1. Mrs. Johnson created this histogram of her 3\textsuperscript{rd} period students’ test scores.

Which boxplot represents the same information as the histogram?

(A) ![Boxplot A]

(B) ![Boxplot B]

(C) ![Boxplot C]

(D) ![Boxplot D]
2. This graph shows annual salaries (in thousands of dollars) for all workers in a certain city.

The median salary is $80,500. Which value is the best approximation for the mean?

(A) $66,500
(B) $80,500
(C) $94,500
For questions 3–5, use the following scenario.

A survey was made of high-school-aged students owning cell phones with text messaging. The survey asked how many text messages each student sends and receives per day. Some results are shown in the table below.

<table>
<thead>
<tr>
<th>Group</th>
<th>Number Surveyed</th>
<th>Number of text messages sent/received per day among teens who text</th>
</tr>
</thead>
<tbody>
<tr>
<td>Girls, 14–17 years old</td>
<td>270</td>
<td>Mean 187 Median 100</td>
</tr>
<tr>
<td>Boys, 14–17 years old</td>
<td>282</td>
<td>Mean 176 Median 50</td>
</tr>
<tr>
<td>Total</td>
<td>552</td>
<td></td>
</tr>
</tbody>
</table>

3. A histogram of the girls’ responses (not shown) has a strong right skew. Which statement would support that observation?

(A) The number of girls’ surveyed is greater than the mean number of texts sent by girls.
(B) The mean number of texts sent by girls is greater than the median number of texts sent by girls.
(C) The mean number of texts sent by girls is greater than the mean number of texts sent by boys.
(D) The median number of texts sent by girls is greater than the median number of texts sent by boys.

4. Which expression shows the mean number of text messages for all girls and boys, 14–17 years old?

(A) \( \frac{187 + 176}{2} \)
(B) \( \frac{187 + 176}{552} \)
(C) \( \frac{270 \times 187 + 282 \times 176}{552} \)
(D) It cannot be computed from the information given.

5. Which group’s data has the larger interquartile range?

(A) Boys
(B) Girls
(C) Neither, they are equal.
(D) It cannot be computed from the information given.
For questions 6–9, use the boxplots of two data sets, P and Q, below.

Set P
Set Q

6. Which data set has the larger median?
   (A) Set P
   (B) Set Q
   (C) Neither, the medians are the same.

7. Which data set has the larger interquartile range?
   (A) Set P
   (B) Set Q
   (C) Neither, the interquartile ranges are the same.

8. Which data set could be described as skewed left?
   (A) Set P only
   (B) Set Q only
   (C) Both sets
   (D) Neither set

9. Which data set has values that are considered outliers?
   (A) Set P only
   (B) Set Q only
   (C) Both sets
   (D) Neither set
10. A data set has 4 values: \{1, 5, 6, 8\}. The mean of the data set is 5. Which expression shows the computation of the standard deviation?

(A) \(\sqrt{\frac{1+5+6+8}{3}}\)

(B) \(\sqrt{\frac{1+25+36+64}{3}}\)

(C) \(\sqrt{\frac{4+0+1+3}{3}}\)

(D) \(\sqrt{\frac{16+0+1+9}{3}}\)

11. The distributions of two classes’ final exam scores are shown below.

Which statement about the box-and-whisker plots is true?

(A) 50% of the scores for Mr. Smith’s class are between 65 and 80.

(B) 50% of the scores for Mrs. Jones’ class are between 80 and 100.

(C) The median scores for the two classes are the same.

(D) The interquartile range of scores for Mr. Smith’s class is greater than the interquartile range of the scores for Mrs. Jones’ class.
12. Examine the dotplots below from three sets of data.

The mean of each set is 5. The standard deviations of the sets are 1.3, 2.0, and 2.9. Match each data set with its standard deviation.

(A) Set A: 1.3  Set B: 2.0  Set C: 2.9
(B) Set A: 2.0  Set B: 1.3  Set C: 2.9
(C) Set A: 2.0  Set B: 2.9  Set C: 1.3
(D) Set A: 2.9  Set B: 1.3  Set C: 2.0
For questions 13–15, use the following scenario.

A survey asked 100 students whether or not they like two sports: soccer and tennis. The results of the survey are shown in the table.

<table>
<thead>
<tr>
<th>Likes Soccer</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Likes Tennis</td>
<td>Yes</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>48</td>
</tr>
</tbody>
</table>

13. What is the relative frequency of students who like tennis, soccer, or both?

   (A) 0.12  
   (B) 0.66  
   (C) 0.78  
   (D) 0.90

14. What is the relative frequency of students who like tennis?

   (A) 0.12  
   (B) 0.18  
   (C) 0.25  
   (D) 0.30

15. What is the relative frequency of students who like both tennis and soccer?

   (A) 0.12  
   (B) 0.30  
   (C) 0.60  
   (D) 0.78
16. The scatterplot below represents the forearm lengths and foot lengths of 10 people.

Based on a linear model of the data, which is the best prediction for the length of a person’s foot if his/her forearm length is 21 centimeters?

(A) 19 cm  
(B) 20 cm  
(C) 22 cm  
(D) 24 cm
17. The line of best fit for the scatterplot below is $\hat{y} = 1.4x + 2.9$

Predict $y$ when $x = 6$.

(A) 2.2
(B) 10.5
(C) 11.3
(D) 18.8
18. Which equation best describes the data shown in the scatterplot?

\[ y = \frac{3}{5}x + 7 \]

\[ y = -\frac{1}{3}x + 8 \]

\[ y = x + 8 \]

\[ y = 4 \]
19. Two residual plots are shown below.

Which residual plot(s) would indicate a linear model is appropriate?

(A) Plot I only  
(B) Plot II only  
(C) Both Plot I and Plot II  
(D) Neither Plot I nor Plot II
20. The line of best fit for the scatterplot below is \( \hat{y} = 1.4x + 2.9 \)

![Scatterplot](image)

What is the residual for the point (4, 10)?

(A) –1.5
(B) 1.5
(C) 8.5
(D) 10

21. A scatterplot is made of a city’s population over time. The equation of the line of best fit is \( \hat{p} = 629t + 150,000 \) where \( \hat{p} \) is the city’s predicted population size and \( t \) is the number of years since 2000. What is the meaning of the slope of this line?

(A) In 2000, the city’s population was about 629 people.
(B) In 2000, the city’s population was about 150,000 people.
(C) The city’s population increases by about 629 people each year.
(D) The city’s population increases by about 150,000 people each year.

22. The equation \( \hat{y} = 31.4 - 0.12x \), gives the predicted population \( \hat{y} \) of a city (in thousands) \( x \) years after 1975. What is meaning of the \( y \)-intercept?

(A) In 1975, the city’s population was about 120 people.
(B) In 1975, the city’s population was about 31,400 people.
(C) The city’s population decreases by about 120 people each year.
(D) The city’s population decreases by about 31,400 people each year.
23. The equation $\hat{P} = -9.50m + 509$ gives the predicted price $\hat{P}$ of a particular style of television $m$ months after the style first became available. What is the meaning of the $P$-intercept?

(A) The original price of the television was about $9.50.

(B) The original price of the television was about $509.00.

(C) The price of the television decreases by about $9.50 each month.

(D) The price of the television increases by about $509.00 each month.

24. The data below comes from a scatterplot.

<table>
<thead>
<tr>
<th>$x$</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>8</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>$y$</td>
<td>2</td>
<td>8</td>
<td>4</td>
<td>1</td>
<td>10</td>
<td>4</td>
<td>6</td>
<td>10</td>
<td>2</td>
<td>7</td>
<td>3</td>
<td>9</td>
</tr>
</tbody>
</table>

Which best describes the linear relationship between $x$ and $y$?

(A) weak or no correlation

(B) strong positive correlation

(C) strong negative correlation

For questions 25–27, evaluate the truth of each statement about the correlation coefficient $r$.

25. A value of $r$ near zero indicates there is a weak linear relationship between $x$ and $y$.

(A) True

(B) False

26. A value of $r = -0.5$ indicates a weaker linear relationship between $x$ and $y$ than a value of $r = 0.5$.

(A) True

(B) False

27. A value of $r = 1$ indicates that there is a cause-and-effect relationship between $x$ and $y$.

(A) True

(B) False
For questions 28–29, use the following scenario.

A linear model describes the relationship between two variables, \( x \) and \( y \). The correlation coefficient of the linear fit is \( r = -0.9 \).

28. The slope of the line of best fit is negative.
   
   (A) True
   (B) False

29. The linear relationship between \( x \) and \( y \) is weak.
   
   (A) True
   (B) False

30. Use the scatterplot below.

A linear model is fit to the data. What is the approximate value of its correlation coefficient?

   (A) \( r = 0.8 \)
   (B) \( r = 1.0 \)
   (C) \( r = -0.8 \)
   (D) \( r = -1.0 \)
31. The table shows the amount of rainfall in Seattle during the month of December in the years 1980–1999.

