XV. Mathematics, Grade 10

Grade 10 Mathematics Test

The spring 2018 grade 10 Mathematics test was based on standards in the 2011 *Massachusetts Curriculum Framework for Mathematics* that match content in the grade 9–10 standards from the 2000 *Massachusetts Mathematics Curriculum Framework*. The standards in the 2011 *Framework* on the grade 10 test are organized under the five major conceptual categories listed below.

- Number and Quantity

- Algebra

- Functions

- Geometry

- Statistics and Probability

The *Massachusetts Curriculum Framework for Mathematics* is available on the Department website at www.doe.mass.edu/frameworks/archive.html. More information and a list of standards assessable on the spring 2018 test are available at www.doe.mass.edu/mcas/transition/?section=math10.

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 chapter indicates each item's reporting category, the 2011 *Framework* standard it assesses, and the 2000 *Framework* standard it assesses. The correct answers for multiple-choice and short-answer items are also displayed in the table.

Test Sessions

The grade 10 Mathematics test included two separate test sessions, which were administered on consecutive days. Each session included multiple-choice and open-response items. Session 1 also included short-answer items.

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 with at least four functions and a square root key. 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

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

DIRECTIONS

This session contains fourteen multiple-choice questions, four short-answer questions, and three open-response questions. Mark your answers to these questions in the spaces provided in your Student Answer Booklet.
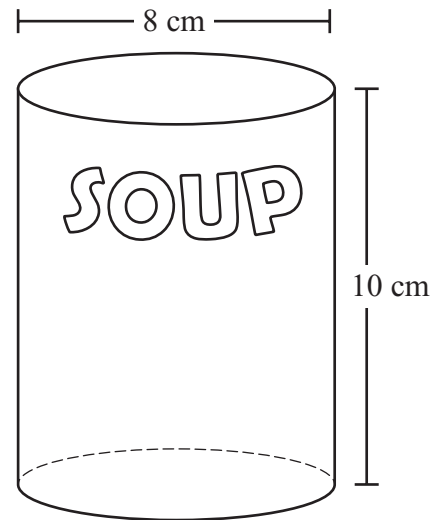
1 Which of the following equations is true?

A. $7 \cdot (2 + 3) = 3 + (7 \cdot 2)$

B. $7 \cdot (2 + 3) = 7 + (2 \cdot 3)$

C. $7 \cdot (2 + 3) = 3 \cdot (2 + 7)$

D. $7 \cdot (2 + 3) = 7 \cdot (3 + 2)$

2 Which of the following is closest to the value of the expression below?

$$\sqrt[3]{120}$$

A. 4

B. 5

C. 9

D. 11

3 A container of soup is in the shape of a right circular cylinder. The container and its dimensions are shown below.

What is the volume, in cubic centimeters, of the container?

A. 200π

B. 160π

C. 80π

D. 40π

4 Which of the following is equivalent to the expression below?

$$(p - 4)(p + 2)$$

A. $p^2 - 2p - 8$

B. $p^2 - 4p - 2$

C. $p^2 - 8$

D. $p^2 - 2$

5 Which of the following values of x is a solution of the equation below?

$$x^2 = 256$$

A. -4

B. -16

C. 128

D. 512

6 A waiter received a 15% tip for a restaurant bill of $59.14. Which of the following estimates is closest to the tip the waiter received?

A. $5.00

B. $7.50

C. $9.00

D. $12.00

7 The weights, in pounds, of 7 packages are listed below.

25, 10, 20, 4, 6, 3, 9

The weight of an 8th package is added to the list. The mean weight of the 8 packages is 12 pounds.

What is the weight, in pounds, of the 8th package?

A. 19

B. 16

C. 11

D. 10

8 Point S is the midpoint of $\overline{RT}$. The coordinates of point R and point T are listed below.

• $R(-11, -12)$

• $T(-7, -4)$

What are the coordinates of point S?

A. $(-2, -4)$

B. $(-8, -10)$

C. $(-9, -8)$

D. $(-18, -16)$

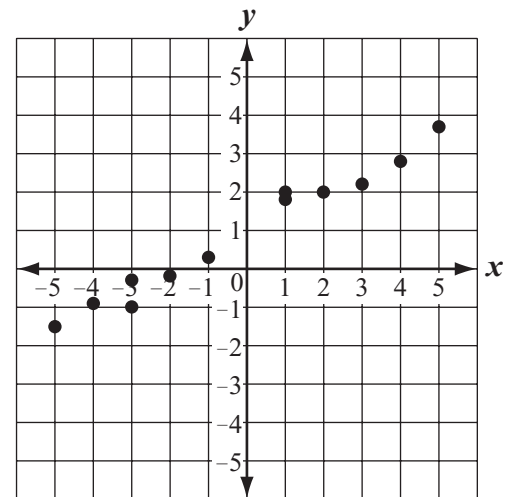**9** Which of the following is equivalent to the expression below?

$$x^2 - 144$$

A. $(x - 1)(x - 144)$

B. $(x - 1)(x + 144)$

C. $(x - 12)(x - 12)$

D. $(x - 12)(x + 12)$

10 A rug in the shape of a square has an area of 33 square feet. Which of the following estimates is closest to the length of each side of the rug?

