



MASSACHUSETTS

Department of Elementary  
and Secondary Education

*Release of Spring 2024  
MCAS Test Items*

*from the*

*Grade 10 Mathematics  
Paper-Based Test*

**June 2024**

**Massachusetts Department of  
Elementary and Secondary Education**



MASSACHUSETTS  
Department of Elementary  
and Secondary Education

This document was prepared by the  
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Acting Commissioner

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# Overview of Grade 10 Mathematics Test

The spring 2024 grade 10 Mathematics test was administered in two formats: a computer-based version and a paper-based version. Most students took the computer-based test. The paper-based test was offered as an accommodation for eligible students who were unable to use a computer. More information can be found on the MCAS Test Administration Resources page at [www.doe.mass.edu/mcas/admin.html](http://www.doe.mass.edu/mcas/admin.html).

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](http://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](http://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 document.

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 authorized bilingual word-to-word dictionaries and glossaries was allowed for students who are currently or were ever reported as English learners. 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	4				
●						
○	○	○	○	○	○	○
0	0	0	0	0	0	0
1	●	1	1	1	1	1
2	2	2	2	2	2	2
3	3	3	3	3	3	3
4	4	●	4	4	4	4
5	5	5	5	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	9

	4	8	3	1	6	
○						
○	○	○	○	○	○	○
0	0	0	0	0	0	0
1	1	1	1	●	1	1
2	2	2	2	2	2	2
3	3	3	●	3	3	3
4	●	4	4	4	4	4
5	5	5	5	5	5	5
6	6	6	6	6	●	6
7	7	7	7	7	7	7
8	8	●	8	8	8	8
9	9	9	9	9	9	9

			6	5	.	3
○						
○	○	○	○	○	○	○
0	0	0	0	0	0	0
1	1	1	1	1	1	1
2	2	2	2	2	2	2
3	3	3	3	3	3	●
4	4	4	4	4	4	4
5	5	5	5	●	5	5
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

	9	.	5	5	5	5
○						
○	○	○	○	○	○	○
0	0	0	0	0	0	0
1	1	1	1	1	1	1
2	2	2	2	2	2	2
3	3	3	3	3	3	3
4	4	4	4	4	4	4
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 An arithmetic sequence is represented by this function.

$$f(n) = 3n + 1$$

Which of the following sequences is represented by the function for  $n = 1$  through  $n = 4$ ?

- Ⓐ 3, 6, 12, 24
- Ⓑ 4, 7, 10, 13
- Ⓒ 4, 10, 28, 82
- Ⓓ 6, 9, 12, 15

- 2 Two numbers are represented by variables.

- The variable  $x$  represents a non-zero rational number.
- The variable  $y$  represents an irrational number.

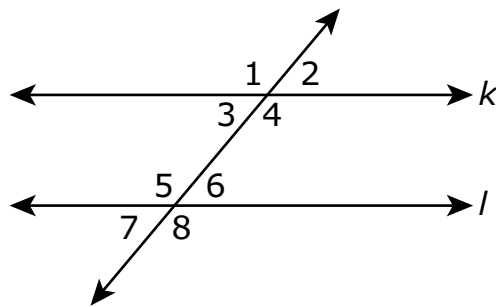
Which of the following expressions has a value that is **rational**?

- Ⓐ  $x^2$
- Ⓑ  $xy$
- Ⓒ  $2xy$
- Ⓓ  $2x + y$

3 Which of the following equations represents a line that has a positive slope and a negative  $y$ -intercept?

- (A)  $3x + y = -6$
- (B)  $3x + y = 6$
- (C)  $-3x + y = -6$
- (D)  $-3x + y = 6$

4 Parallel lines  $k$  and  $l$  are cut by a transversal, as shown in this diagram.



The measure of  $\angle 7$  is  $50^\circ$ . What is the measure of  $\angle 2$ ?

- (A)  $40^\circ$
- (B)  $50^\circ$
- (C)  $130^\circ$
- (D)  $180^\circ$

- 5 Consider this system of linear equations.

$$3x + 2y = 8$$

$$2x + y = 5$$

Which of the following systems of equations has the **same** solution as the given system of equations?

Ⓐ  $3x + 2y = 8$   
 $x = 2$

Ⓑ  $3x + 2y = 8$   
 $x = -2$

Ⓒ  $3x + 2y = 8$   
 $x = 18$

Ⓓ  $3x + 2y = 8$   
 $x = -18$



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

- 6 The prices, in dollars, of ten magazines for sale at a newsstand are shown in this list.

7.00	7.50	7.50	7.50	8.00
8.00	8.00	8.00	8.50	10.00

- A. What is the range of the prices, in dollars, of the ten magazines? Show or explain how you got your answer.
- B. What is the **median** price, in dollars, of the ten magazines? Show or explain how you got your answer.
- C. Two new magazines will be for sale at the newsstand.
- Each new magazine will have the same price.
  - The prices of both new magazines will be included in the list.

The median price of all the magazines in the list, including the two new magazines, will **not** change.

What **could be** the price, in dollars, of each new magazine? Show or explain how you got your answer.

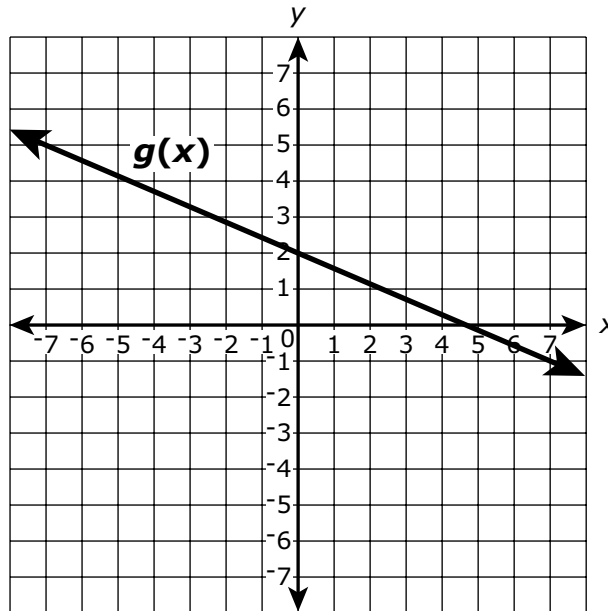
- D. The **mean** price of all the magazines for sale at the newsstand will increase by \$1.00 when the prices of the two new magazines are included in the list.
- Based on this information, what will be the **actual** price, in dollars, of each new magazine? Show or explain how you got your answer.



- 7 This equation represents linear function  $f(x)$ .

$$f(x) = \frac{5}{4}x - 7$$

This graph represents a **different** linear function,  $g(x)$ .



Which of the following statements about the slopes and the  $y$ -intercepts of the two functions are true?

Select the **three** correct answers.

- (A) The slope of  $f(x)$  is positive.
- (B) The slope of  $f(x)$  is negative.
- (C) The slope of  $g(x)$  is positive.
- (D) The slope of  $g(x)$  is negative.
- (E) The  $y$ -intercept of  $f(x)$  is less than the  $y$ -intercept of  $g(x)$ .
- (F) The  $y$ -intercept of  $f(x)$  is greater than the  $y$ -intercept of  $g(x)$ .

- 8 An equation of a circle is shown.

$$(x - 1)^2 + (y + 2)^2 = 9$$

The equation is graphed on a coordinate plane. What are the coordinates of the center of the circle?