<table>
<thead>
<tr>
<th>Year</th>
<th>December</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980</td>
<td>7.4</td>
</tr>
<tr>
<td>1981</td>
<td>5.6</td>
</tr>
<tr>
<td>1982</td>
<td>6.2</td>
</tr>
<tr>
<td>1983</td>
<td>5.0</td>
</tr>
<tr>
<td>1984</td>
<td>5.0</td>
</tr>
<tr>
<td>1985</td>
<td>1.5</td>
</tr>
<tr>
<td>1986</td>
<td>6.8</td>
</tr>
<tr>
<td>1987</td>
<td>6.1</td>
</tr>
<tr>
<td>1988</td>
<td>7.5</td>
</tr>
<tr>
<td>1989</td>
<td>4.8</td>
</tr>
<tr>
<td>1990</td>
<td>3.1</td>
</tr>
<tr>
<td>1991</td>
<td>3.3</td>
</tr>
<tr>
<td>1992</td>
<td>4.1</td>
</tr>
<tr>
<td>1993</td>
<td>4.5</td>
</tr>
<tr>
<td>1994</td>
<td>8.2</td>
</tr>
<tr>
<td>1995</td>
<td>6.4</td>
</tr>
<tr>
<td>1996</td>
<td>5.2</td>
</tr>
<tr>
<td>1997</td>
<td>2.2</td>
</tr>
<tr>
<td>1998</td>
<td>9.0</td>
</tr>
<tr>
<td>1999</td>
<td>5.1</td>
</tr>
</tbody>
</table>

The histogram shows the distribution of rainfall in Seattle during the month of July in the same years, using intervals of 0.5 inches.

(a) Create a histogram on the grid above that shows the distribution of rainfall in December using intervals of 1.0 inch.

(b) Describe the shapes of the distributions for July and December.

(c) How does the mean rainfall for July compare to the median rainfall? Explain.

(d) Compare the median rainfalls for July and December over the period 1980–1999.

(e) Describe how to compute the standard deviation of the December rainfalls. (You do not have to actually compute it.)

(f) Which month’s rainfall, July or December, has the greater standard deviation? Explain.

(g) One of the rainfall amounts for July was recorded at 2.4 inches. In actuality, it was only 1.4 inches. Explain how this would affect the mean and median of July rainfall.
Question 31 continued.

(h) On the grid below, create a scatterplot showing December monthly rainfall over the period from 1980–1999.

(i) Describe the relationship between December rainfall and year.
32. Students surveyed teachers at a school and asked, “How much did you spend on your last haircut?”
   The results of the survey, including the teachers’ gender, are given in the table at right

   (a) Construct a display that allows you to compare, by gender, the amount teachers spent on their last haircut.

   (b) Compare and contrast the distributions of amounts spent between male and female teachers.

<table>
<thead>
<tr>
<th>Gender</th>
<th>Amount Spent ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>10</td>
</tr>
<tr>
<td>F</td>
<td>10</td>
</tr>
<tr>
<td>F</td>
<td>15</td>
</tr>
<tr>
<td>F</td>
<td>15</td>
</tr>
<tr>
<td>F</td>
<td>15</td>
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<tr>
<td>F</td>
<td>20</td>
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<td>F</td>
<td>20</td>
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<tr>
<td>F</td>
<td>20</td>
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<tr>
<td>F</td>
<td>25</td>
</tr>
<tr>
<td>F</td>
<td>25</td>
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<td>25</td>
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<td>F</td>
<td>30</td>
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<td>F</td>
<td>30</td>
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<tr>
<td>F</td>
<td>35</td>
</tr>
<tr>
<td>F</td>
<td>35</td>
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<td>45</td>
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<tr>
<td>F</td>
<td>50</td>
</tr>
<tr>
<td>F</td>
<td>70</td>
</tr>
<tr>
<td>F</td>
<td>85</td>
</tr>
<tr>
<td>F</td>
<td>100</td>
</tr>
<tr>
<td>M</td>
<td>0</td>
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<td>0</td>
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<td>M</td>
<td>10</td>
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<td>M</td>
<td>15</td>
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<td>M</td>
<td>20</td>
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<td>M</td>
<td>20</td>
</tr>
<tr>
<td>M</td>
<td>20</td>
</tr>
<tr>
<td>M</td>
<td>25</td>
</tr>
<tr>
<td>M</td>
<td>30</td>
</tr>
</tbody>
</table>
33. A high school principal randomly surveyed students about a change in the dress code. The results are shown in the table.

<table>
<thead>
<tr>
<th>Class</th>
<th>Freshmen</th>
<th>Sophomores</th>
<th>Juniors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Favors the change</td>
<td>Yes</td>
<td>56</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>24</td>
<td>37</td>
</tr>
</tbody>
</table>

(a) What percentage of all respondents favors the policy change?
(b) Which class has the highest favorable percentage? Which class has the lowest favorable percentage?
(c) Is there a relationship between class and favoring the dress code change? Explain.

34. Which is equivalent to $\sqrt{18x^2y^3}$ where $x > 0$ and $y > 0$?

(A) $9xy\sqrt{y}$
(B) $3xy\sqrt{2y}$
(C) $3x^2y^2\sqrt{2y}$
(D) $9x^2y^2\sqrt{y}$

35. Which is equivalent to $\frac{\sqrt{64}}{\sqrt{100}}$ ?

(A) $\frac{32}{10}$
(B) $\frac{32}{50}$
(C) $\frac{8}{10}$
(D) $\frac{8}{100}$
36. Which is equivalent to $\sqrt{6\sqrt{8}}$?

(A) $4\sqrt{3}$  
(B) $8\sqrt{3}$  
(C) 12  
(D) 24

37. Which is equivalent to $\frac{\sqrt{27}}{\sqrt{36}}$?

(A) $\frac{3}{4}$  
(B) $\frac{\sqrt{3}}{4}$  
(C) $\frac{3}{2}$  
(D) $\frac{\sqrt{3}}{2}$

38. Which is equivalent to $\sqrt{24}$?

(A) $8\sqrt{3}$  
(B) $2\sqrt{6}$  
(C) $6\sqrt{2}$  
(D) $2\sqrt{12}$
39. Which is equivalent to \( \sqrt{xy} \sqrt{x^3 y^5} \)?

- (A) \( x^2 y^3 \)
- (B) \( x^4 y^6 \)
- (C) \( xy^2 \sqrt{xy} \)
- (D) \( x^2 y^4 \sqrt{xy} \)

40. Which is equivalent to \( \sqrt[3]{120} \)?

- (A) \( 2\sqrt{10} \)
- (B) \( 4\sqrt{10} \)
- (C) \( 10\sqrt{2} \)
- (D) \( 10\sqrt{4} \)

41. A class of students was told to compute the area of the rectangle below.

\[
\begin{array}{c}
\sqrt{5} \\
\sqrt{15}
\end{array}
\]

The class came up with three different values for the area:

- \( 2\sqrt{5} \)
- \( 5\sqrt{3} \)
- \( \sqrt{75} \)

How many of those values correctly represent the area of the rectangle?

- (A) 0
- (B) 1
- (C) 2
- (D) 3
42. The irrational numbers are closed under multiplication.
   (A) True
   (B) False

For questions 43–44, classify each number as rational or irrational.

43. \(-7 + \sqrt{3}\)
   (A) rational
   (B) irrational

44. \(2\frac{1}{3} + \frac{17}{2}\)
   (A) rational
   (B) irrational

45. Answer each part.
   (a) What is an irrational number?
   (b) Explain why \(2 + \sqrt{3}\) is an irrational number.

46. In each part, provide an example of the statement.
   (a) The sum of two rational numbers is rational.
   (b) The product of a rational number and an irrational number is irrational.
   (c) The product of two irrational numbers can be rational.

47. Answer each part.
   (a) Write \(\sqrt{24}\) as the product of a rational and an irrational number.
   (b) Give an example where the product of two irrational numbers is a rational number.
   (c) Explain why the sum of a rational number and an irrational number must be irrational.
48. Which expression is equivalent to \( xc + xb + yc + yb \)?

(A) \((x + b)(y + c)\)
(B) \((x + c)(y + b)\)
(C) \((x + y)(b + c)\)

49. Which is equivalent to \( (4x^2 - 9y^4) \)?

(A) \((2x - 3y^2)^2\)
(B) \((2x - 3y^2)(2x + 3y^2)\)
(C) \((2x + 3y^2)(2x - 3y)(2x + 3y)\)

For questions 50–52, use the expression \( x^4 - y^4 \).

50. \( (x^2 - y^2)(x^2 + y^2) \) is equivalent to the given expression.

(A) True
(B) False

51. \( (x - y)(x + y)(x^2 + y^2) \) is equivalent to the given expression.