A. $5\frac{1}{4}$ feet

B. $5\frac{3}{4}$ feet

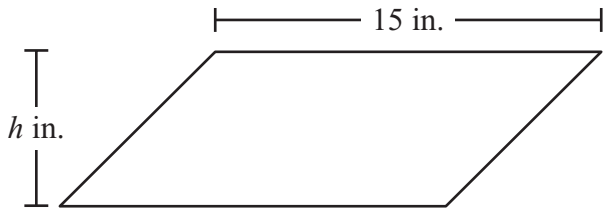C. $6\frac{3}{4}$ feet

D. $8\frac{1}{4}$ feet

11 A set of data is shown in the scatterplot below.

Which of the following equations best represents the line of best fit for the data in the scatterplot?

A. $y = -\frac{1}{2}x - 2$

B. $y = -\frac{1}{2}x + 1$

C. $y = \frac{1}{2}x - 2$

D. $y = \frac{1}{2}x + 1$

12 A parallelogram and some of its dimensions are shown below.

The area of the parallelogram is 90 square inches. What is h, the height in inches of the parallelogram?

A. 6

B. 8

C. 10

D. 12

13 Which of the following expressions is equivalent to 17?

A. $3 \cdot \sqrt[3]{17}$

B. $\frac{1}{3} \cdot \sqrt[3]{17}$

C. $\sqrt[3]{17^3}$

D. $\sqrt[3]{\frac{17}{3}}$

14 Two groups are going on a trip to a theater. The first group has 30 students and 4 adult chaperones. The second group has 25 students and 4 adult chaperones.

The cost, in dollars, for each student ticket, s, and each adult ticket, a, can be determined using the system of equations below.

$$30s + 4a = 720$$
$$25s + 4a = 620$$

What is the cost for each **student** ticket?

A. $5

B. $20

C. $25

D. $30

Questions 15 and 16 are short-answer questions. Write your answers to these questions in the boxes provided in your Student Answer Booklet. Do not write your answers in this test booklet. You may do your figuring in the test booklet.

15 What is the value of the expression below?

$$-2(3^2 - 10)$$

16 The line plot below shows the number of red items of clothing owned by each student in a class.

Number of Red Items of Clothing
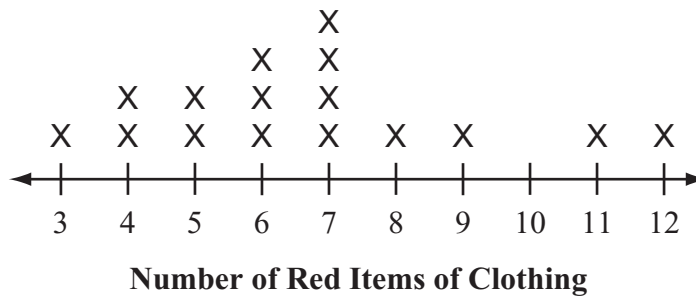
What is the median number of red items of clothing owned by the students in the class?

Question 17 is an open-response question.

- **BE SURE TO ANSWER AND LABEL ALL PARTS OF THE QUESTION.**
- **Show all your work (diagrams, tables, or computations) in your Student Answer Booklet.**
- **If you do the work in your head, explain in writing how you did the work.**

Write your answer to question 17 in the space provided in your Student Answer Booklet.

17   Stacey will paint the four walls of a room. Two walls each have a length of 20 feet, and the other two walls each have a length of 16 feet.

The expression below represents the total perimeter, in feet, of the room.

$$2(20 + 16)$$

a. What is the total perimeter, in feet, of the room? Show or explain how you got your answer.

The room has 2 windows and 3 doors. Each window is 4 feet high and 3 feet wide, and each door is 7 feet high and 3 feet wide.

The expression below represents the total area, in square feet, of the windows and doors in the room.

$$2(4 \cdot 3) + 3(7 \cdot 3)$$

b. What is the total area, in square feet, of the windows and doors in the room? Show or explain how you got your answer.

The height of each of the walls in the room is 8 feet. Stacey will not paint the windows or doors.

The expression below represents the total area, in square feet, that Stacey will paint.

$$2(20 \cdot 8 + 16 \cdot 8) - [2(4 \cdot 3) + 3(7 \cdot 3)]$$

c. What is the total area, in square feet, that Stacey will paint? Show or explain how you got your answer.

Each gallon of paint covers a total area of 300 square feet. Stacey will cover the walls with 2 layers of paint.

The expression below represents the total number of gallons of paint Stacey will need to paint the room with 2 layers of paint.

$$\frac{2\{2(20 \cdot 8 + 16 \cdot 8) - [2(4 \cdot 3) + 3(7 \cdot 3)]\}}{300}$$

Each gallon of paint costs $26. Stacey must purchase full gallons of paint.

d. What is the total cost, in dollars, of the gallons of paint Stacey will need to purchase to paint the room? Show or explain how you got your answer.

Questions 18 and 19 are short-answer questions. Write your answers to these questions in the boxes provided in your Student Answer Booklet. Do not write your answers in this test booklet. You may do your figuring in the test booklet.

18 Rectangle *ABCD* is similar to rectangle *EFGH*. The rectangles and some of their dimensions are shown in the diagram below.