- Ⓐ  $(-2, 1)$
- Ⓑ  $(-1, 2)$
- Ⓒ  $(1, -2)$
- Ⓓ  $(2, -1)$

- 9 This table shows a linear relationship between values of  $x$  and  $y$ .

$x$	1	2	3	4	5
$y$	5	3	1	-1	-3

Which of the following equations describes the relationship shown in the table?

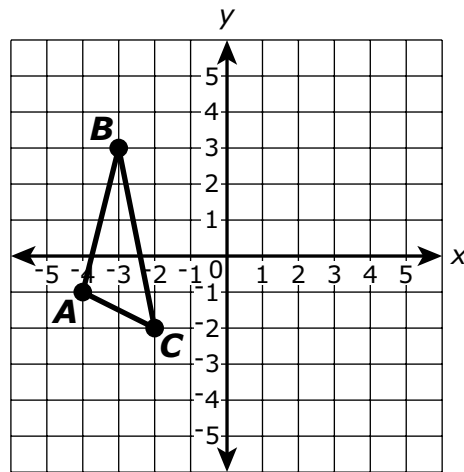
- (A)  $y = 5 - 2x$
- (B)  $y = 5 + 2(x - 1)$
- (C)  $y = 7 - 2x$
- (D)  $y = 7 - 2(x - 1)$
- 10 Which of the following is equivalent to this expression?

$$(3x^2 - 4x + 9) - (5x^2 + 3x - 4)$$

- (A)  $2x^2 - x + 5$
- (B)  $-2x^2 - x + 5$
- (C)  $2x^2 - 7x + 13$
- (D)  $-2x^2 - 7x + 13$

This question has two parts.

- 11 Triangle  $ABC$  is graphed on this coordinate plane.



**Part A**

Triangle  $ABC$  is translated, according to a rule, to create triangle  $DEF$ .

The coordinates of point  $E$  are  $(2, 1)$ .

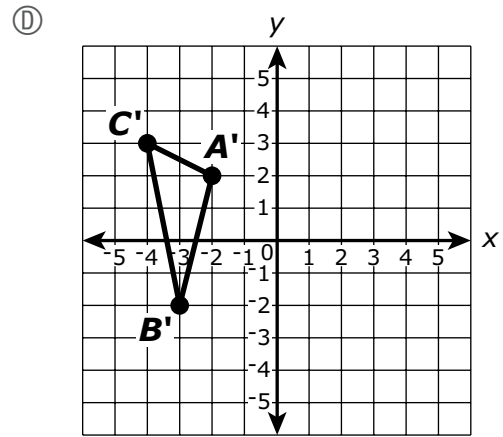
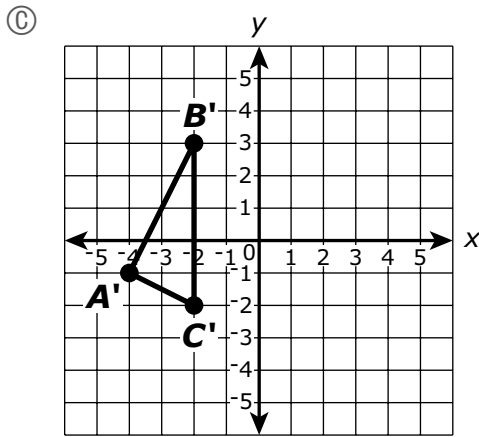
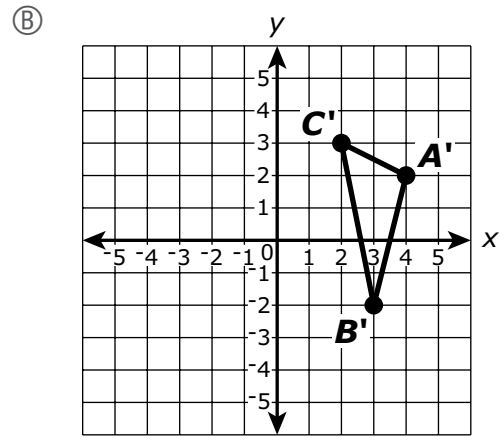
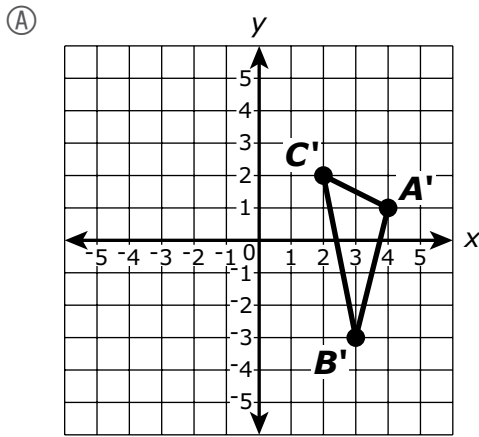
Which rule translates triangle  $ABC$  to create triangle  $DEF$ ?

- Ⓐ  $(x, y) \rightarrow (x - 3, y - 4)$
- Ⓑ  $(x, y) \rightarrow (x - 1, y + 5)$
- Ⓒ  $(x, y) \rightarrow (x + 2, y + 1)$
- Ⓓ  $(x, y) \rightarrow (x + 5, y - 2)$

**Part B**

Triangle  $ABC$  will be rotated  $180^\circ$  clockwise about the origin to create its image, triangle  $A'B'C'$ .

Which of the following graphs shows the image of triangle  $A'B'C'$  after the rotation?



**12** What are the solutions of this equation?

$$4x(x - 8) = 0$$

(A)  $x = -4; x = 8$

(B)  $x = 0; x = -8$

(C)  $x = 0; x = 8$

(D)  $x = 4; x = -8$

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

- 13** Three students, Alice, Clive, and Denise, are studying exponential and radical expressions and equations.

A. Alice writes this expression.

$$64^{\frac{1}{3}}$$

Which of the following is equivalent to the expression?

Mark your answer by filling in the appropriate circle on the next page.

**A**  $\sqrt{8}$

**B**  $\sqrt[3]{8}$

**C**  $\sqrt{64}$

**D**  $\sqrt[3]{64}$

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

C. Clive writes this expression.

$$\sqrt[5]{x^7}$$

Clive will rewrite the expression, using a rational exponent, in the form  $x^p$ . What is the value of  $p$  in Clive's rewritten expression? Show or explain how you got your answer.

D. Denise writes this equation.

$$(n^{\frac{1}{2}})^{\frac{2}{5}} = n^{\frac{1}{2}} \cdot n^{\frac{2}{5}}$$

Denise claims the equation is true for all positive values of  $n$ . Is Denise's claim correct? Explain your reasoning.



13 A. (A)  $\sqrt{8}$

(B)  $\sqrt[3]{8}$

(C)  $\sqrt{64}$

(D)  $\sqrt[3]{64}$

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This question has two parts.

- 14 In a statewide survey, ninth-grade and tenth-grade students were asked about the number of glasses of water they drink per day. This table shows the results of the survey. All numbers in the table are in thousands.

**Water Survey**

	<b>0–2 Glasses</b>	<b>3–4 Glasses</b>	<b>5 or More Glasses</b>	<b>Total</b>
<b>Ninth-Grade Students (thousands)</b>	10	13	22	45
<b>Tenth-Grade Students (thousands)</b>	9	11	17	37
<b>Total</b>	19	24	39	82

**Part A**

Based on the table, what is the probability that a randomly selected student from the survey drinks 0 to 2 glasses of water per day?