(A) True
(B) False

52. \( (x - y)(x + y)^3 \) is equivalent to the given expression.

(A) True
(B) False
For questions 53–54, use the equation \( x^2 = (2x + p)^2 \).

53. \( x = 2x + p \)
   (A) True
   (B) False

54. \( x = -(2x + p) \)
   (A) True
   (B) False

55. Let \( x^2 + y^2 = 23 \) and \( xy = 6 \). What is the value of \( (x + y)^2 \)?
   (A) 9
   (B) 23
   (C) 29
   (D) 35

56. Which of these is NOT a factor of \( 12x^2 + 6x - 90 \)?
   (A) 6
   (B) 2x
   (C) \( x + 3 \)
   (D) \( 2x - 5 \)
For questions 57–59, consider the solutions to the equation \((x + 5)(x - 3) = 0\).

57. \(x^2 - 15 = 0\) has the same solutions as the given equation.
   (A) True
   (B) False

58. \(x^2 + 2x - 15 = 0\) has the same solutions as the given equation.
   (A) True
   (B) False

59. \((x + 1)^2 - 14 = 0\) has the same solutions as the given equation.
   (A) True
   (B) False

60. The expression \(4x^2 + bx - 3\) is factorable into two binomials. Which could NOT equal \(b\)?
   (A) \(-7\)
   (B) \(-1\)
   (C) \(1\)
   (D) \(11\)

61. Given \(4x^2 + 28x + c = (2x + q)^2\), where \(c\) and \(q\) are integers, what is the value of \(c\)?
   (A) 2
   (B) 7
   (C) 14
   (D) 49
62. Which quadratic equation has solutions of \( x = 2a \) and \( x = -b \)?

(A) \( x^2 - 2ab = 0 \)
(B) \( x^2 - x(b + 2a) - 2ab = 0 \)
(C) \( x^2 - x(b - 2a) + 2ab = 0 \)
(D) \( x^2 + x(b - 2a) - 2ab = 0 \)

63. If \((x - 7)\) is a factor of \(2x^2 - 11x + k\), what is the value of \(k\)?

(A) \(-21\)
(B) \(-7\)
(C) \(7\)
(D) \(28\)

64. Factor \(25x^2 + 4\).

(A) \((5x + 2)(5x - 2)\)
(B) \((5x + 2)^2\)
(C) The expression is not factorable with real coefficients.

65. Factor \(9x^2 - 16\).

(A) \((3x + 4)(3x - 4)\)
(B) \((3x - 4)^2\)
(C) The expression is not factorable with real coefficients.

66. Which is a factor of \(4x^2 - 6x - 40\)?

(A) \(2x + 5\)
(B) \(2x - 5\)
(C) \(2x + 4\)
(D) \(2x - 4\)
67. Which equation has roots of 4 and –6?

(A) \((x - 4)(x + 6) = 0\)

(B) \((x - 4)(x - 6) = 0\)

(C) \((x + 4)(x + 6) = 0\)

(D) \((x + 4)(x - 6) = 0\)

68. Which expression is equivalent to \(x^2 + 3x - 40\)?

(A) \((x - 5)(x + 8)\)

(B) \((x - 5)(x - 8)\)

(C) \((x + 5)(x + 8)\)

(D) \((x + 5)(x - 8)\)

69. Which expression is equivalent to \(35x^2 + 26x - 16\)?

(A) \((7x - 2)(5x + 8)\)

(B) \((7x + 2)(5x - 8)\)

(C) \((7x - 8)(5x + 2)\)

(D) \((7x + 8)(5x - 2)\)

70. What value of \(c\) makes the expression \(y^2 - 9y + c\) a perfect trinomial square?

(A) \(-9\)

(B) \(-\frac{9}{2}\)

(C) \(81\)

(D) \(\frac{81}{4}\)
71. What expression must the center cell of the table contain so that the sums of each row, each column, and each diagonal are equivalent?

<table>
<thead>
<tr>
<th>[5x^2 + x - 9]</th>
<th>[-x^2 - x - 4]</th>
<th>[2x^2 + 3x - 2]</th>
</tr>
</thead>
<tbody>
<tr>
<td>[-x^2 + 3x + 2]</td>
<td>[5x^2 - x - 12]</td>
<td>[2x^2 - x - 8]</td>
</tr>
<tr>
<td>[2x^2 - x - 8]</td>
<td>[5x^2 + 3x - 6]</td>
<td>[-x^2 + x - 1]</td>
</tr>
</tbody>
</table>

(A) \(2x^2 + x - 5\)  
(B) \(4x^2 + 2x - 10\)  
(C) \(6x^2 + 3x - 15\)

72. Which is equivalent to \(3x(x^2 y + 2xy^2)\)?

(A) \(3x^2y + 6xy^3\)  
(B) \(3x^3y + 2xy^2\)  
(C) \(3x^3y + 6x^2y^2\)  
(D) \(9x^4y^3\)

73. Under what operations is the system of polynomials NOT closed?

(A) addition  
(B) subtraction  
(C) multiplication  
(D) division

74. Which expression is equivalent to \(6x^2 - 4x + 3 - 5 - 8x^2 + 7x\)?

(A) \(-2x^2 + 3x - 2\)  
(B) \(-2x^2 + 11x - 2\)  
(C) \(14x^2 + 3x + 8\)  
(D) \(14x^2 + 11x + 8\)
75. Subtract:

\[
\left(9y^2 - 5y + 6\right) - \left(3y^2 + y - 4\right)
\]

(A) \(6y^2 - 4y + 2\)
(B) \(6y^2 - 4y + 10\)
(C) \(6y^2 + 6y + 2\)
(D) \(6y^2 - 6y + 10\)

76. Expand the expression \((3x - 7)^2\).

(A) \(9x^2 - 42x - 49\)
(B) \(9x^2 - 42x + 49\)
(C) \(9x^2 - 49\)
(D) \(9x^2 + 49\)

For questions 77–79, answer each with respect to the system of polynomials.

77. The system of polynomials is closed under subtraction.
   (A) True
   (B) False

78. The system of polynomials is closed under division.
   (A) True
   (B) False

79. The system of polynomials is closed under multiplication.
   (A) True
   (B) False
80. The distance traveled by a dropped object (ignoring air resistance) equals \( \frac{1}{2} gt^2 \), where \( g \) is the acceleration of the object due to gravity and \( t \) is the time since it was dropped. If acceleration due to gravity is about 10 m/s\(^2\), how much time does it take an object to fall 80 meters?

(A) about 3 seconds
(B) about 4 seconds
(C) about 5.5 seconds
(D) about 9 seconds

81. The area of the triangle below is 24 square units. What is the height of the triangle?

![Diagram of a triangle with base 2x and height x]

(A) 6 units
(B) 12 units
(C) \( \sqrt{12} \) units
(D) \( \sqrt{24} \) units

82. Solve the equation \( \frac{u^2}{2} + P = h \) for \( u \), where all variables are positive real numbers.

(A) \( u = \sqrt{2h - P} \)
(B) \( u = \sqrt{\frac{h - P}{2}} \)
(C) \( u = \sqrt{2(h - P)} \)
(D) \( u = \sqrt{\frac{h}{2} - P} \)
For questions 83–84, use the scenario below.

A rectangular playground is built such that its length is twice its width.

83. The area of the playground can be expressed as $2w^2$.
   (A) True
   (B) False

84. The perimeter of the playground can be expressed as $4w^4$.
   (A) True
   (B) False

85. The quadratic equation $2x^2 - 16x - 15 = 0$ is rewritten as $(x - p)^2 = q$. What is the value of $q$?
   (A) $\frac{47}{2}$
   (B) $\frac{15}{2}$
   (C) $\frac{143}{2}$

86. What number should be added to both sides of the equation to complete the square in $x^2 + 8x = 17$?
   (A) 4
   (B) 16
   (C) 29
   (D) 49
87. If \( p^2 = 25 \) and \( q^2 = 16 \), which of these CANNOT equal \( p + q \)?

(A) –1  
(B) 9  
(C) 41

88. What value(s) of \( x \) make the equation \((x - m)(x - n) = 0\) true? (\( m \) and \( n \) do not equal zero.)

(A) \(-m\) and \(-n\)  
(B) \( m \) and \( n \)  
(C) \( mn \)  
(D) 0

For questions 86–87, the quadratic equation \( f(x) = 2x^2 - 3x + c = 0 \) has exactly one real solution.

89. \( f(x) \) can be written as a difference of squares.

