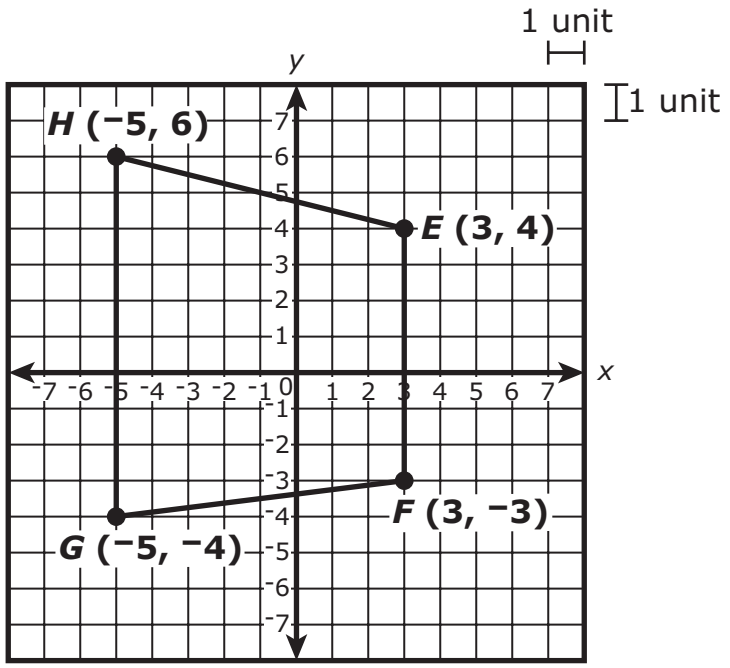
Ⓐ On average, $f(x)$ increases by 1.6 units as x increases by 1 unit over the interval $-1 \leq x \leq 2$.

Ⓑ On average, $f(x)$ decreases by 1.6 units as x increases by 1 unit over the interval $-1 \leq x \leq 2$.

Ⓒ On average, $f(x)$ increases by 3.6 units as x increases by 1 unit over the interval $-1 \leq x \leq 2$.

Ⓓ On average, $f(x)$ decreases by 3.6 units as x increases by 1 unit over the interval $-1 \leq x \leq 2$.

42 Trapezoid *EFGH* is shown on this coordinate plane.



Which of the following is **closest** to the perimeter of the trapezoid?

Ⓐ 30.0 units

Ⓑ 32.7 units

Ⓒ 33.3 units

Ⓓ 36.0 units

MASSACHUSETTS DEPARTMENT OF ELEMENTARY AND SECONDARY EDUCATION

Massachusetts Comprehensive Assessment System
Grade 10 Mathematics Reference Sheet

CONVERSIONS

1 cup = 8 fluid ounces
1 pint = 2 cups
1 quart = 2 pints
1 gallon = 4 quarts
1 gallon ≈ 3.785 liters
1 liter ≈ 0.264 gallon
1 liter = 1000 cubic centimeters

1 inch = 2.54 centimeters
1 meter ≈ 39.37 inches
1 mile = 5280 feet
1 mile = 1760 yards
1 mile ≈ 1.609 kilometers
1 kilometer ≈ 0.62 mile

1 pound = 16 ounces
1 pound ≈ 0.454 kilogram
1 kilogram ≈ 2.2 pounds
1 ton = 2000 pounds

AREA (A) FORMULAS

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

TOTAL SURFACE AREA (SA) FORMULAS

cube . . . . . $SA = 6s^2$
right square pyramid . . . . $SA = s^2 + 2s\ell$
(ℓ = slant height)
right rectangular prism . . $SA = 2(lw) + 2(hw) + 2(lh)$

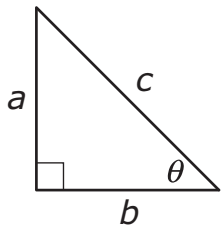
VOLUME (V) FORMULAS

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

CIRCLE FORMULAS

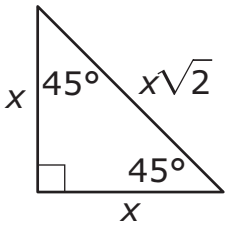
pi . . . . . $\pi \approx 3.14$
circumference . . . . $C = 2\pi r$ OR $C = \pi d$
area . . . . . $A = \pi r^2$

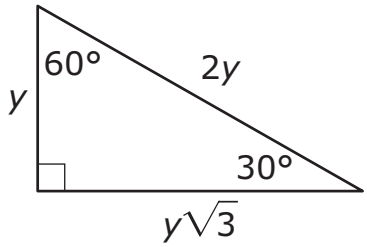
RIGHT TRIANGLES



Pythagorean Theorem
$a^2 + b^2 = c^2$
Trigonometric Ratios
$\sin\theta = \frac{a}{c}$
$\cos\theta = \frac{b}{c}$
$\tan\theta = \frac{a}{b}$