A _____ B   E _____ F

5 inches   *x* inches

D _____ C   H _____ G
10 inches   12 inches
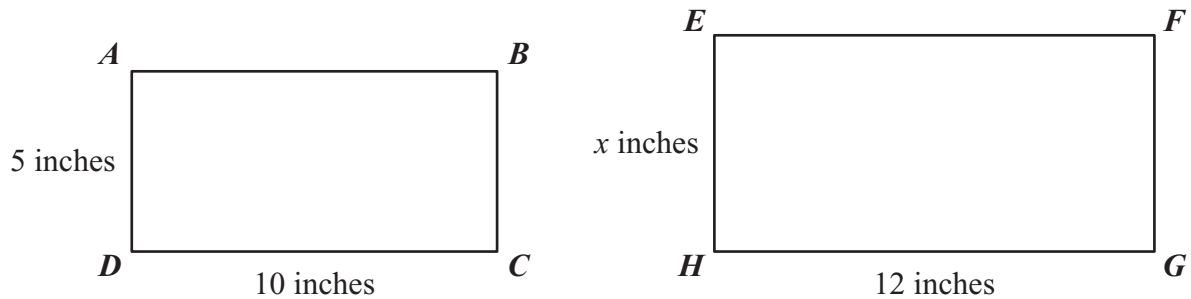
Based on the dimensions in the diagram, what is the value of *x*?

19 The equation below has two solutions.

$$|n + 4| = 1$$

One solution of the equation is -3. What is the other solution of the equation?

Questions 20 and 21 are open-response questions.

- **BE SURE TO ANSWER AND LABEL ALL PARTS OF EACH QUESTION.**
- **Show all your work (diagrams, tables, or computations) in your Student Answer Booklet.**
- **If you do the work in your head, explain in writing how you did the work.**

Write your answer to question 20 in the space provided in your Student Answer Booklet.

20 Lionel wrote an arithmetic sequence. The first five terms of the sequence are shown below.

$$3, \ 10, \ 17, \ 24, \ 31, \ldots$$

a. What is the next term of Lionel's sequence? Show or explain how you got your answer.

b. Write an expression that can be used to find the nth term of Lionel's sequence.

Bella also wrote an arithmetic sequence. Each term of Bella's sequence is equal to three times the corresponding term of Lionel's sequence.

c. Write an expression that can be used to find the mth term of Bella's sequence.

d. What is the 20th term of Bella's sequence? Show or explain how you got your answer.

Write your answer to question 21 in the space provided in your Student Answer Booklet.

21 A company packages fruit baskets of different weights and ships them to customers. The company charges a flat fee for packaging the baskets. The total packaging and shipping cost in dollars, y, of a fruit basket weighing x pounds is represented by the line on the graph below.

Packaging and Shipping Costs for Fruit Baskets
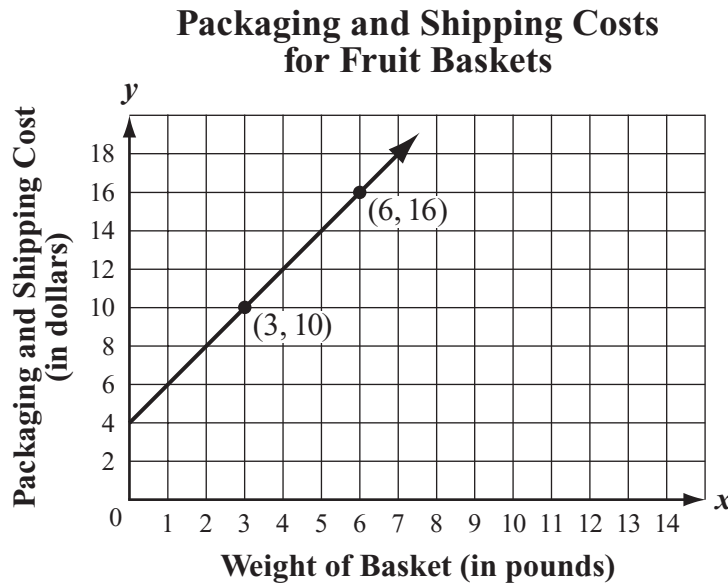
a. What is the y-intercept of the line on the graph?

b. What does the y-intercept of the line represent in this situation?

c. What is the slope of the line on the graph? Show or explain how you got your answer.

d. What does the slope of the line represent in this situation?

e. Write an equation that represents the line on the graph.

f. Use the equation you wrote in part (e) to determine the weight, in pounds, of the heaviest fruit basket that could be packaged and shipped for $50. Show or explain how you got your answer.

Grade 10 Mathematics
SESSION 2

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

DIRECTIONS
This session contains eighteen multiple-choice questions and three open-response questions.
Mark your answers to these questions in the spaces provided in your Student Answer Booklet.

22 Rasha and Scott went to a bakery. Rasha bought 4 plain bagels and 2 chocolate donuts for a total of $8.70. Scott bought 3 chocolate donuts for a total of $2.55.
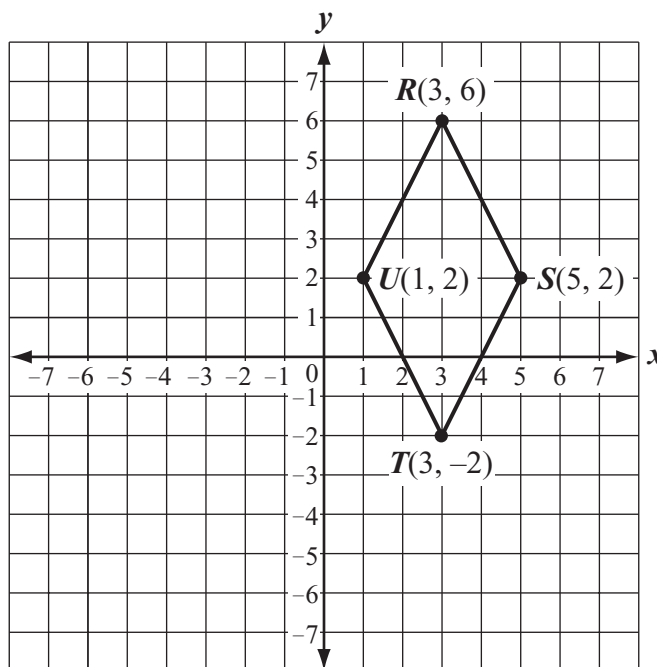
What is the cost of one plain bagel at the bakery?