(A) True  
(B) False

90. \( c = \frac{9}{8} \)

(A) True  
(B) False
91. Solve the equation for $x$:

$$a(x-h)^2 + k = p$$

$$(A) \quad x = h \pm \sqrt{\frac{p}{a} - k}$$

$$(B) \quad x = h \pm \sqrt{\frac{p}{a} - k}$$

$$(C) \quad x = h \pm \sqrt{\frac{p-k}{a}}$$

$$(D) \quad x = h \pm \sqrt{\frac{p-k}{a}}$$

92. Solve the quadratic $4x^2 = 14x + 8$.

$$(A) \quad x = -2 \text{ or } x = 1$$

$$(B) \quad x = -\frac{1}{2} \text{ or } x = 4$$

$$(C) \quad x = -\frac{1}{7} \text{ or } x = 8$$

$$(D) \quad x = 0 \text{ or } x = -\frac{7}{4}$$

93. When $2x^2 + (4 - p)x - 2p = 0$, $x = -2$ is a solution. Which is a factor of $2x^2 + (4 - p)x - 2p$?

$$(A) \quad 2x - p$$

$$(B) \quad 2x + p$$

$$(C) \quad 4 - p$$

$$(D) \quad x - 2p$$
94. The equation $x^2 = a$ has no real solutions. What must be true?

(A) $a < 0$
(B) $a = 0$
(C) $a > 0$

95. What is the solution set of the equation $4(t - 3)^2 - 1 = 8$?

(A) $\left\{ \frac{1}{2}, 4, \frac{1}{2} \right\}$
(B) $\left\{ \frac{3}{4}, \frac{5}{4} \right\}$
(C) $\left\{ 3 - \sqrt{3}, 3 + \sqrt{3} \right\}$
(D) $\left\{ 3 - \sqrt{5}, 3 + \sqrt{5} \right\}$

96. How many real solutions does the equation $x^2 + 4 = 0$ have?

(A) 0
(B) 1
(C) 2

97. How many real solutions does the equation $3y^2 = 0$ have?

(A) 0
(B) 1
(C) 2
98. What is the solution set of \(-4x^2 = 5x + 9\)?

(A) \(\left\{ -1, \frac{-1}{4} \right\} \)

(B) \(\left\{ -1, \frac{9}{4} \right\} \)

(C) \(\left\{ \frac{-5 + \sqrt{119}}{4}, \frac{-5 - \sqrt{119}}{4} \right\} \)

(D) There are no real solutions.

99. The graph of \(y = x^2 - 3x + 6\) has how many \(x\)-intercepts?

(A) 0

(B) 1

(C) 2

(D) 6

100. Which shows the correct use of the quadratic formula to find the solutions of \(8x^2 + 2x = 1\)?

(A) \(x = \frac{2 \pm \sqrt{(2)^2 - 4(8)(1)}}{2(8)}\)

(B) \(x = \frac{2 \pm \sqrt{(2)^2 - 4(8)(-1)}}{2(8)}\)

(C) \(x = \frac{-2 \pm \sqrt{(2)^2 - 4(8)(1)}}{2(8)}\)

(D) \(x = \frac{-2 \pm \sqrt{(2)^2 - 4(8)(-1)}}{2(8)}\)
101. What is the solution set for the equation \( x^2 + 8x + 16 = 49 \)?

   (A) \( \{4, 7\} \)

   (B) \( \{-7, -4\} \)

   (C) \( \{-11, 3\} \)

   (D) \( \{-3, 11\} \)

102. What are the solutions of \( 236 - 2x = -2 \)?

   (A) \( x = \frac{1 \pm \sqrt{3}}{3} \)

   (B) \( x = \frac{-1 \pm \sqrt{3}}{3} \)

   (C) \( x = 1 \pm \frac{\sqrt{3}}{3} \)

   (D) \( x = -1 \pm \frac{\sqrt{3}}{3} \)

103. What is the solution set of the equation \( 36x^2 - 25 = 0 \)?

   (A) \( \left\{ \frac{5}{6} \right\} \)

   (B) \( \left\{ \frac{25}{36} \right\} \)

   (C) \( \left\{ -\frac{5}{6}, \frac{5}{6} \right\} \)

   (D) \( \left\{ -\frac{25}{36}, \frac{25}{36} \right\} \)
104. Mark and Sofia are looking at this pattern of dots.

Mark says the number of dots in figure number $n$ is equal to $n^2 + 1$.

Sofia says the number of dots in figure number $n$ is equal to $n(n + 1) - (n - 1)$.

(a) Using the dot patterns, explain why each student is correct.
(b) Show algebraically that Mark’s and Sofia’s expressions are equivalent.

105. A quadratic expression has two factors. One factor is $(2x - 3)$.

In each part below, find another factor of the quadratic, if possible. If the situation described is not possible, explain why.

(a) The quadratic has no real zeros.
(b) The quadratic has only one real zero.
(c) The quadratic has two distinct real zeros.

106. Answer each part.

(a) Define “polynomial” and give two examples.
(b) Give an example where the sum of two binomials is a trinomial.
(c) When two polynomials are multiplied, the result must be a polynomial. Explain why this is true.

107. Given $ax^2 + bx + c = 2(1.2x + 0.3)(x - 0.5) + (0.5x^2 + 2.5x - 1.3)$.

What are the values of $a$, $b$, and $c$?
108. Given \( f(x) = 2x - 3 \), \( g(x) = \frac{x}{3} + 2 \), and \( h(x) = 3x^2 - x - 4 \), find:

(a) \( f(x) \cdot g(x) \)

(b) \( f(x) + h(x) \)

(c) \( f(x) - g(x) \)

109. One way of expressing a quadratic function is \( f(x) = ax^2 + bx + c \). A second way is \( f(x) = a(x-h)^2 + k \).

(a) Find \( b \) in terms of \( a \), \( h \), and \( k \).

(b) Find \( c \) in terms of \( a \), \( h \), and \( k \).

110. Use the figure below.

![Diagram of a triangle with base \( b \) and height \( h \)]

The length of the triangle’s base \( b \) is twice its height \( h \).

(a) What are the approximate lengths of the base and height when the triangle’s area is 25 m\(^2\)?

(b) A similar triangle has a height whose measure (in feet) is a positive integer. What could its area be?

111. The braking distance \( d \), in feet, for a car can be modeled by \( d = \frac{3(s^2 + 10s)}{40} \), where \( s \) is the speed of the car in miles per hour. What is the fastest speed that a car can be moving so that braking distance does not exceed 150 feet? Show your work.

112. Find all solutions to the equation \( x^2 - 10x + 25 = 81 \). Show your work.
113. Solve each quadratic equation for \( x \).

(a) \( x^2 - 8 = 0 \)

(b) \( (x - 2)^2 - 4 = 0 \)

(c) \( 3(x + 6)^2 = 15 \)

114. The figure below shows a proposed sand pit, an area in a park that will be filled with sand.

![Sand pit diagram](image)

The sand pit is to be a large rectangular area twice as long as it is wide, plus a smaller rectangular area 3 feet long and as wide as the large area. The two areas share a common side.

(a) Write an expression for the total perimeter of the sand pit as a function of \( x \).

(b) Write an expression for the total area of the sand pit as a function of \( x \).

(c) The sand in the pit is to be 3 inches deep throughout. The park has 40 cubic feet of sand available. What will be the approximate dimensions of the sand pit?

(d) The pit is to be bordered by a chain link fence. How much fencing is needed?

115. Explain why the relation \( y = x^2 \) is a function even though \( x = -2 \) and \( x = 2 \) both produce \( y = 4 \).

116. A farmer can grow about 10,000 bushels of soybeans on a plot of land 1 kilometer by 1 kilometer.

(a) Write a function that shows how many bushels of soybeans the farmer can grow on a plot of land \( x \) kilometers by \( x \) kilometers.

(b) The price per bushel is \( p \) dollars per bushel. Write a function that shows how much money can be earned from a plot of land \( x \) kilometers by \( x \) kilometers.

(c) Last year, a farmer sold $960,000 of soybeans at $15/bushel. What would be the dimensions of a square field that produced this sale of soybeans?
117. Define and sketch the three quadratic functions that have the following characteristics.

(a) \( f \) has an axis of symmetry at \( x = 2 \) and no \( x \)-intercepts.
(b) \( g \) has a \( y \)-intercept at 3 and opens downward.
(c) \( h \) has a zero at \( x = -2 \) and a minimum value of \(-6\).

118. A parabola is defined as \( f(x) = a(x - 3)^2 + 10 \), where \( a \) is a positive real number. As \( a \) increases, what happens to the \( y \)-coordinate of the parabola’s vertex?

(A) it decreases  
(B) it increases  
(C) it does not change

119. A parabola is defined as \( f(x) = a(x - 3)^2 + 10 \), where \( a \) is a positive real number. As \( a \) increases, what happens to the \( y \)-coordinate of the parabola’s \( y \)-intercept?