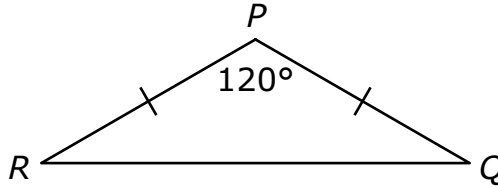
- (A)  $\frac{10}{19}$  (B)  $\frac{10}{82}$   
(C)  $\frac{19}{82}$  (D)  $\frac{82}{19}$

**Part B**

What is the probability that a tenth-grade student drinks 5 or more glasses of water per day?

- (A)  $\frac{17}{37}$  (B)  $\frac{17}{39}$   
(C)  $\frac{17}{74}$  (D)  $\frac{17}{82}$

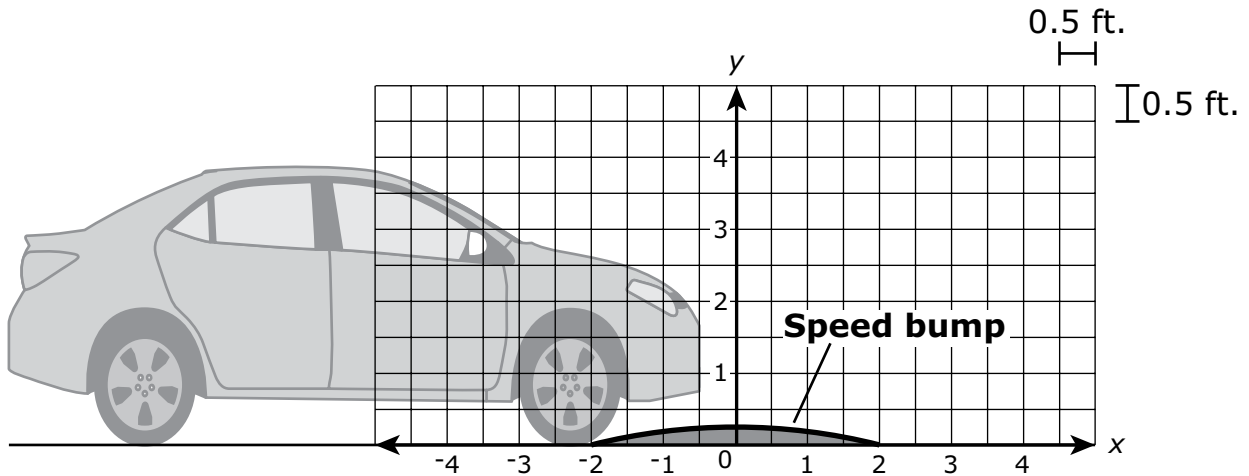
- 15 Consider isosceles triangle  $PQR$ .



Which of the following transformations, if performed on triangle  $PQR$ , would **not** create a congruent image?

- Ⓐ a  $270^\circ$  counterclockwise rotation about the midpoint of  $\overline{PQ}$
- Ⓑ a dilation by a scale factor of 2 with respect to point  $P$
- Ⓒ a  $180^\circ$  clockwise rotation about point  $R$
- Ⓓ a reflection over side  $\overline{QR}$

- 16 A cross-sectional view of a speed bump is represented on this coordinate plane.



The curve created by the speed bump on the graph is modeled by this quadratic function.

$$f(x) = -0.0625x^2 + 0.25$$

In the function,  $x$  and  $f(x)$  represent measurements, in feet, at different locations along the surface of the speed bump.

Which of the following shows the value of  $f(0)$  **and** describes what the value represents?

- Ⓐ The value of  $f(0)$  is 0.25, which represents the maximum width, in feet, of the speed bump.
- Ⓑ The value of  $f(0)$  is 0.25, which represents the maximum height, in feet, of the speed bump.
- Ⓒ The value of  $f(0)$  is 0.625, which represents the maximum width, in feet, of the speed bump.
- Ⓓ The value of  $f(0)$  is 0.625, which represents the maximum height, in feet, of the speed bump.

- 17 Duane earned \$607.50 for 37.5 hours of work. Which of the following is **closest** to the amount of money, in dollars, he earned per hour?
- Ⓐ \$12
  - Ⓑ \$16
  - Ⓒ \$20
  - Ⓓ \$24

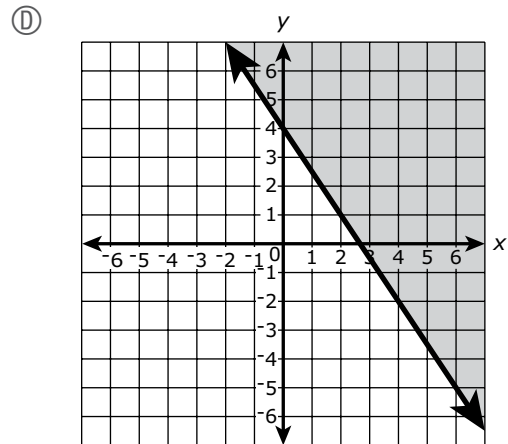
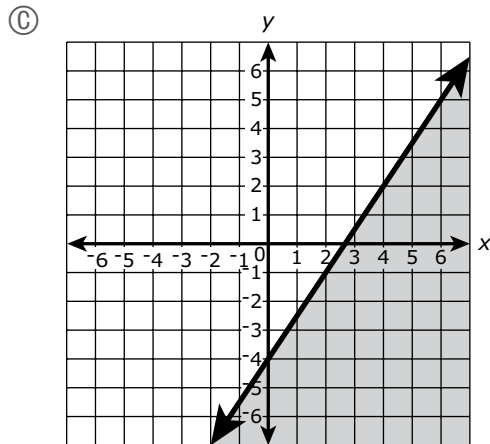
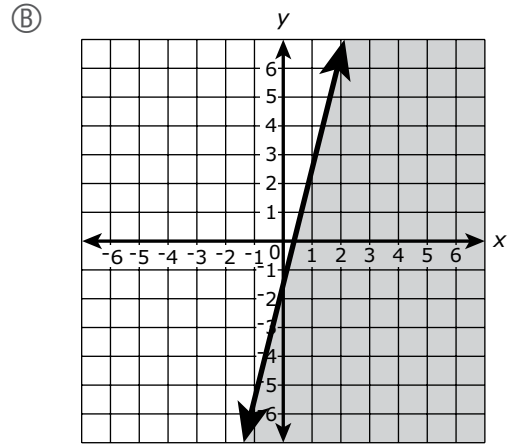
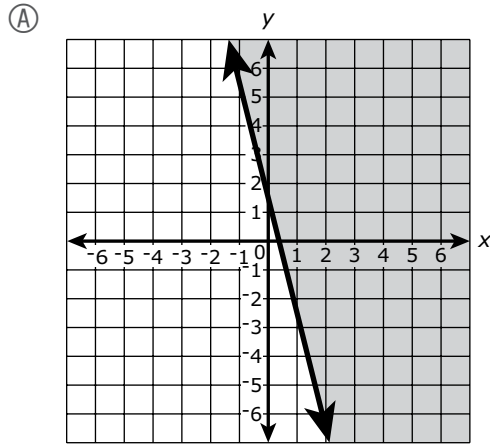
This question has two parts.

**18** Part A

Consider this inequality.