A. $0.85

B. $1.45

C. $1.75

D. $2.05

23 The first term of an arithmetic sequence is 5. The third term of the sequence is 13.

Which of the following expressions represents the nth term of the sequence?

A. $4n + 1$

B. $4n + 5$

C. $5n + 1$

D. $5n + 5$

**24** Quadrilateral *RSTU* is graphed on the coordinate grid below.

Quadrilateral *RSTU* will be reflected over the y-axis and translated 4 units down. What will be the coordinates of the image of point *S* after the transformations?

A. $(-5, -2)$

B. $(1, -2)$

C. $(-1, 2)$

D. $(-5, 2)$

324

25 The box-and-whisker plot below shows the distribution of the numbers of calories per serving for a selection of breakfast cereals.
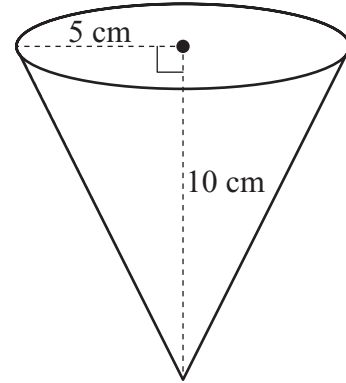
Breakfast Cereal Calories per Serving

50 65 80 95 110 125 140 155 170 185 200
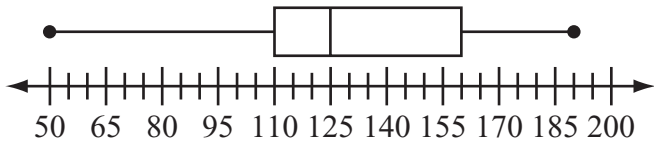
Based on the box-and-whisker plot, what is the median number of calories per serving for the breakfast cereals?

A. 110

B. 120

C. 125

D. 135

26 The diagram below shows a cup in the shape of a right circular cone and some of its measurements.

Which of the following is closest to the volume, in cubic centimeters, of the cup?

A.   83

B. 105

C. 262

D. 524

27 The volume of a right circular cylinder is 1696 cubic centimeters. The height of the cylinder is 15 centimeters. Which of the following is closest to the radius of the right circular cylinder?

   A. 2 centimeters

   B. 6 centimeters

   C. 18 centimeters

   D. 36 centimeters

28 Melissa owns a catering company. For lunch and dinner parties, she serves appetizers before each meal. The number of appetizers Melissa serves is directly proportional to the number of guests at the party.

    • For lunch parties, she serves 3 appetizers per guest.

    • For dinner parties, she serves 5 appetizers per guest.

When serving 22 guests, what is the difference of the number of appetizers she serves for dinner and the number of appetizers she serves for lunch?

   A. 10

   B. 35

   C. 44

   D. 64

29 A physician recorded the resting heart rates of some of her patients. She also recorded the average number of hours each of those patients exercises daily. She will make a graphical display of the data to help determine whether the two variables are associated.

Which of the following displays should the physician make?

   A. bar graph

   B. scatterplot

   C. circle graph

   D. box-and-whisker plot

**30** For all non-zero values of x, which of the following expressions has a value of 1?

   A. $\dfrac{4}{x} \cdot \left(\dfrac{-4}{x} \right)$

   B. $\dfrac{4}{x} \cdot \left(\dfrac{1}{4x} \right)$

   C. $\dfrac{4}{x} \cdot \left(\dfrac{-x}{4} \right)$

   D. $\dfrac{4}{x} \cdot \left(\dfrac{x}{4} \right)$

31 An animal population doubles every month. The population begins with 20 animals.

Which of the following expressions shows the animal population after 3 months?

A. $20 \cdot 2^3$

B. $20 \cdot 3^2$

C. $20^3 \cdot 2$

D. $20 \cdot 2 \cdot 3$

32 The distance from the base of a flagpole to a point on the ground is 24 feet. The flagpole has a height of 18 feet, as shown in the diagram below.
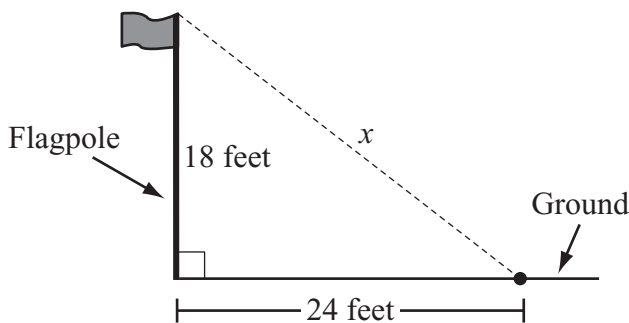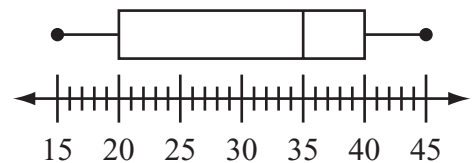

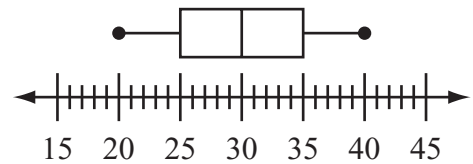What is x, the distance from the **top** of the flagpole to the point on the ground?