(A) it decreases  
(B) it increases  
(C) it does not change

120. A quadratic function is defined as \( y = (x + 4)^2 - 7 \). Which statement is true?

(A) The parabola has a maximum value of \(-7\).
(B) The parabola has a minimum value of \(-7\).
(C) The parabola has a maximum value of \(-4\).
(D) The parabola has a minimum value of \(-4\).
121. Solve the system of equations.

\[
\begin{align*}
y &= (x + 4)^2 - 6 \\
-2x + y &= 5
\end{align*}
\]

(A) \((-4, 6)\)  
(B) \((0, 5)\)  
(C) \((-5, -5)\) and \((-1, 3)\)  
(D) \((-5, -5)\)

For questions 122–123, use the table below.

<table>
<thead>
<tr>
<th>(x)</th>
<th>-4</th>
<th>-3</th>
<th>-2</th>
<th>-1</th>
<th>0</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>(f(x))</td>
<td>-23</td>
<td>-10</td>
<td>-3</td>
<td>-2</td>
<td>-7</td>
<td>-18</td>
</tr>
<tr>
<td>(g(x))</td>
<td>-13</td>
<td>-11.5</td>
<td>-10</td>
<td>-8.5</td>
<td>-7</td>
<td>-5.5</td>
</tr>
</tbody>
</table>

122. \(f(x) = g(x)\) at \((0, -7)\).

(A) True  
(B) False

123. \(f(x) = g(x)\) somewhere on the interval \(-3 < x < -2\).

(A) True  
(B) False

124. The parabola \(y = x^2 - 9\) and the line \(y = -8x\) intersect at two points. Which equation would be useful to find these points?

(A) \((-8x)^2 - 9 = 0\)  
(B) \(-8(x^2 - 9) = 0\)  
(C) \(x^2 + 8x - 9 = 0\)  
(D) \(x^2 - 8x - 9 = 0\)
125. Which value of $x$ is a solution to the equation $x^2 - 3x - 3 = -\frac{3}{5}x + \frac{3}{2}$?

(A) $x \approx -0.68$
(B) $x \approx -1.24$
(C) $x \approx 2.50$
(D) $x \approx 3.79$

126. Which quadratic function’s graph is symmetric about the line $x = 3$?

(A) $y = x^2 - 6x + 2$
(B) $y = 3x^2 + x - 7$
(C) $y = x^2 - 3x + 5$
(D) $y = 2x^2 + 12x - 1$
In questions 127–129, use the graph below. The graph shows the height \( h \) above the ground (in meters) of a thrown ball as a function of time (in seconds).

127. The ball hits the ground 3 seconds after it is thrown.
   (A) True
   (B) False

128. Height begins decreasing as soon as the ball is thrown \((t = 0)\).
   (A) True
   (B) False

129. The domain of the function that describes the height of the ball is all real numbers.
   (A) True
   (B) False
130. A scientist drops an object from the top of an 80-foot building. The scientist uses a stopwatch to measure the time between when it was dropped and when it hits the ground. The height of the object above ground as a function of time is given by \( h(t) = 80 - 16t^2 \). Which is the domain of this function?

(A) \( t \) can be any real number.

(B) \( t \) can be any positive real number.

(C) \( t \) can be any real number between 0 and 80, inclusive.

(D) \( t \) can be any real number between 0 and \( \sqrt{5} \), inclusive.

131. What are the domain and range of the function \( y = x^2 - 6x + 8 \) shown in the graph below?

(A) Domain: all real numbers
   Range: \( y \geq -1 \)

(B) Domain: all real numbers
   Range: all real numbers

(C) Domain: \( 2 \leq x \leq 4 \)
   Range: \( y \geq -1 \)

(D) Domain: \( 2 \leq x \leq 4 \)
   Range: all real numbers
132. The table below is of a quadratic function, \( g(x) \), where \( x \) is measured in seconds and \( g(x) \) is measured in meters.

<table>
<thead>
<tr>
<th>( x )</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>( g(x) )</td>
<td>2.3</td>
<td>-1.0</td>
<td>1.7</td>
<td>10.4</td>
<td>25.1</td>
</tr>
</tbody>
</table>

What is the approximate rate of change over the interval \( 0 \leq x \leq 4 \)?

(A) 22.8 m/s  
(B) 8.7 m/s  
(C) 6.3 m/s  
(D) 5.7 m/s

133. Which graph represents the piecewise function?

\[
f(x) = \begin{cases} 
3x + 2, & x < -2 \\
1/2 x + 3, & x \geq -2
\end{cases}
\]

(A) ![Graph A](image)  
(B) ![Graph B](image)  
(C) ![Graph C](image)  
(D) ![Graph D](image)
134. Which of the following is the graph of \( y = -x^2 + 4x - 5 \)?
135. A quadratic function is given by \( h(x) = ax^2 + bx + c \), where \( a \) and \( c \) are negative real numbers. Which of these could be the graph of \( y = h(x) \)?

(A) \[\text{Graph A}\]

(B) \[\text{Graph B}\]

(C) \[\text{Graph C}\]

(D) \[\text{Graph D}\]
136. Which is the graph of \( f(x) = x^2 + 2x - 3 \)?
137. Use the graph.

Which equation defines this set of parabolas?

(A) \( y = kx^2 + 1 \)

(B) \( y = \frac{1}{k}x^2 + 1 \)

(C) \( y = x^2 + k \)
138. Use the graph.

Which equation is represented the following graph?

(A) \( y = x^2 - x - 6 \)
(B) \( y = x^2 - x + 6 \)
(C) \( y = x^2 + x - 6 \)
(D) \( y = x^2 + x + 6 \)

139. A piecewise function is defined as \( f(x) = \begin{cases} x - 2, & \text{for } x \geq 0 \\ -x - 2, & \text{for } x < 0 \end{cases} \). Which is another way of defining this function?

(A) \( f(x) = |x - 2| \)
(B) \( f(x) = |x| - 2 \)
(C) \( f(x) = -(x - 2) \)
(D) \( f(x) = -x + 2 \)
140. The postage for a letter is $0.45 for letter weights up to and including one ounce. For each additional ounce, or portion of an ounce, another $0.20 is charged. Which graph represents the postage of a letter weighing $x$ ounces?
141. Taxi fare in Las Vegas is $3.30 plus $0.35 for every $\frac{1}{7}$ of a mile or fraction thereof. Which graph shows the cost of a Las Vegas taxi ride of $x$ miles?
142. Use the graph.

What is the equation of the function?

(A) \( y = x \)
(B) \( y = |x| \)
(C) \( y = \lfloor x \rfloor \)
(D) \( y = x - 1 \)

For questions 143-144, consider the graph of \( y = 4x^2 - 5x - 4 \).

143. The graph opens up.

(A) True
(B) False

144. The axis of symmetry is at \( x = -\frac{5}{8} \).

(A) True
(B) False
145. What is the vertex of the parabola in the given equation?

\[ y = -3x^2 + 12x - 5 \]

(A) \((-2, -41)\) 

(B) \((2, 7)\) 

(C) \((2, 55)\) 

(D) \((6, -41)\)

146. Where is the axis of symmetry in the quadratic \( f(x) = 3(x - 9)(x + 5) \)?

(A) \(x = 4\) 

(B) \(x = 2\) 

(C) \(x = 6\) 

(D) \(x = -2\)
147. Use the graph below.

Which equation could define the given parabola, where $a$ is a positive real number?

(A) $f(x) = a(x-2)^2 - 3$

(B) $f(x) = a(x+2)^2 - 3$

(C) $f(x) = a(x-2)^2 + 3$

(D) $f(x) = a(x+2)^2 + 3$
In questions 148–150, use the diagram and scenario below.

A cannonball is shot from the top of an ocean cliff as shown. The height (in meters) of the cannonball above the water is given by \( h(t) = -5t^2 + 15t + 8 \), where \( t \) is the number of seconds after the shot.

148. The cannon is 8 meters above the water.
   (A) True  
   (B) False

149. The cannonball reaches its maximum height at 1.5 seconds after it is shot.
   (A) True  
   (B) False

150. The cannonball hits the water 8 seconds after it is shot.
   (A) True  
   (B) False
In questions 151–154, consider a quadratic \( y = f(x) \) that has \( x \)-intercepts at \((r, 0)\) and \((s, 0)\), and a \( y \)-intercept at \((0, c)\).

151. The function \( y = f(x) \) has an axis of symmetry at \( x = \frac{r + s}{2} \).

   (A) True
   (B) False

152. The function \( y = f(x + 2) \) has \( x \)-intercepts at \((r + 2, 0)\) and \((s + 2, 0)\).

   (A) True
   (B) False

153. The function \( y = f(x) - 2 \) has a \( y \)-intercept at \((0, c - 2)\).

   (A) True
   (B) False

154. If \( y = f(x) \) opens upward, then \( y = -f(x) \) opens downward.

   (A) True
   (B) False
155. Look at the graph of the quadratic \( f(x) \) below.

The graph of \( g(x) = 3x^2 + bx - 24 \) has the same \( x \)-intercepts.

What is the value of \( b \)?