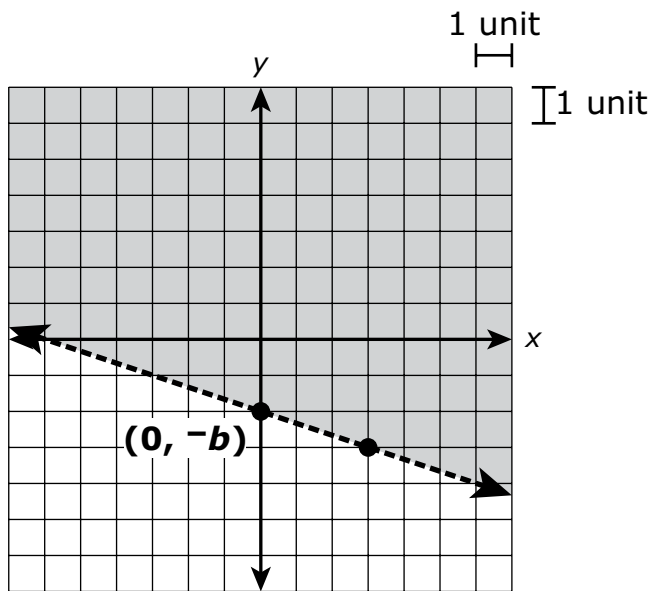
$$y \leq \frac{3}{2}x - 4$$

Which of the following graphs represents the solution set of the inequality?



**Part B**

Consider the inequality graphed on this coordinate plane.



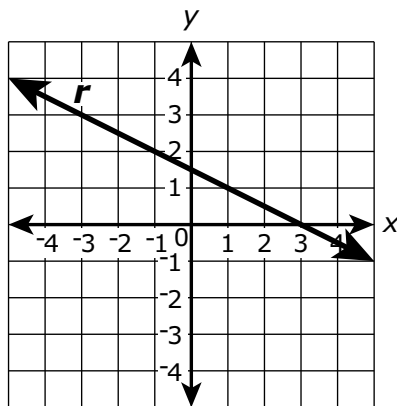
Which of the following inequalities is represented by the graph?

- Ⓐ  $3y > -x - 3b$
- Ⓑ  $3y > -x + 3b$
- Ⓒ  $y < -3x - b$
- Ⓓ  $y < -3x + b$

19 Which of the following equations is true?

- Ⓐ  $x^2 - y^2 = (x + y)(x + y)$
- Ⓑ  $x^2 - y^2 = (x - y)(x - y)$
- Ⓒ  $x^2 + 2xy + y^2 = (x + y)(x + y)$
- Ⓓ  $x^2 - 2xy + y^2 = (x + y)(x - y)$

20 Line  $r$  is graphed on this coordinate plane.



Which of the following equations best represents the line that passes through the point  $(2, -3)$  and is parallel to line  $r$ ?

- Ⓐ  $y = -\frac{1}{2}x - 2$
- Ⓑ  $y = -\frac{1}{2}x - 3$
- Ⓒ  $y = 2x - 4$
- Ⓓ  $y = 2x - 7$



- 21 A student incorrectly solved an equation. The equation and the steps the student used to solve it are shown in this table.

<b>Equation</b>	$-2(3x + 1) = 3x - 20$
<b>Step 1</b>	$-6x - 2 = 3x - 20$
<b>Step 2</b>	$-6x - 3x = -20 + 2$
<b>Step 3</b>	$-9x = -18$
<b>Step 4</b>	$x = -2$

In which step in the table does the student's error first appear?

- Ⓐ step 1
- Ⓑ step 2
- Ⓒ step 3
- Ⓓ step 4

# 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.

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-	1	4				
●						
○	○	○	○	○	○	○
0	0	0	0	0	0	0
1	●	1	1	1	1	1
2	2	2	2	2	2	2
3	3	3	3	3	3	3
4	4	●	4	4	4	4
5	5	5	5	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	9

	4	8	3	1	6	
○						
○	○	○	○	○	○	○
0	0	0	0	0	0	0
1	1	1	1	●	1	1
2	2	2	2	2	2	2
3	3	3	●	3	3	3
4	●	4	4	4	4	4
5	5	5	5	5	5	5
6	6	6	6	6	●	6
7	7	7	7	7	7	7
8	8	●	8	8	8	8
9	9	9	9	9	9	9

			6	5	.	3
○						
○	○	○	○	○	○	○
0	0	0	0	0	0	0
1	1	1	1	1	1	1
2	2	2	2	2	2	2
3	3	3	3	3	3	●
4	4	4	4	4	4	4
5	5	5	5	●	5	5
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

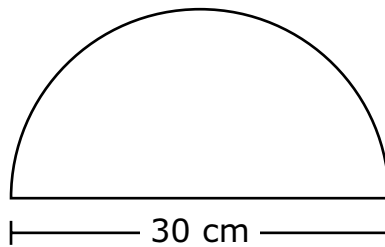
	9	.	5	5	5	5
○						
○	○	○	○	○	○	○
0	0	0	0	0	0	0
1	1	1	1	1	1	1
2	2	2	2	2	2	2
3	3	3	3	3	3	3
4	4	4	4	4	4	4
5	5	5	●	●	●	●
6	6	6	6	6	6	6
7	7	7	7	7	7	7
8	8	8	8	8	8	8
9	●	9	9	9	9	9

- 22** A polygon is translated 3 units left and 4 units up on a coordinate plane.

Which of the following represents the translation of the points of the polygon to their image points?

- Ⓐ  $(x, y) \rightarrow (x - 3, y + 4)$
- Ⓑ  $(x, y) \rightarrow (x - 4, y + 3)$
- Ⓒ  $(x, y) \rightarrow (x + 3, y - 4)$
- Ⓓ  $(x, y) \rightarrow (x + 4, y - 3)$

- 23** This diagram shows a semicircle and its diameter.



Which of the following is closest to the area of the semicircle?

- Ⓐ 353 square centimeters
- Ⓑ 707 square centimeters
- Ⓒ 1,414 square centimeters
- Ⓓ 2,827 square centimeters

- 24 The current population of an endangered bird species is 1,800 birds. The population is **decreasing** at a rate of 5% per year.

Which of the following functions can be used to model  $B(t)$ , the population of these endangered birds  $t$  years from now?

- (A)  $B(t) = 0.95(1,800)^t$
- (B)  $B(t) = 1.50(1,800)^t$
- (C)  $B(t) = 1,800(1.05)^t$
- (D)  $B(t) = 1,800(0.95)^t$
- 25 Consider this expression.

$$\sqrt[5]{y}$$

Which of the following is equivalent to the expression?