A. 16 feet

B. 21 feet

C. 30 feet

D. 42 feet

33 In a community college class, the interquartile range of student ages is 20 years, and the median student age is 30 years. Which of the following box-and-whisker plots could represent the distribution of the ages of the students in the class?
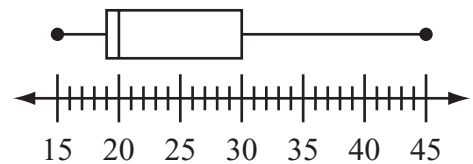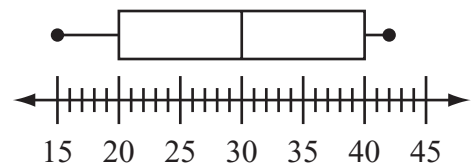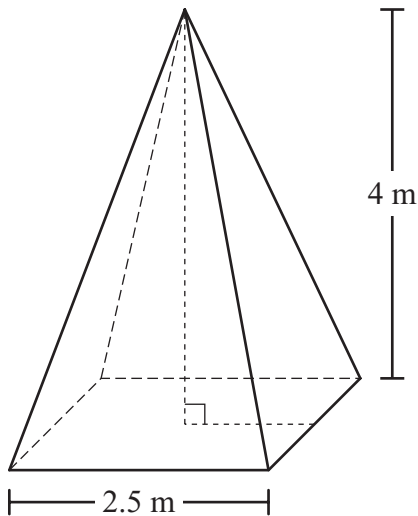
A.

Student Ages


```
15  20  25  30  35  40  45
```

B.

Student Ages


```
15  20  25  30  35  40  45
```

C.

Student Ages


```
15  20  25  30  35  40  45
```

D.

Student Ages


```
15  20  25  30  35  40  45
```

34 A right square pyramid and its dimensions are shown below.

4 m

2.5 m

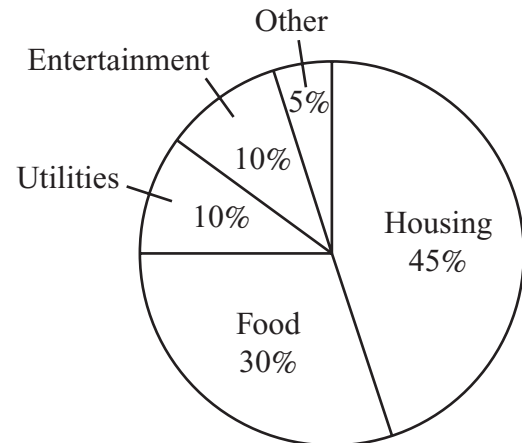Which of the following is closest to the volume of the right square pyramid?

A. 3 m³

B. 7 m³

C. 8 m³

D. 13 m³

35 The percentage of Deatrice's income that she budgets each month for different expenses is shown in the circle graph below.

Deatrice's Monthly Budget

Other

Entertainment

5%

10%

Utilities

10%

Housing
45%

Food
30%

Deatrice budgets $900 for food each month. Based on the circle graph, what is the total amount she budgets for housing each month?

A. $945

B. $1050

C. $1200

D. $1350

Question 36 is an open-response question.

- **BE SURE TO ANSWER AND LABEL ALL PARTS OF THE QUESTION.**
- **Show all your work (diagrams, tables, or computations) in your Student Answer Booklet.**
- **If you do the work in your head, explain in writing how you did the work.**

Write your answer to question 36 in the space provided in your Student Answer Booklet.

36 Kite *PQRS* has diagonals that intersect at point *T*. The kite and some of its angle measures are shown in the diagram below.
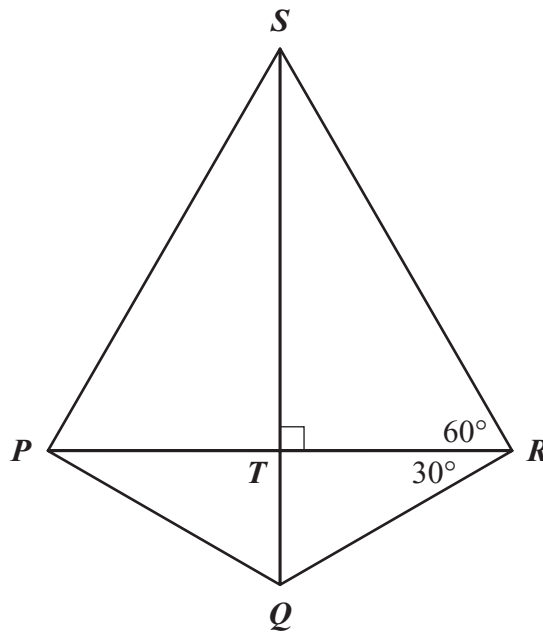
The length of $\overline{RS}$ is 20 centimeters.

a. What is the length, in centimeters, of $\overline{PS}$? Show or explain how you got your answer.

b. What is the length, to the nearest tenth of a centimeter, of $\overline{ST}$? Show or explain how you got your answer.

c. What is the length, to the nearest tenth of a centimeter, of $\overline{TQ}$? Show or explain how you got your answer.

d. What is the perimeter, to the nearest tenth of a centimeter, of kite *PQRS*? Show or explain how you got your answer.