(A) \(-6\)

(B) \(-2\)

(C) 1

(D) 14
156. The table below is of the quadratic \( f(x) \).

<table>
<thead>
<tr>
<th>( x )</th>
<th>-3</th>
<th>-2</th>
<th>-1</th>
<th>0</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>( f(x) )</td>
<td>0</td>
<td>-9</td>
<td>-12</td>
<td>-9</td>
<td>0</td>
<td>15</td>
</tr>
</tbody>
</table>

A second quadratic is defined as \( g(x) = x^2 - 6x - 5 \).

Which is true about the two functions’ minimum values?

(A) \( f(x) \) has a smaller minimum value.

(B) \( g(x) \) has a smaller minimum value.

(C) The minimum values of \( f(x) \) and \( g(x) \) are equal.

(D) Which function has the smaller minimum cannot be determined from the information given.

157. A company produces toy trains. The cost \( C \) of producing \( t \) trains is given by the equation \( C = 300 + 15t \). Which shows the number of trains that can be produced for a given cost?

(A) \( t = -300 + 15C \)

(B) \( t = 300 - 15C \)

(C) \( t = -300 + \frac{1}{15}C \)

(D) \( t = -20 + \frac{1}{15}C \)
158. A function \( f(x) \) takes values of \( x \) and applies the following:

- Step 1) divide \( x \) by 5
- Step 2) subtract 3 from the result in Step 1

Which of these describes the inverse function of \( f(x) \)?

(A) Step 1) multiply \( x \) by 5  
   Step 2) add 3 to the result in Step 1

(B) Step 1) subtract 3 from \( x \)  
   Step 2) divide the result in Step 1 by 5

(C) Step 1) add 3 to \( x \)  
   Step 2) multiply the result in Step 1 by 5

(D) Step 1) divide \( x \) by \( \frac{1}{5} \)  
   Step 2) subtract –3 from the result in Step 1

159. The function \( f(x) = x^2 - 2x - 3 \) does not have an inverse unless the domain is restricted. Which restricted domain will allow \( f(x) \) to have an inverse?

(A) \( x \geq -4 \)  
(B) \( x \geq -1 \)  
(C) \( x \geq 0 \)  
(D) \( x \geq 1 \)
160. Which of the functions shown does not have an inverse function?

(A)

(B)

(C)
For questions 161–162, use the graph below.

161. There are values of $x < 0$ where $2^x > 2x^2 + 5$.
   
   (A) True
   (B) False

162. There are values of $x > 7$ where $2x^2 + 5 > 2^x$.
   
   (A) True
   (B) False
163. The graph below shows a function.

Which model best describes the graph?

(A) absolute value
(B) exponential
(C) linear
(D) quadratic
164. Three scatterplots are shown below.

Three functions are defined.

\[ f(x) = 2x + 1 \quad g(x) = 2^x + 1 \quad h(x) = x^2 + 1 \]

Match the functions to scatterplots as models for them.

(A) Plot I: \( f(x) \) \quad Plot II: \( g(x) \) \quad Plot III: \( h(x) \)

(B) Plot I: \( f(x) \) \quad Plot II: \( h(x) \) \quad Plot III: \( g(x) \)

(C) Plot I: \( f(x) \) \quad Plots II and III cannot be determined from the information given

(D) Plots I, II, and III cannot be determined from the information given

165. The graph of \( y = x^2 - 4 \) intersects a line at \( (p, 0) \) and \( (t, 5) \). What is the greatest possible value of the slope? Explain your reasoning.

166. The surface area of a hemisphere with radius \( r \) is given by \( A_H = 2\pi r^2 \).

The lateral surface area of a cylinder with radius \( r \) and height \( h \) is given by \( A_L = 2\pi rh \).

A “capsule” is composed of two hemispheres attached to a cylinder with a common radius. In this capsule, the height of the cylinder is 7 times its radius.

(a) Create a function \( C(r) \) that describes the surface area of the capsule.

(b) What is the radius of a capsule with a surface area of 2.3 cm\(^2\)?
167. Use the function \( f(x) = -2x^2 - 2x + 1 \).

Show all work.

(a) Identify the intercepts.
(b) Identify the axis of symmetry.
(c) Determine the coordinates of the vertex.
(d) Sketch the graph.
(e) State the domain and range.

168. An online retailer charges shipping based on the following table.

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<td>etc. etc.</td>
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(a) Write an equation that describes shipping as a function of weight.
(b) Sketch the function.

169. Answer each part.

(a) Factor completely: \( 2x^2 + 4x - 16 \)
(b) Solve: \( 2x^2 + 4x - 16 = 0 \)
(c) Graph \( f(x) = 2x^2 + 4x - 16 \), and label key points and the axis of symmetry.
(d) Solve the system \( y = f(x) \) and \( y = -2x - 8 \).

170. Given \( f(x) = x^2 - 2x + 9 \).

(a) Complete the square for \( f(x) \).
(b) Using the quadratic formula, explain why the graph of \( y = f(x) \) has no \( x \)-intercepts.
171. Use the graph below.

(a) What is the equation of the function shown?
(b) Find the $x$-intercepts of the function.
(c) What is the average rate of change of the function between the two points identified on the graph?
### Selected Response Key

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31. This question assesses the student’s ability to create graphical representations of univariate and bivariate data and describe their characteristics; compare characteristics of multiple data sets; compute measures of center and spread; and describe the effect of extreme values on statistical measures.

(b) July’s distribution is skewed right. December’s distribution is symmetric. (Students may choose to make the histogram using bin widths of 0.5 inches or 1.0 inches.)

(c) Since the distribution of July rainfall is skewed right, the mean will be greater than the median.

(d) The median rainfall for December is 5.15 inches. The median rainfall for July is between 0.5 inches and 1.0 inch. The median rainfall for December is at least 4 inches greater than July.

(e) 1) Compute the mean rainfall for the 20 observations.
   2) Subtract the mean from each of the 20 observations.
   3) Square those values.
   4) Add up those squares.
   5) Divide by 19.
   6) Take the square root of that value. The standard deviation will have units of inches.

(f) December’s rainfall has the larger standard deviation because its distribution has a much wider spread than July’s.

(g) The median is between 0.5 and 1.0 inches. Changing 2.4 to 1.4 will not affect the median because the value will remain greater than the median. Changing 2.4 to 1.4 will decrease the mean by $\frac{1.0}{20} = 0.05$ inches.
constructed response solutions

31. continued

(h)

(i) There is no relationship between rainfall and year. That is, the rainfall amounts over time seem to vary randomly with no trend of increase or decrease.

32. This question assesses the student’s ability create graphical representations of univariate data and compare by a second variable.

(a) The display could be dotplots on the same scale, histograms on the same scale, parallel boxplots, or a back-to-back stemplot.

(b) The distribution of the amount spent by females is right skewed with two outliers at $85 and $100, centered at $25, with an interquartile range of $22.50; The males’ distribution is symmetric, centered at $15, with an interquartile range of $10.

Females spend more, on average, than males by $10 per haircut. The variability of the amounts females spend is more than double that of males ($22.50 to $10).
**Constructed Response Solutions**

33. This question assesses the student’s ability to interpret two-way tables of categorical data and look for relationships between the variables.

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<th>Sophomores</th>
<th>Juniors</th>
<th>Total</th>
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<tr>
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(a) \( \frac{126}{245} \approx 51\% \)

(b) Freshmen: \( \frac{56}{80} = 70\% \)  **Highest favorability**  
Sophomores: \( \frac{38}{75} \approx 51\% \)  
Juniors: \( \frac{32}{90} \approx 36\% \)  **Lowest favorability**

(c) There is a relationship. The older the student, the less chance he favors the change in dress code.

45. This question assesses the student’s understanding of the properties of real number system and its subsets, specifically rational and irrational numbers.

(a) An irrational number is a real number that cannot be expressed as the ratio of two integers.

(b) We know 2 is rational and \( \sqrt{3} \) is irrational. Assume \( 2 + \sqrt{3} = n \), where \( n \) is a rational number. Then \( \sqrt{3} = n - 2 \). Since \( n \) and 2 are both rational, and the rational numbers are closed under subtraction, \( n - 2 \) is also rational. That means \( \sqrt{3} \) is rational. But that contradicts what was given, that \( \sqrt{3} \) is irrational. Thus, \( 2 + \sqrt{3} \) must be irrational.

46. This question assesses the student’s understanding of the properties of real number system and its subsets, specifically rational and irrational numbers.

(a) \( \frac{1}{2} + \frac{1}{4} = \frac{3}{4} \). Both addends are ratios of integers, as is the sum.

(b) \( 2 \times \sqrt{3} = \frac{2}{1} \times \sqrt{3} = \sqrt{12} \). Radicals are rational if they are perfect squares. Only one factor is rational; the product is irrational.