SPECIAL RIGHT TRIANGLES





Grade 10 Mathematics
Spring 2021 Released Operational Items

PBT Item No.	Page No.	Reporting Category	Standard	Item Type*	Item Description	Correct Answer**
1	4	*Geometry*	G-SRT.A.1	SR	Determine which graph shows a triangle and its image after a dilation.	A
2	5	*Number and Quantity*	N-Q.A.2	SR	Use modeling and estimation techniques to solve a real-world problem.	B
3	5	*Algebra and Functions*	A-REI.D.11	SR	Select the values that make a given quadratic equation true.	D,E
4	6	*Statistics and Probability*	S-ID.A.1	SR	Identify which histogram represents a given set of data.	C
5	7	*Algebra and Functions*	A-REI.C.7	SR	Solve a system consisting of the equations of a line and a circle.	B,D
6	8	*Geometry*	G-GPE.B.5	CR	Write equations of lines that are parallel and perpendicular to given lines passing through given points.	
7	10	*Geometry*	G-CO.B.6	SR	Determine which transformation performed on a triangle will not result in a congruent image.	A
8	10	*Algebra and Functions*	A-REI.C.5	SR	Choose a system of equations that has the same solution as a given system of linear equations.	C
9	11	*Statistics and Probability*	S-ID.A.3	SR	Determine the effect on the mean if an outlier is removed from a set of data.	B
10	11	*Algebra and Functions*	F-IF.A.2	SR	Find a specified term in an arithmetic sequence that is represented by a given function.	A
11	12	*Number and Quantity*	N-RN.B.3	SR	Determine the value of expressions that contain rational and irrational numbers.	B;C
12	13	*Algebra and Functions*	A-APR.A.1	SR	Multiply a monomial and a binomial to identify an equivalent expression.	D
13	14	*Number and Quantity*	N-RN.A.1	CR	Translate between radical and exponential representations of different expressions and create a radical expression based on stated parameters.	
14	16	*Algebra and Functions*	F-LE.A.2	SR	Use the values of a function in a table to describe an exponential function and determine which equation models the function.	D;B
15	17	*Algebra and Functions*	A-REI.B.4	SR	Find the solutions of a quadratic equation.	B
16	18	*Algebra and Functions*	F-IF.A.3	SR	Find a specified term in a geometric sequence, given the value of two other terms in the sequence.	B
17	19	*Number and Quantity*	N-Q.A.2	SR	Use a mathematical model to estimate a quantity in a real-world situation.	D
18	20–21	*Algebra and Functions*	A-REI.C.6	SR	Solve a system of linear equations and determine which graph represents the system.	D;C
19	22	*Statistics and Probability*	S-ID.B.6	SR	Use the line of best fit for data in a scatter plot to predict a value in a real-world situation.	B
20	22	*Algebra and Functions*	A-CED.A.2	SR	Determine which equation describes the relationship between two variables in a real-world context.	B
21	23	*Algebra and Functions*	F-LE.A.3	SR	Given the graphs of three different functions, determine which function has the greatest initial value and which function has the greatest value when x is a specific value.	A
22	26	*Geometry*	G-SRT.C.8	SR	Use the Pythagorean Theorem to determine the missing side length of a triangle in a real-world context.	A
23	26	*Algebra and Functions*	F-BF.A.2	SR	Analyze an algebraic sequence that represents a real-world situation.	C

PBT Item No.	Page No.	Reporting Category	Standard	Item Type*	Item Description	Correct Answer**
24	27	*Geometry*	G-SRT.B.5	SR	Use proportions to find a missing side length in a diagram displaying similar triangles.	B
25	28	*Geometry*	G-GMD.A.3	SR	Use the volume formula for a cone to solve a real-world problem.	B
26	29	*Geometry*	G-GPE.B.6	SR	Locate a point on a line segment, graphed on a coordinate plane, that divides the segment in a specified ratio.	A
27	30	*Statistics and Probability*	S-ID.B.5	CR	Calculate relative frequencies based on data displayed in a two-way table.	
28	32	*Number and Quantity*	N-Q.A.3	SR	Determine the effects of rounding on measurements in a real-world situation.	D
29	33	*Geometry*	G-SRT.C.6	SR	Use trigonometric ratios to determine a missing side length in a right triangle.	B
30	34	*Geometry*	G-CO.A.1	SR	Identify geometric terms that are correctly defined.	B,C,F
31	35	*Geometry*	G-CO.A.2	SR	Determine the coordinates of a vertex of a triangle, graphed on a coordinate plane, after a sequence of transformations.	B
32	36–37	*Geometry*	G-GMD.A.1	SR	Determine the volume of a cylinder, and compare the volumes of other cylinders that have similar dimensions.	B;B,F
33	38	*Algebra and Functions*	A-REI.B.3	SR	Solve a compound linear inequality that represents a real-world problem.	C
34	39	*Algebra and Functions*	A-CED.A.1	CR	Write and solve a linear equation and linear inequalities based on a real-world situation.	
35	41	*Geometry*	G-CO.A.3	SR	Determine the coordinates of a vertex of a parallelogram after a reflection and the sequence of transformations that would map the parallelogram onto itself.	A;B
36	42–43	*Geometry*	G-CO.A.5	SR	Identify the image of a point on a coordinate plane after a reflection over a given line.	D
37	44	*Geometry*	G-CO.C.9	SR	Identify the theorem about parallel lines and transversals that proves two pairs of angles in a diagram are congruent.	C
38	45	*Algebra and Functions*	F-IF.B.5	SR	Identify the domain of a function based on a real-world situation.	B
39	46–47	*Statistics and Probability*	S-CP.A.4	SA	Complete a two-way frequency table and use the table to calculate a conditional probability.	184;B
40	48	*Geometry*	G-C.A.2	SR	Determine the measure of an angle in a triangle inscribed in a circle.	B
41	49	*Algebra and Functions*	F-IF.B.6	SR	Calculate the average rate of change of an exponential function over a given interval.	D
42	50	*Geometry*	G-GPE.B.7	SR	Calculate the perimeter of a trapezoid graphed on a coordinate plane.	C

* 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 constructed-response items will be posted to the Department's website later this year.