Mark your answers to multiple-choice questions 37 through 40 in the spaces provided in your Student Answer Booklet. Do not write your answers in this test booklet. You may do your figuring in the test booklet.

37 If $q \neq 0$, which of the following is the additive inverse of the expression below?

$$-\frac{2}{q}$$

A. $-2q$

B. $-\dfrac{q}{2}$

C. $2q$

D. $\dfrac{2}{q}$

38 Howard runs every day for 1 hour.

- For the first half-hour, he runs at a rate of 10 minutes per mile.
- For the second half-hour, he runs at a rate of 7.5 minutes per mile.

Which of the following is the total distance, in miles, that Howard runs every day?

A. 6

B. 7

C. 8

D. 14

39 Parallel lines k and m are intersected by lines p and q. The diagram below shows the lines and the measures of some of the angles formed by the intersections of the lines.
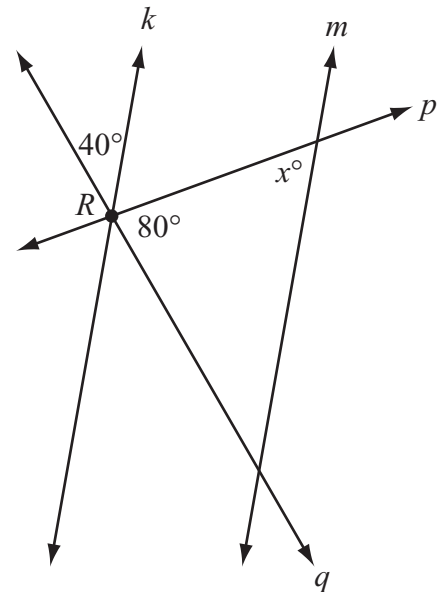
Lines k, p, and q intersect at point R.

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

A. 40

B. 50

C. 60

D. 80

40 The scatterplot below shows the weekly incomes, in dollars, for 15 individuals and the number of years of higher education each individual completed.

Weekly Incomes
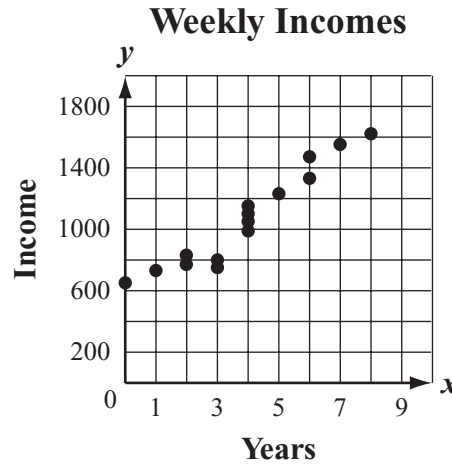
Which of the following graphs best represents the line of best fit for the data shown in the scatterplot?

A. **Weekly Incomes**

C. **Weekly Incomes**

B. **Weekly Incomes**

D. **Weekly Incomes**
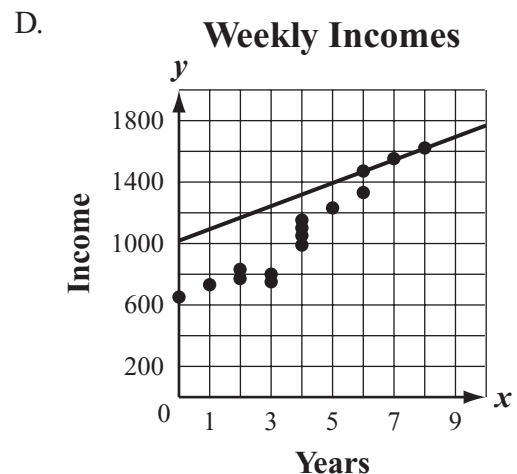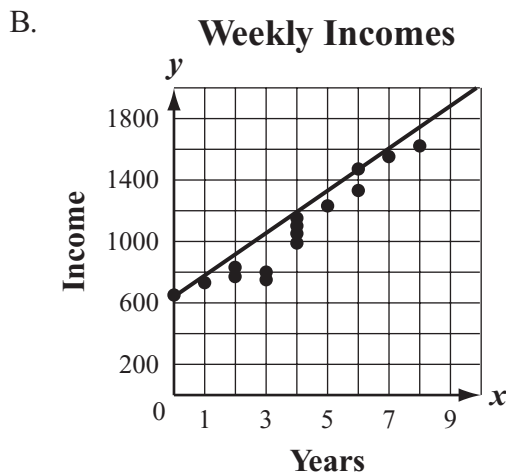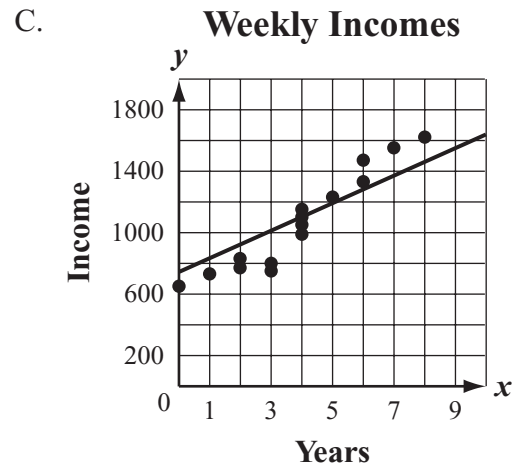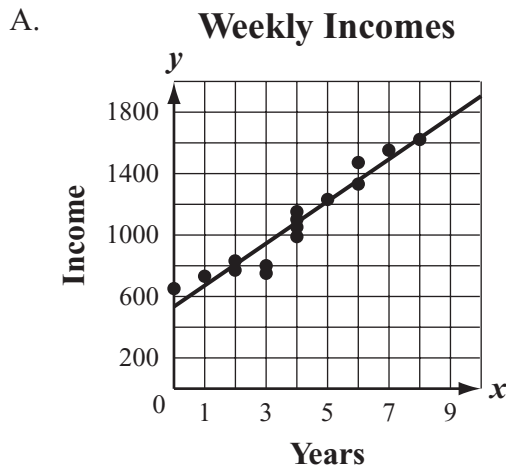
Questions 41 and 42 are open-response questions.