(c) \( \sqrt{2} \times \sqrt{8} = \sqrt{16} = 4 \). Both factors are irrational, but the product is rational.
Constructed Response Solutions

47. This question assesses the student’s understanding of the properties of real number system and its subsets, specifically rational and irrational numbers.

(a) \( \sqrt{24} = \sqrt{4 \times 6} = 2 \times \sqrt{6} \)

(b) \( \sqrt{2 \times \sqrt{8}} = \sqrt{16} = 4 \)

(c) Let \( a \) be a rational number and \( b \) be an irrational number. Assume \( a + b \), where \( n \) is a rational number. Then \( b = n - a \).
Since \( n \) and \( a \) are both rational, and the rational numbers are closed under subtraction, \( n - a \) is also rational. That means \( b \) is rational. But that contradicts what was given, that \( b \) is irrational. Thus, \( a + b \) must be irrational.

104. This question assesses the student’s ability to construct algebraic expressions for sequences from physical patterns and show algebraic expressions are equivalent.

(a) Mark is correct because each figure is a square of \( n \times n \) dots plus one additional dot, or \( n^2 + 1 \).

\[
\begin{array}{cccc}
1 & 2 & 3 & 4 \\
\cdot & \cdot & \cdot & \cdot \\
\cdot & \cdot & \cdot & \cdot \\
\cdot & \cdot & \cdot & \cdot \\
\end{array}
\]

\[
\begin{array}{cccc}
1 & 2 & 3 & 4 \\
\cdot & \cdot & \cdot & \cdot \\
\cdot & \cdot & \cdot & \cdot \\
\cdot & \cdot & \cdot & \cdot \\
\end{array}
\]

Sofia is correct because each figure is a rectangle of \( n \times (n + 1) \) minus a rectangle of \( 1 \times (n - 1) \), or \( n(n+1)-(n-1) \).

\[
\begin{array}{cccc}
1 & 2 & 3 & 4 \\
\cdot & \cdot & \cdot & \cdot \\
\cdot & \cdot & \cdot & \cdot \\
\cdot & \cdot & \cdot & \cdot \\
\end{array}
\]

\[
\begin{array}{cccc}
1 & 2 & 3 & 4 \\
\cdot & \cdot & \cdot & \cdot \\
\cdot & \cdot & \cdot & \cdot \\
\cdot & \cdot & \cdot & \cdot \\
\end{array}
\]

(b) Using Sofia’s expression,
\[
n(n+1)-(n-1) = n^2 + n - n + 1 = n^2 + 1
\]
which is Mark’s expression.
105. This question assesses the student’s understanding of quadratic equations and the number of solutions they may have under certain circumstances.

If the quadratic has a factor of \(2x - 3\), then it has a zero at \(x = \frac{3}{2}\).

It is NOT possible for the quadratic to have no real zeros since we know it already has one.

To have only one real zero, the other factor must be the same, so the expression is \((2x - 3)^2\).

To have two real zeros, the other factor can be any linear expression, for example \((2x - 3)(x + 2)\).

106. This question assesses the student’s understanding that polynomials are similar to systems of numbers.

(a) A polynomial is a monomial or sum of monomials. A monomial is a number, a variable, or the product of a number and one or more variables raised to whole number powers.

(b) \((x^2 + 3) + (2x + 4) = x^2 + 2x + 7\)

(c) The product of two polynomials is the sum of all products of all monomials between the two polynomials. The coefficients of the monomials are real numbers, and since multiplication is closed for real numbers, any coefficients must also be real numbers. Since variables in monomials must be whole number powers, which are closed under addition, and when multiplying monomials the resulting exponents are the sums of the exponents in the factors, the product must have whole number powers. When like terms are added, since real numbers are closed under addition, the resulting coefficients must also be real numbers. Hence, all terms in the resulting expression meet the definition of a monomial, and the sum of them is therefore a polynomial.

107. This question assesses the student’s ability to do arithmetic with polynomials.

\[2(1.2x + 0.3)(x - 0.5) + (0.5x^2 + 2.5x - 1.3)\]
\[= 2(1.2x^2 - 0.6x + 0.3x - 0.15) + (0.5x^2 + 2.5x - 1.3)\]
\[= 2(1.2x^2 - 0.3x - 0.15) + (0.5x^2 + 2.5x - 1.3)\]
\[= 2.4x^2 - 0.6x - 0.3 + 0.5x^2 + 2.5x - 1.3\]
\[= 2.9x^2 + 1.9x - 2.6\]
so \(a = 2.9, b = 1.9,\) and \(c = -2.6\)

108. This question assesses the student’s ability to do arithmetic with polynomials.

(a) \(f(x) \cdot g(x) = (2x - 3) \cdot \left(\frac{x}{3} + 2\right) = \frac{2}{3}x^2 + 3x - 6\)

(b) \(f(x) + h(x) = (2x - 3) + (3x^2 - x - 4) = 3x^2 + x - 7\)

(c) \(f(x) - g(x) = (2x - 3) - \left(\frac{x}{3} + 2\right) = \frac{5x}{3} - 5\)
109. This question assesses the student’s ability to find equivalent forms of expressions.

\[ f(x) = a(x - h)^2 + k \]
\[ = a(x^2 - 2hx + h^2) + k \]
\[ = ax^2 - 2ahx + ah^2 + k \]
\[ = ax^2 + (-2ah)x + (ah^2 + k) \]
\[ = ax^2 + bx + c \]

So, \( b = -2ah, c = ah^2 + k \)

110. This question assesses the student’s ability to use polynomial arithmetic and solve equations in applied situation.

(a) Given that \( b = 2h \) and \( A = 25 \)
\[ A = \frac{1}{2}bh \]
\[ 25 = \frac{1}{2}(2h)h \]
\[ 25 = h^2 \]
\[ \pm 5 = h \]

The negative value is extraneous here, so the base has length 10 m and the height is 5 m.

(b) Any similar triangle has a base twice the length of the height, so
\[ A = \frac{1}{2}bh \]
\[ A = \frac{1}{2}(2h)h \]
\[ A = h^2 \]

The area can be any positive number (in square feet) that is a perfect square, since \( h \) is an integer. For example, if \( h = 4 \) feet, then \( A = 16 \) square feet.
111. This question assesses the student’s ability to use polynomial arithmetic and solve equations in applied situation.

Graphing \( d = \frac{3(s^2 + 10s)}{40} \) and \( d = 150 \):

When \( d = 150 \) feet, \( s = 40 \) mph. Distances less than 150 feet correspond to speeds less than 40 mph. So, the fastest speed a car can be moving so braking distance does not exceed 150 feet is 40 miles per hour.

112. This question assesses the student’s ability to use solve a quadratic equation.

\[
\begin{align*}
    x^2 - 10x + 25 &= 81 \\
    (x - 5)^2 &= 81 \\
    x - 5 &= \pm 9 \\
    x &= 5 + 9 \text{ or } x = 5 - 9 \\
    x &= 14 \text{ or } x = -4
\end{align*}
\]

113. This question assesses the student’s ability to use solve a quadratic equation.

\[
\begin{align*}
    x^2 - 8 &= 0 \\
    x^2 &= 8 \\
    x &= \pm \sqrt{8} \\
    \text{(a) } x &= \pm \sqrt{8} \\
    \text{or} \\
    x &= \pm 2\sqrt{2} \\

    (x - 2)^2 - 4 &= 0 \\
    (x - 2)^2 &= 4 \\
    x &= 2 \pm 2 \\
    \text{(b) } x &= 2 \pm 2 \\

    3(x + 6)^2 &= 15 \\
    (x + 6)^2 &= 5 \\
    x &= -6 \pm \sqrt{5} \\
    \text{(c) } x &= -6 \pm \sqrt{5}
\end{align*}
\]
114. This question assesses the student’s ability to create equations, apply polynomial arithmetic, solve quadratic equations, and use units in applied situations.

(a) Perimeter = \(x + 2x + 3 + x + 3 + 2x = 6x + 3\) feet.

(b) Area = \((2x)(x) + (3)(x) = 2x^2 + 3x\) square feet.

(c) The volume of sand is 40 cubic feet. The sand is 3 inches deep which is \(\frac{1}{4}\) of a foot. So, the volume of the pit is

\[
\frac{1}{4}(2x^2 + 3x) = 40
\]

\[2x^2 + 3x = 160\]

\[2x^2 + 3x - 160 = 0\]

\[x = \frac{-3 \pm \sqrt{3^2 - 4(2)(-160)}}{2(2)}\]

\[x = \frac{-3 \pm \sqrt{1289}}{4}\]

\[x \approx 8.22\]

A graphical solution is also shown.

(d) The dimensions of the pit are about 8.22 feet by 19.45 feet.

The fence will be on the perimeter, so \(6(8.22) + 3 \approx 52.35\) feet are needed.