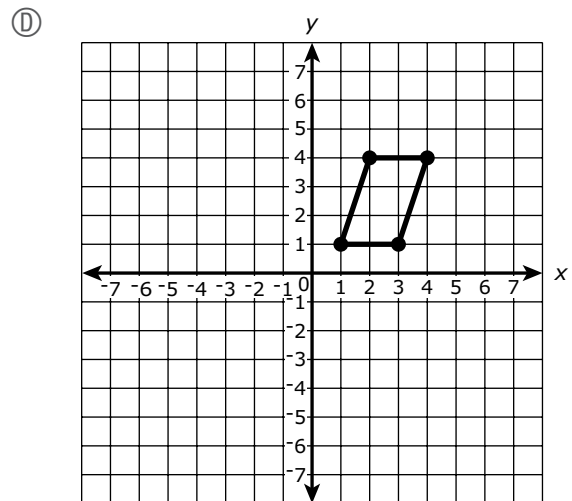
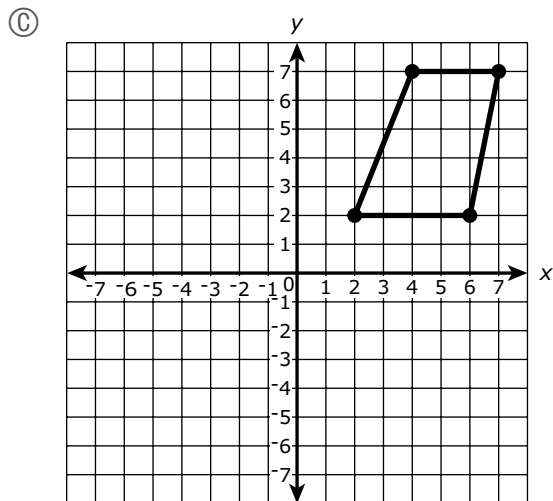
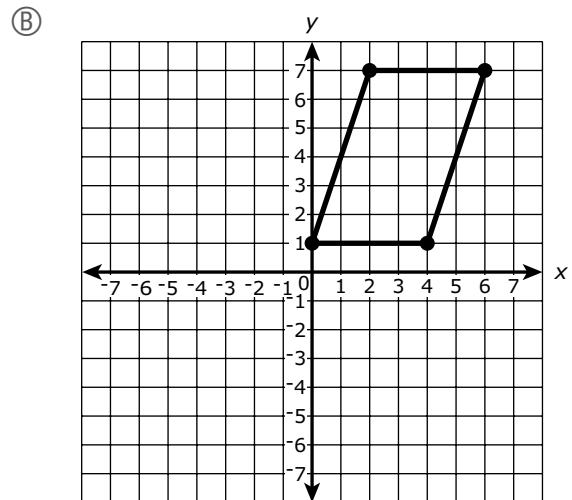
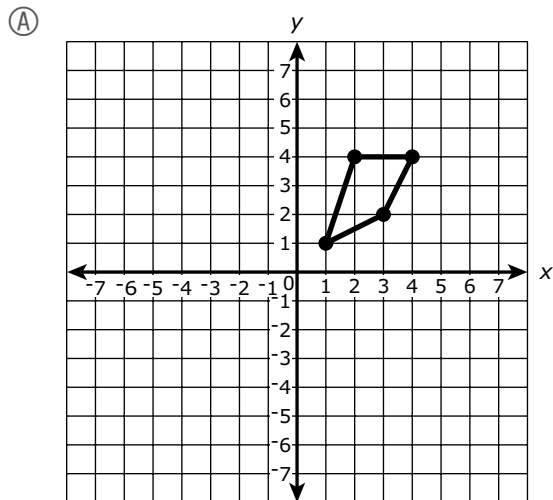
- (A)  $y^{\frac{1}{5}}$
- (B)  $5^{\frac{1}{y}}$
- (C)  $y^5$
- (D)  $5^y$

- 26 Quadrilateral  $JKLM$  was graphed on a coordinate plane.

The coordinates of the vertices of the quadrilateral are shown.

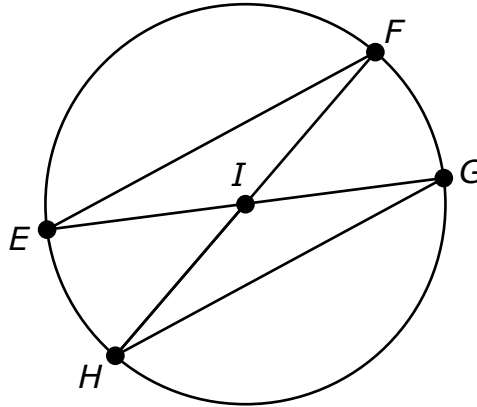
- $J(2, 2)$
- $K(6, 2)$
- $L(8, 8)$
- $M(4, 8)$

Quadrilateral  $JKLM$  will be dilated by a scale factor of  $\frac{1}{2}$  with respect to the origin. Which graph shows the **image** of quadrilateral  $JKLM$  after the dilation?



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

27 In circle  $I$ ,  $\overline{EG}$  and  $\overline{FH}$  are diameters, and  $\overline{EF}$  and  $\overline{GH}$  are parallel, as shown.



The measure of angle  $EIH$  is  $42^\circ$ .

- A. What is the measure, in degrees, of  $\widehat{FG}$ ? Show or explain how you got your answer.
- B. What is the measure, in degrees, of  $\widehat{EF}$ ? Show or explain how you got your answer.
- C. What is the measure, in degrees, of  $\widehat{FGE}$ ? Show or explain how you got your answer.
- D. What is the measure, in degrees, of **angle**  $FHG$ ? Show or explain how you got your answer.

**27** \_\_\_\_\_

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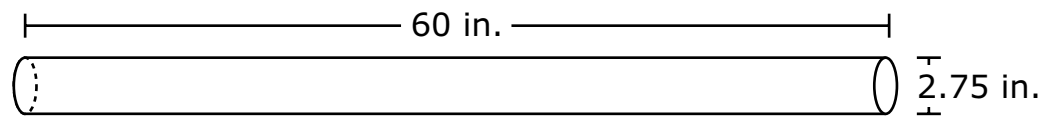


- 28 An executive at a company expects sales of a new product to increase by 20% per year. Sales of the product were \$110,000 at the end of the first year.

What are the expected sales of the product at the end of the third year?

- (A) \$154,000
- (B) \$158,400
- (C) \$176,000
- (D) \$180,400

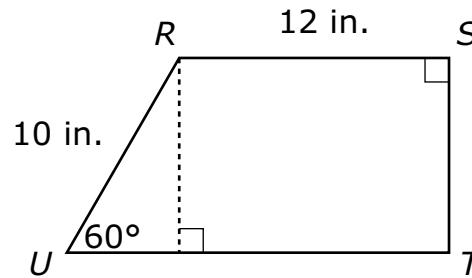
- 29 A right circular cylinder and its dimensions are shown in this diagram.



Which of the following is closest to the volume of the right circular cylinder?

- (A) 113 cubic inches
- (B) 356 cubic inches
- (C) 454 cubic inches
- (D) 1,426 cubic inches

- 30 Trapezoid  $RSTU$  and some of its measurements are shown in this diagram.



Based on the diagram, what is the length of line segment  $TU$ ?

- (A) 17 in.
  - (B) 18 in.
  - (C) 22 in.
  - (D) 29 in.
- 31 A student makes a deposit of \$1,100 into a savings account and makes no additional deposits or withdrawals. This function represents the balance, in dollars, in the account after  $t$  years.

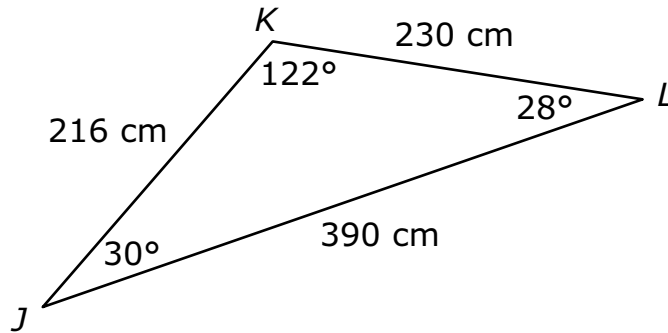
$$f(t) = 1,100(1.012)^t$$

Based on the function, which statement about the savings account is **not** true?