- **BE SURE TO ANSWER AND LABEL ALL PARTS OF EACH QUESTION.**
- **Show all your work (diagrams, tables, or computations) in your Student Answer Booklet.**
- **If you do the work in your head, explain in writing how you did the work.**

Write your answer to question 41 in the space provided in your Student Answer Booklet.

41 The histogram below shows the heights, in inches, of the students in Landon's class.

Heights of Students

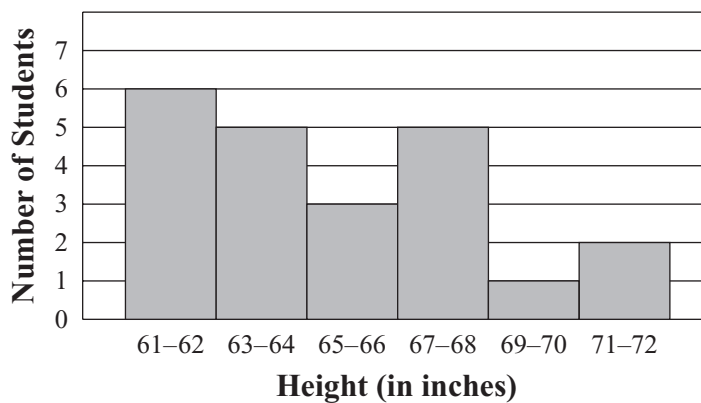a. How many of the students in Landon's class are at least 65 inches tall? Show or explain how you got your answer.

b. What **fraction** of the students in Landon's class are between 65 and 68 inches tall? Show or explain how you got your answer.

c. What could be the median height of the students in Landon's class? Show or explain how you got your answer.

Landon's teacher will add her height to the data. She is 65 inches tall.

d. Will the new median height be less than, equal to, or greater than the median height you found in part (c)? Explain your reasoning.

Write your answer to question 42 in the space provided in your Student Answer Booklet.

42 A small cube and a large cube with edge lengths represented by expressions are shown in the diagram below.

x inches $3x$ inches
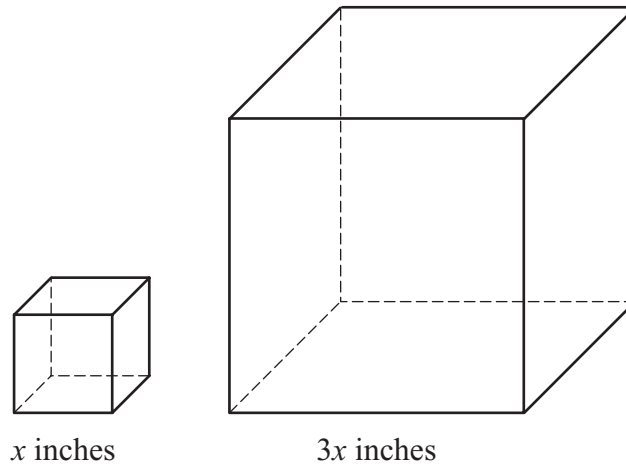
The small cube has a volume of 64 cubic inches.

a. What is the value of x? Show or explain how you got your answer.

b. What is the surface area, in square inches, of the small cube? Show or explain how you got your answer.

c. The surface area of the large cube is how many times the surface area of the small cube? Show or explain how you got your answer.

d. The volume of the large cube is how many times the volume of the small cube? Show or explain how you got your answer.