115. This question assesses the student’s understanding of the concept of a function.

A function is a relation where for each element of the domain, there is only one element in the range. In \(y = x^2\), when \(x = -2\), \(y = 4\). There is only one value of \(y\) for that value of \(x\). When \(x = 2\), \(y = 4\), and again there is only one value of \(y\) for that value of \(x\). To be a function, it is NOT the case that for any value of \(y\) there must be only one \(x\).
116. This question assesses the student’s ability to create quadratic functions and use them in applied situations, and use units to make sense of problems.

(a) Let $S$ equal the number of bushels the farmer can grow at a rate of 10000 bushels/km$^2$. So, on a $x \times x$ km plot a farmer can grow $S = 10000x^2$ bushels.

(b) Let $E$ equal the earnings made at $p$ dollars/bushel. 

$$E = S \cdot p = \left(10000x^2 \text{ bushels} \right) \left( p \frac{\text{dollars}}{\text{bushel}} \right) = 10000px^2 \text{ dollars}.$$  

$$E = 960000 \text{ dollars} = \left( 10000 \text{ bushels/km}^2 \right) \left( 15 \frac{\text{dollars}}{\text{bushel}} \right) x^2$$

(c) $6.4 \text{ km}^2 = x^2$

$$x = \sqrt{6.4} \text{ km}$$

$$x \approx 2.5 \text{ km}$$

So the field is 2.5 km square.

117. This question assesses the student’s ability to define and sketch quadratic functions with certain characteristics.

Answers will vary.

(a) $f$ should be of the form, or equivalent to, $f(x) = a(x - 2)^2 + k$ where $a > 0$ and $k > 0$.

(b) $g$ should be of the form, or equivalent to, $g(x) = ax^2 + bx + 3$ where $a < 0$.

(c) $h$ should be of the form, or equivalent to, $h(x) = a(x + 2)(x - r)$ where $a(r + 2)^2 = 24$.
165. This question assesses the student’s ability to find solutions to quadratic functions and slopes of linear functions in the context of a system of a quadratic and a linear function.

The quadratic \( y = x^2 - 4 \) goes through \((p, 0)\), so \( 0 = p^2 - 4 \), thus \( p = \pm 2 \).

The quadratic \( y = x^2 - 4 \) goes through \((t, 5)\), so \( 5 = t^2 - 4 \), thus \( t = \pm 3 \).

Of the four lines that can go through \((p, 0)\) and \((t, 5)\), the one with the greatest slope will go through \((2, 0)\) and \((3, 5)\) and has a slope of 5.

166. This question assesses the student’s ability to find solutions to quadratic functions and slopes of linear functions in the context of a system of a quadratic and a linear function.

(a) We are told the height of the cylinder is 7 times its radius, so the lateral surface can be written as \( A_L = 2\pi r(7r) = 14\pi r^2 \).

The surface area of the capsule is the cylinder’s lateral area plus the surface area of two hemispheres.

\[
C(r) = 7\pi r^2 + 2\left(2\pi r^2\right) = 11\pi r^2 .
\]

\[
11\pi r^2 = 2.3 \text{ cm}^2
\]

\[
r^2 = \frac{2.3 \text{ cm}^2}{11\pi}
\]

(b)

\[
r = \pm \sqrt{\frac{2.3 \text{ cm}^2}{11\pi}}
\]

\[
r \approx 0.2579... \text{ cm}
\]

To two significant figures, \( r \approx 0.26 \text{ cm} \).
167. This question assesses the student’s ability to find solutions to graph quadratic functions and describe characteristics of the function.

(a) There is a $y$-intercept when $x = 0$; $y = -2(0)^2 - 2(0) + 1 = 1$. The $y$-intercept is at (0, 1).

$$0 = -2x^2 - 2x + 1$$

$$x = \frac{2 \pm \sqrt{(-2)^2 - 4(-2)(1)}}{2(-2)}$$

The $x$-intercepts occur when $y = 0$; $x = \frac{2 \pm \sqrt{12}}{4}$.

$$x = \frac{2 \pm \sqrt{3}}{2}$$

Since the $x$-intercepts at $\left(-\frac{1}{2} + \frac{\sqrt{3}}{2}, 0\right)$ and $\left(-\frac{1}{2} - \frac{\sqrt{3}}{2}, 0\right)$ or approximately (0.37, 0) and (–1.37, 0).

(b) The axis of symmetry is at $x = \frac{b}{2a} = -\frac{-2}{2(-2)} = -\frac{1}{2}$.

(c) The $x$-coordinate of the vertex is at $x = \frac{b}{2a} = -\frac{-2}{2(-2)} = -\frac{1}{2}$. The $y$-coordinate is

$$y = -2\left(-\frac{1}{2}\right)^2 - 2\left(-\frac{1}{2}\right) + 1 = -\frac{1}{2} + 1 + 1 = \frac{3}{2}.$$ The vertex is at $\left(-\frac{1}{2}, \frac{3}{2}\right)$.

(d) $y$

(e) The domain is all real numbers, the range is $f(x) \leq \frac{3}{2}$.
168. This question assesses the student’s ability to find solutions to graph quadratic functions and describe characteristics of the function.

(a) \[ \text{charges} = \$2.50 + \frac{\$0.50 \text{weight}}{\text{pound}} \]

(b)

169. This question assesses the student’s ability to factor, solve, and graph a quadratic function; and solve a system of a quadratic and a linear function.

(a) \[ 2x^2 + 4x - 16 = 2(x + 4)(x - 2) \]

\[ 2x^2 + 4x - 24 = 0 \]

(b) \[ 2(x + 4)(x - 2) = 0 \]

\[ x = -4 \text{ or } x = 2 \]

(c) The key points are the x-intercepts at \((-4, 0)\) and \((2, 0)\), the y-intercept at \((0, -16)\), and the vertex at \((-1, -18)\).

(d) \[ -2x - 8 = 2x^2 + 4x - 16 \]

\[ 0 = 2x^2 + 6x - 8 \]

\[ 0 = 2(x + 4)(x - 1) \]

\[ x = 1 \text{ and } x = -4 \]

The solution to the system is \((1, -10)\) and \((-4, 0)\).
**Constructed Response Solutions**

170. This question assesses the student’s ability to complete the square and apply the quadratic formula to a quadratic function.

\[ f(x) = x^2 - 2x + 9 \]

(a) \[ (x^2 - 2x + 1) + 9 + 1 \]

\[ = (x + 1)^2 + 10 \]

\[ x = \frac{2 \pm \sqrt{(-2)^2 - 4(1)(9)}}{2(1)} \]

(b) \[ 2 \pm \sqrt{-34} \]

Because the discriminant is negative, there are no real zeros for this quadratic.

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171. This question assesses the student’s ability to derive the equation of a quadratic from a graph, find its zeros, and compute the rate of change between two points.

(a) The vertex of the quadratic is at \((1, 5)\), so the equation is of the form \( y = a(x - 1)^2 + 5 \). The \(y\)-intercept at \((0, 4)\) is a solution, so \(-1 = a(1)^2 \). Thus, the equation of the parabola is \( y = -(x - 1)^2 + 5 \).

\[-1 = a \]

\[-(x - 1)^2 + 5 = 0 \]

(b) Its \(x\)-intercepts are where \((x - 1)^2 = 5\).

\[ x - 1 = \pm\sqrt{5} \]

\[ x = 1 \pm \sqrt{5} \]

(c) The average rate of change of the function between \((0, 4)\) and \((1, 5)\) is \( \frac{5 - 4}{1 - 0} = 1 \).
Notes on Practice Materials

The Algebra I Practice Materials are provided to help teachers and students prepare for the CCSD Semester Exams in Algebra I.

The questions are representative of the style, format, and type that will be on the exams. They are not, however, completely parallel in construction. That is, practice questions on a particular standard show how that standard may be assessed, but the questions on the actual exam could assess that standard in a different way. Teachers must provide students with opportunities to explore all aspects of a standard, and not simply focus on those addressed by the practice materials.

There are 3 types of questions in the practice materials that will appear on the semester exams.

- MC – Multiple Choice. This is a traditional selected-response type of question. Each item will have 3 or 4 possible responses. Some multiple choice questions may have a common lead-in statement and should remain grouped together when provided for practice.

- MTF – Multiple True/False. These items will have 2–4 true/false questions based on a common lead-in statement or concept. These should remain grouped together when provided for practice.

- CR – Constructed response. These items may have multiple parts that address one or more standards. The DOK level is the overall level of the item, though some parts may be at lower levels. Short CR items average about 6–8 minutes to complete; longer CR items average 10–15 minutes to complete.

A fourth type of question is the Extended Response (ER). These will not appear on the semester exam at this time, but are indicative of longer, performance-type tasks that will appear on the Smarter Balanced Assessments beginning in 2013–2014.

Sample solutions are provided for CR and ER questions. Student methods may vary and any logical, mathematically correct approach should be accepted as correct.