- (A) The account is increasing in value.
- (B) The balance is increasing exponentially.
- (C) The account has an interest rate of 12%.
- (D) The account had an initial balance of \$1,100.

This question has two parts.

- 32 This diagram shows triangle  $JKL$ , its side lengths, and its angle measures.



**Part A**

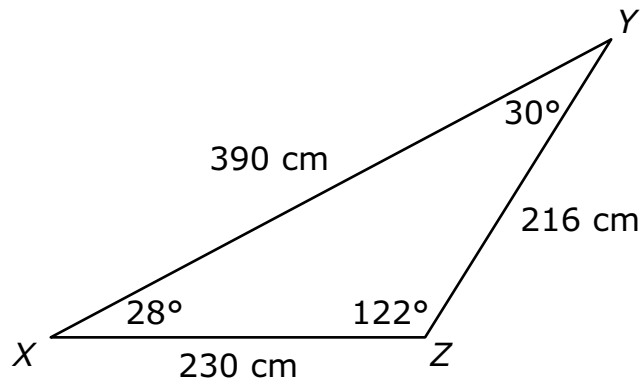
Triangle  $PQR$  (not shown) is congruent to triangle  $JKL$ . What is the measure, in degrees, of angle  $R$ ?

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

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•	•	•	•	•	•	•	•
0	0	0	0	0	0	0	0
1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3
4	4	4	4	4	4	4	4
5	5	5	5	5	5	5	5
6	6	6	6	6	6	6	6
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9	9	9	9	9	9	9	9

**Part B**

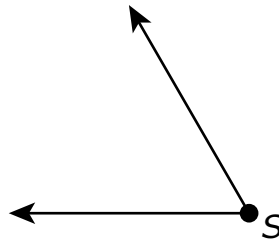
This diagram shows triangle  $XYZ$ , its side lengths, and its angle measures.



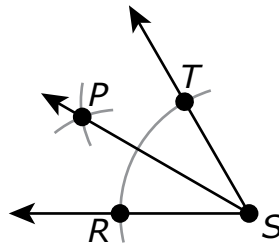
Based on both diagrams, which of the following is true?

- Ⓐ  $\triangle JKL \cong \triangle XYZ$
- Ⓑ  $\triangle JKL \cong \triangle XZY$
- Ⓒ  $\triangle JKL \cong \triangle YXZ$
- Ⓓ  $\triangle JKL \cong \triangle YZX$

- 33 Consider  $\angle S$ .



A compass and a straightedge were used to perform a construction given  $\angle S$ . This diagram shows the completed construction.



These steps were followed to complete the construction.

- The compass was used to draw an arc from point  $S$  through the sides of the angle to create point  $R$  and point  $T$ .
- Arcs were drawn, each with the same compass setting, one from point  $R$  and one from point  $T$ . The intersection of the arcs was labeled point  $P$ .
- The straightedge was used to draw a ray from point  $S$  through point  $P$ .

Which of the following statements describes what is illustrated by the steps used to complete the construction?

- (A) The steps illustrate how to copy angle  $S$  so that angle  $TSP$  is congruent to angle  $RST$ .
- (B) The steps illustrate how to copy angle  $S$  so that angle  $RSP$  is congruent to angle  $TSP$ .
- (C) The steps illustrate how to bisect angle  $S$  so that angle  $TSP$  is congruent to angle  $RST$ .
- (D) The steps illustrate how to bisect angle  $S$  so that angle  $RSP$  is congruent to angle  $TSP$ .

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

- 34** A. Greta exercises for a total of 2 hours each day. She runs for  $r$  hours and then walks for  $w$  hours.

Create an equation in terms of  $r$  and  $w$  that can be used to represent the amount of time, in hours, Greta exercises each day.

- B. Greta runs at a rate of 6.5 miles per hour and walks at a rate of 4 miles per hour. She covers a total distance of 9 miles while exercising.

Create an equation in terms of  $r$  and  $w$  that can be used to represent the total distance, in miles, Greta covers while exercising.

- C. Determine the number of hours Greta **runs** while exercising. Show or explain how you got your answer.

- D. Evan runs at a rate of 8 miles per hour and walks at a rate of 3 miles per hour. His goal is to cover 9 miles in no more than 1.5 hours.

What is the greatest number of hours that Evan can walk and still achieve his goal? Show or explain how you got your answer.

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This question has two parts.

- 35 Jordan is driving a car. The car’s navigation system provides directions for how to reach Jordan’s destination.

**Part A**

The navigation system indicates that Jordan should turn left onto Main Street in 1,000 feet.

Which of the following is **closest** to the distance, in miles, Jordan should drive before turning left onto Main Street?

- (A)  $\frac{1}{5}$  mile
- (B)  $\frac{1}{4}$  mile
- (C)  $\frac{2}{5}$  mile
- (D)  $\frac{3}{5}$  mile

**Part B**

Once Jordan turns onto Main Street, the navigation system indicates that it will take 13 minutes to drive the remaining 5.2 miles to the destination.

Based on this information, what is the average rate, in **miles per hour**, of the remaining 5.2 miles to Jordan’s destination?

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

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0	0	0	0	0	0	0	0
1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3
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



- 36 A research company conducted a survey that asked people at a local mall what their age was and whether they generally sleep later on Saturdays or on Sundays. The results of the survey are shown in this table.

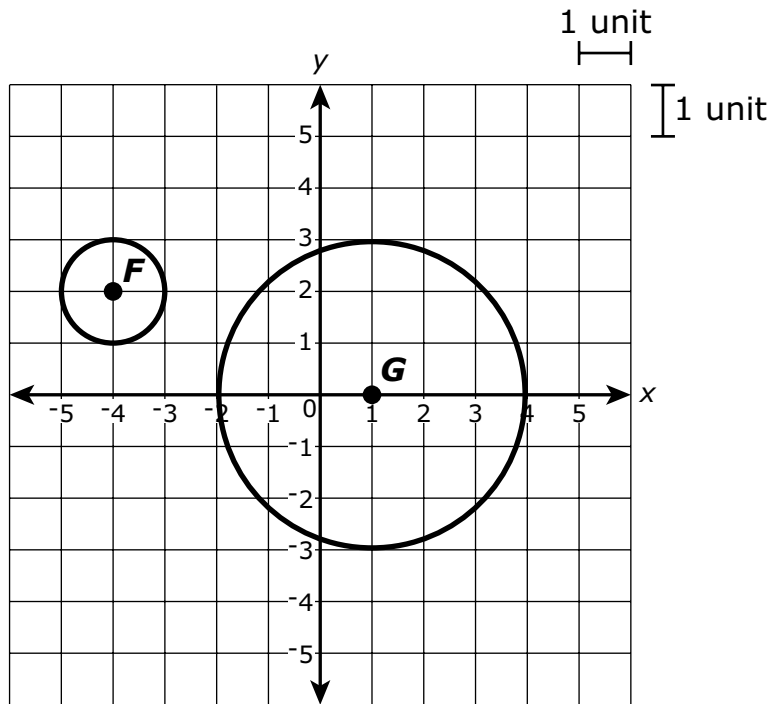
**Sleep Survey**

	Saturdays	Sundays	Total
Ages 20–34	58	62	120
Ages 35–50	27	93	120
Total	85	155	240

Based on the table, what fraction of the people surveyed who are ages 35–50 sleep later on Sundays?