AREA FORMULAS

square .... $A = s^2$

rectangle .... $A = bh$

parallelogram .... $A = bh$

triangle .... $A = \frac{1}{2}bh$

trapezoid .... $A = \frac{1}{2}h(b_1 + b_2)$

circle .... $A = \pi r^2$

LATERAL SURFACE AREA FORMULAS

right rectangular prism .... $LA = 2(hw) + 2(lh)$

right circular cylinder .... $LA = 2\pi rh$

right circular cone .... $LA = \pi r\ell$
          (ℓ = slant height)

right square pyramid .... $LA = 2s\ell$
          (ℓ = slant height)

TOTAL SURFACE AREA FORMULAS

cube .... $SA = 6s^2$

right rectangular prism .... $SA = 2(lw) + 2(hw) + 2(lh)$

sphere .... $SA = 4\pi r^2$

right circular cylinder .... $SA = 2\pi r^2 + 2\pi rh$

right circular cone .... $SA = \pi r^2 + \pi r\ell$
          (ℓ = slant height)

right square pyramid .... $SA = s^2 + 2s\ell$
          (ℓ = slant height)

VOLUME FORMULAS

cube .... $V = s^3$
          (s = length of an edge)

right rectangular prism............ $V = lwh$

OR

$V = Bh$
(B = area of a base)

sphere .... $V = \frac{4}{3}\pi r^3$

right circular cylinder .... $V = \pi r^2 h$

right circular cone .... $V = \frac{1}{3}\pi r^2 h$

right square pyramid .... $V = \frac{1}{3}s^2 h$

CIRCLE FORMULAS

$C = 2\pi r$

$A = \pi r^2$

SPECIAL RIGHT TRIANGLES
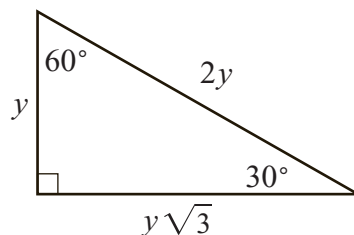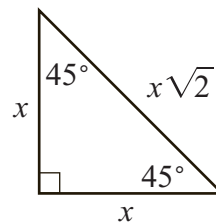
Grade 10 Mathematics
Spring 2018 Released Items:
Reporting Categories, Standards, and Correct Answers

Item No.	Page No.	Reporting Category[1]	Standard[1]	Correct Answer[2] (MC/SA)		2000 Standard[3]
1	315	*Number and Quantity*	7.EE.2.03	D		10.N.1
2	315	*Number and Quantity*	8.NS.1.02	B		10.N.3
3	315	*Geometry*	G.GMD.1.03	B		10.M.2
4	316	*Algebra and Functions*	A.APR.1.01	A		10.P.3
5	316	*Algebra and Functions*	A.REI.2.04	B		10.P.5
6	316	*Number and Quantity*	7.EE.2.03	C		10.N.4
7	316	*Statistics and Probability*	S.ID.1.02	A		10.D.1
8	316	*Geometry*	G.GPE.2.06	C		10.G.7
9	317	*Algebra and Functions*	A.SSE.1.02	D		10.P.4
10	317	*Number and Quantity*	8.NS.1.02	B		10.N.3
11	317	*Statistics and Probability*	S.ID.2.06	D		10.D.2
12	318	*Geometry*	7.G.2.06	A		10.M.1
13	318	*Number and Quantity*	N.RN.1.02	C		10.N.1
14	318	*Algebra and Functions*	A.REI.3.06	B		10.P.8
15	319	*Number and Quantity*	7.EE.2.03	2		10.N.2
16	319	*Statistics and Probability*	S.ID.1.01	6.5		10.D.1
17	320	*Number and Quantity*	7.EE.2.03			10.N.2
18	321	*Geometry*	G.SRT.1.02	6 inches		10.G.4
19	321	*Algebra and Functions*	A.REI.2.03	−5		10.P.6
20	322	*Algebra and Functions*	F.LE.1.02			10.P.1
21	323	*Algebra and Functions*	F.IF.2.04			10.P.2
22	324	*Algebra and Functions*	A.REI.3.06	C		10.P.8
23	324	*Algebra and Functions*	F.LE.1.02	A		10.P.1
24	324	*Geometry*	G.CO.1.02	A		10.G.9
25	325	*Statistics and Probability*	S.ID.1.01	C		10.D.1
26	325	*Geometry*	G.GMD.1.03	C		10.M.2
27	326	*Geometry*	G.GMD.1.03	B		10.M.2
28	326	*Algebra and Functions*	A.CED.1.01	C		10.P.7
29	326	*Statistics and Probability*	S.ID.2.06	B		10.D.1
30	326	*Number and Quantity*	7.NS.1.03	D		10.N.1
31	327	*Algebra and Functions*	F.LE.1.02	A		10.P.7
32	327	*Geometry*	G.SRT.3.08	C		10.G.5
33	327	*Statistics and Probability*	S.ID.1.01	D		10.D.1
34	328	*Geometry*	G.GMD.1.03	C		10.M.2
35	328	*Statistics and Probability*	6.SP.2.04	D		10.D.1
36	329	*Geometry*	G.SRT.3.06			10.G.6
37	330	*Number and Quantity*	7.NS.1.03	D		10.N.1
38	330	*Algebra and Functions*	A.CED.1.01	B		10.P.7
39	330	*Geometry*	8.G.1.05	C		10.G.3
40	331	*Statistics and Probability*	S.ID.2.06	A		10.D.2
41	332	*Statistics and Probability*	S.ID.1.02			10.D.1
42	333	*Geometry*	7.G.2.06			10.M.3

[1] The Reporting Category and Standard columns refer to the 2011 *Massachusetts Curriculum Framework for Mathematics*.

[2] Answers are provided here for multiple-choice and short-answer items only. Sample responses and scoring guidelines for open-response items, which are indicated by the shaded cells, will be posted to the Department's website later this year.

[3] The Department is providing the standard from the 2000 curriculum framework for Mathematics for reference purposes.