- (A)  $\frac{62}{93}$
- (B)  $\frac{62}{120}$
- (C)  $\frac{93}{120}$
- (D)  $\frac{93}{155}$

- 37 Circle  $F$  and circle  $G$  are shown on this coordinate plane.



The radius of circle  $F$  is 1 unit and the radius of circle  $G$  is 3 units.

Which transformations can be performed to prove that the circles are similar?

- Ⓐ Translate circle  $F$  such that its center is the point  $(2, 1)$ , and then dilate it by a scale factor of 3 with respect to its center.
- Ⓑ Translate circle  $F$  such that its center is the point  $(1, 2)$ , and then dilate it by a scale factor of 1 with respect to its center.
- Ⓒ Translate circle  $F$  such that its center is the point  $(1, 0)$ , and then dilate it by a scale factor of 3 with respect to its center.
- Ⓓ Translate circle  $F$  such that its center is the point  $(0, 1)$ , and then dilate it by a scale factor of 1 with respect to its center.

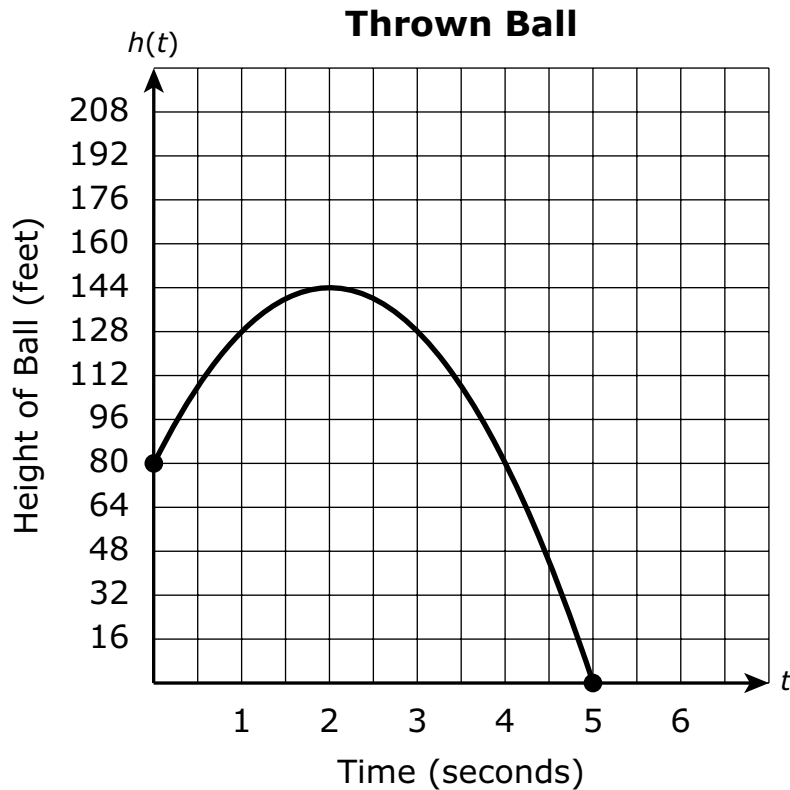
- 38 Terry has a bag that contains 7 red marbles and 8 blue marbles. All of the marbles have the same size and shape. Terry randomly selects a marble from the bag, does **not** return it to the bag, and then randomly selects another marble.

Which of the following expressions represents the probability that the first marble selected is red and the second marble selected is blue?

- Ⓐ  $\frac{7}{8} \cdot \frac{6}{7}$
- Ⓑ  $\frac{7}{15} \cdot \frac{6}{14}$
- Ⓒ  $\frac{7}{15} \cdot \frac{7}{14}$
- Ⓓ  $\frac{7}{15} \cdot \frac{8}{14}$

This question has two parts.

- 39 A ball was thrown from the top of a building as part of an experiment. This graph shows  $h(t)$ , the height, in feet, of the ball  $t$  seconds after it was thrown.



**Part A**

What are the coordinates of the point on the graph at which the ball reached its maximum height?

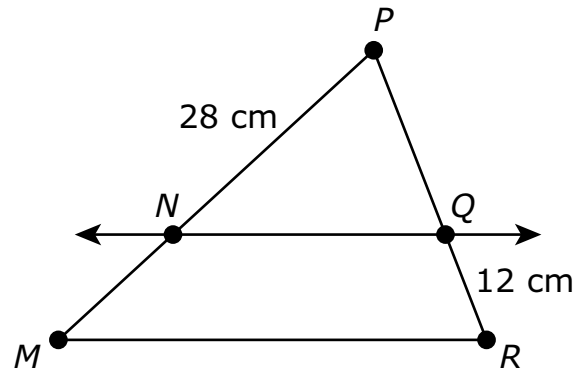
- Ⓐ  $(0, 80)$
- Ⓑ  $(2, 144)$
- Ⓒ  $(4, 80)$
- Ⓓ  $(6, 208)$

**Part B**

Based on the graph, which of the following statements is true?

- Ⓐ The ball was in the air for a total of 6 seconds.
- Ⓑ The ball was thrown from an initial height of 80 feet.
- Ⓒ The height of the ball was increasing for a greater interval of time than it was decreasing.
- Ⓓ The height of the ball was always increasing after it was thrown from the top of the building.

- 40 A line intersects triangle  $MPR$  at point  $N$  and at point  $Q$ . The line, the triangle, and some measurements are shown in this diagram.



In the diagram,

- the length of  $\overline{MP}$  is 44 centimeters, and
- $\overline{NQ}$  is parallel to  $\overline{MR}$ .

What is the length, in centimeters, of  $\overline{PQ}$ ?

- |           |           |
|-----------|-----------|
| (A) 12 cm | (B) 16 cm |
| (C) 21 cm | (D) 33 cm |

- 41 A city planner recorded the number of residents of each apartment building in a city and each building's distance from the city center. This equation models the data.

$$P = 510 - 17d$$

In the model,

- $P$  represents the number of residents of an apartment building, and
- $d$  represents the building's distance, in miles, from the city center.

Based on the model, which of the following statements is true?

- Ⓐ The number of residents of an apartment building decreases by 30 for every 1-mile increase in the building's distance from the city center.
- Ⓑ The number of residents of an apartment building decreases by 17 for every 1-mile increase in the building's distance from the city center.
- Ⓒ The number of residents of an apartment building increases by 30 for every 1-mile increase in the building's distance from the city center.
- Ⓓ The number of residents of an apartment building increases by 17 for every 1-mile increase in the building's distance from the city center.

- 42 Points  $E$  and  $G$  lie on circle  $F$  (not shown).

- The radius of circle  $F$  is 15 centimeters.
- The length of arc  $EG$  is  $12\pi$  centimeters.

Which of the following is the measure, in degrees, of angle  $EFG$ ?

- Ⓐ  $72^\circ$
- Ⓑ  $144^\circ$
- Ⓒ  $180^\circ$
- Ⓓ  $225^\circ$

**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 . . . . .  $A = lw$   
 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 . . . .  $SA = s^2 + 2s\ell$   
 ( $\ell$  = slant height)  
 right rectangular prism . .  $SA = 2(lw) + 2(hw) + 2(lh)$

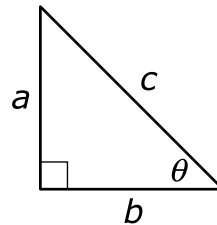
**VOLUME (V) FORMULAS**

- 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**

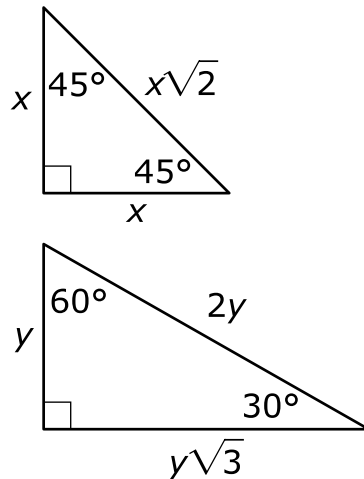
- pi . . . . .  $\pi \approx 3.14$   
 circumference . . . .  $C = 2\pi r$  OR  $C = \pi d$   
 area . . . . .  $A = \pi r^2$

**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 2024 Released Operational Items**

PBT Item No.	Page No.	Reporting Category	Standard	Item Type*	Item Description	Correct Answer**
1	4	<i>Algebra and Functions</i>	F-IF.A.3	SR	Given a function that represents an arithmetic sequence, identify the first four numbers in the sequence.	B
2	4	<i>Number and Quantity</i>	N-RN.B.3	SR	Given variables that represent a rational and an irrational number, identify a variable expression that is rational.	A
3	5	<i>Algebra and Functions</i>	A-SSE.B.3	SR	Identify the equation of a line that meets given slope and intercept criteria.	C
4	5	<i>Geometry</i>	G-CO.C.9	SR	Determine an unknown angle measure in a diagram with parallel lines crossed by a transversal.	B
5	6	<i>Algebra and Functions</i>	A-REI.C.5	SR	Identify a system of linear equations that has the same solution as a given system of linear equations.	A
6	7	<i>Statistics and Probability</i>	S-ID.A.2	CR	Calculate the range and the median of a set of real-world data and determine the values of additional data based on changes in measures of center.	
7	9	<i>Algebra and Functions</i>	F-IF.C.9	SR	Compare properties of two linear functions, one represented by an equation and the other represented by a graph.	A,D,E
8	10	<i>Geometry</i>	G-GPE.A.1	SR	Determine the coordinates of the center of a circle given its equation.	C
9	11	<i>Algebra and Functions</i>	F-LE.A.2	SR	Identify the equation of a linear function based on values in a table.	C
10	11	<i>Algebra and Functions</i>	A-APR.A.1	SR	Identify an equivalent expression by finding the difference of two trinomials.	D
11	12	<i>Geometry</i>	G-CO.A.5	SR	Identify a transformation rule used to map one triangle onto another, and identify the graph of the triangle over a rotation.	D;A
12	13	<i>Algebra and Functions</i>	A-REI.B.4	SR	Identify the solutions of a factored quadratic equation in one variable.	C
13	14	<i>Number and Quantity</i>	N-RN.A.2	CR	Equate various radical expressions to exponential expressions and evaluate a claim based on the properties of exponents.	
14	16	<i>Statistics and Probability</i>	S-CP.A.4	SR	Calculate a marginal probability and a conditional probability based on survey data displayed in a table.	C;A
15	17	<i>Geometry</i>	G-CO.B.6	SR	Identify a transformation which, if performed on a triangle, would not produce a congruent image.	B
16	18	<i>Algebra and Functions</i>	F-IF.A.2	SR	Analyze a quadratic function that models a relationship based on a real-world situation.	B
17	19	<i>Number and Quantity</i>	N-Q.A.2	SR	Use estimation to determine a unit rate in a real-world situation involving quantities with different units.	B
18	20	<i>Algebra and Functions</i>	A-REI.D.12	SR	Identify the graph of the solution set of a linear inequality, and identify a different inequality based on the graph of its solution set.	C;A
19	22	<i>Algebra and Functions</i>	A-SSE.A.2	SR	Multiply two binomials to determine an equivalent polynomial.	C
20	22	<i>Geometry</i>	G-GPE.B.5	SR	Identify an equation of a line parallel to a line graphed on a coordinate plane, which passes through a given point.	A
21	23	<i>Algebra and Functions</i>	A-REI.A.1	SR	Identify which step in the solution of an equation contains an error.	D

PBT Item No.	Page No.	Reporting Category	Standard	Item Type*	Item Description	Correct Answer**
22	26	Geometry	G-CO.A.2	SR	Identify a transformation rule that represents the translation of a polygon on a coordinate plane.	A
23	26	Geometry	G-GMD.A.1	SR	Determine the area of a semicircle given the length of its diameter.	A
24	27	Algebra and Functions	F-BF.A.1	SR	Identify an exponential function that models a relationship based on a real-world situation.	D
25	27	Number and Quantity	N-RN.A.1	SR	Identify an exponential expression equivalent to a given radical expression.	B
26	28	Geometry	G-SRT.A.1	SR	Identify the graph of the image of a quadrilateral, over a dilation, on a coordinate plane.	D
27	29	Geometry	G-C.A.2	CR	Determine minor arc measures, a major arc measure, and an angle measure given a figure inscribed in a circle.	
28	31	Algebra and Functions	A-CED.A.1	SR	Create and solve a one-variable exponential equation based on a real-world context.	B
29	31	Geometry	G-GMD.A.3	SR	Calculate the volume of a right circular cylinder given its dimensions.	B
30	32	Geometry	G-SRT.C.8	SR	Use a trigonometric relationship to calculate an unknown measurement in a trapezoid.	A
31	32	Algebra and Functions	F-LE.B.5	SR	Interpret an exponential function based on the context it represents.	C
32	33	Geometry	G-CO.B.7	SA	Relate the side lengths and angle measures in pairs of congruent triangles.	28;D
33	35	Geometry	G-CO.D.12	SR	Analyze the construction of an angle bisector.	D
34	36	Algebra and Functions	A-CED.A.3	CR	Create and solve a system of linear equations in two variables using given constraints, and create and analyze a related inequality.	
35	38	Number and Quantity	N-Q.A.1	SA	Use dimensional analysis to solve real-world problems involving distance and time.	A;24
36	39	Statistics and Probability	S-ID.B.5	SR	Calculate a relative frequency based on real-world data displayed in a two-way table.	C
37	40	Geometry	G-C.A.1	SR	Identify a sequence of transformations that can be used to prove two circles are similar.	C
38	41	Statistics and Probability	S-CP.B.6	SR	Identify an expression that can be used to calculate the probability of two dependent events occurring.	D
39	42	Algebra and Functions	F-IF.B.4	SR	Given the graph of a quadratic function, interpret the value of the vertex and analyze other aspects of the function, based on the context it represents.	B;B
40	44	Geometry	G-SRT.B.4	SR	Use a proportion to calculate an unknown length in a diagram of a triangle and a line parallel to one of its sides.	C
41	45	Statistics and Probability	S-ID.C.7	SR	Interpret the rate of change in a linear equation that models data in a real-world situation.	B
42	45	Geometry	G-C.B.5	SR	Calculate the measure of the central angle of a circle given the radius of the circle and the length of the arc intercepted by the angle.	B

\* 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.