Student Journal Answers

Chapter 1

Chapter 1 Maintaining Mathematical Proficiency

1. -4 **2.** -12

3. 7 **4.** -11

5. *Sample answer:* -2 and -4, -8 and 2

6. 60°F **7.** -26

8. 40 **9.** -7

10. 10

11. *Sample answer:* -5 and 4, 10 and -2

12. -9

1.1 Explorations

1. a. 110; 90; 92; 68; 360°

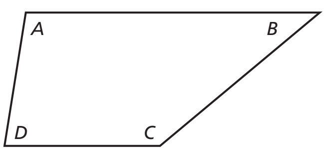
b. 65; 147; 58; 90; 360°

c. 91; 79; 75; 115; 360°

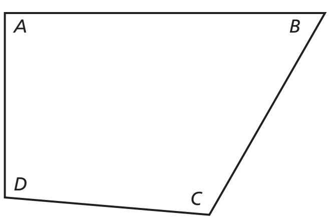
Answers will vary.

2. equals 360°

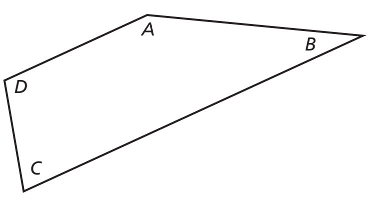
Sample answer:



$100 + 40 + 140 + 80 = 360$



$90 + 60 + 115 + 95 = 360$



$150 + 30 + 75 + 105 = 360$

Divide the quadrilateral into two triangles.

The sum of the angle measures of a triangle is 180°, so the sum of the angle measures of a quadrilateral is 2(180°) = 360°.

3. a. $85 + 100 + x + 80 = 360$; $x = 95$

b. $x + 78 + 60 + 72 = 360$; $x = 150$

c. $90 + 30 + 90 + x = 360$; $x = 150$

4. Simple equations can relate parts of geometric shapes and can be used to find missing parts.

5. The corners can be arranged so the angles complete a full circle, which is 360°.

1.1 Extra Practice

1. $w = 12$; Subtract 4 from each side.

2. $x = -19$; Subtract 7 from each side.

3. $w = 21$; Add 15 to each side.

4. $z = 13$; Add 5 to each side.

5. $y = 7$; Add 9 to each side.

6. $q = 5$; Divide each side by 7.

7. $b = -13$; Divide each side by 4.

8. $q = 33$; Multiply each side by 11.

9. $n = 30$; Multiply each side by -2.

10. $p - 17.95 = 71.80$; \$89.75

11. 40

1.2 Explorations

1. a. $(30 + x) + 9x + 30 = 180$; Write the equation.

$10x + 60 = 180$; Combine like terms.

$10x = 120$; Subtract 60 from each side.

$x = 12$; Divide each side by 10.

42°, 108°, 30°

b. $(x + 10) + (x + 20) + 50 = 180$; Write the equation.

$2x + 80 = 180$; Combine like terms.

$2x = 100$; Subtract 80 from each side.

$x = 50$; Divide each side by 2.

60°, 70°, 50°

c. $50 + (2x + 30) + (2x + 20) + x = 360$; Write the equation.

$5x + 100 = 360$; Combine like terms.

$5x = 260$; Subtract 100 from each side.

$x = 52$; Divide each side by 5.

50°, 134°, 124°, 52°

d. $(x - 17) + x + (x + 42) + (x + 35) = 360$; Write the equation.

$4x + 60 = 360$; Combine like terms.

$4x = 300$; Subtract 60 from each side.

$x = 75$; Divide each side by 4.

58°, 75°, 117°, 110°

e. $(5x + 2) + (3x + 5) + (8x + 8) + (4x + 15) + (5x + 10) = 540$; Write the equation.

$25x + 40 = 540$; Combine like terms.

$25x = 500$; Subtract 40 from each side.

$x = 20$; Divide each side by 25.

102°, 65°, 168°, 95°, 110°

f. $(3x + 16) + (3x + 16) + (2x + 8) + (4x - 18) + (2x + 25) + (3x - 7) = 720$; Write the equation.

$17x + 40 = 720$; Combine like terms.

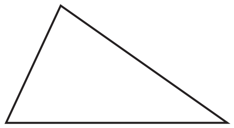
$17x = 680$; Subtract 40 from each side.

$x = 40$; Divide each side by 17.

136°, 136°, 88°, 142°, 105°, 113°

Measure the angles with a protractor.

2. a. *Sample answer:*



b. *Sample answer:* 80°, 35°, 65°

c. *Sample answer:* $x = 10$; $8x$, $3x + 5$, $6x + 5$

d. Check students' work.

e. *Sample answer:* $(16x + 4) + (6x + 4) + (23x + 2) + (13x + 2) = 360$, $x = 6$; 100°, 40°, 140°, 80°; yes; The angles are close to those measured with a protractor.

3. Use multi-step equations to find the values of missing parts in an object with the shape of a geometric figure.

4. Connecting a vertex with each of the other vertices in a polygon creates $n - 2$ triangles, each of which has a total angle measure of 180°.

5. 8; Solve the equation $180(n - 2) = 1080$ for n.

1.2 Extra Practice

1. $x = 5$
2. $z = 2$
3. $z = 8$
4. $d = -9$
5. $f = -16$
6. $q = 29$
7. $x = 3.5$
8. $z = -1$
9. $x = 2.5$
10. $z = 0$
11. $z = 0$
12. $z = 1.5$
13. $r = 4$
14. $g = -3$
15. $(2n + 1) + (2n + 3) + (2n + 5) = 63$, $n = 9$; 19, 21, 23
16. 76°; 38°
17. 19; 11

1.3 Explorations

1. $2x + 14 = 3x + 10$; $x = 4$; Add the side lengths of each figure to get the perimeters and set them equal to each other; $P = 22$

2. a. $x + 18 = 4x + \frac{3}{2}x$; $x = 4$; Add the side lengths to get the perimeter. Add the area of the triangle to the area of the rectangle to get the total area. Then set the perimeter equal to the area; $P = 22$ ft, $A = 22$ ft^2

b. $2x + 14 = 6x - 2$; $x = 4$; Add the side lengths to get the perimeter. Subtract the area of the small rectangle from the area of the large rectangle to get the total area. Then set the perimeter equal to the area; $P = 22$ ft, $A = 22$ ft^2

c. $2\pi + 2x + 4 = 2\pi + 4x$; $x = 2$; Add the circumference of the semicircle to the remaining 3 side lengths to find the perimeter. Add the area of the semicircle to the area of the rectangle to find the total area. Then set the perimeter equal to the area; $P = 2\pi + 8$ ft, $A = 2\pi + 8$ ft^2

3. Collect the variable terms on one side of the equation and the constant terms on the other side of the equation, then solve.

4. *Sample answer:* $5x - 7 = 2x + 5$, $x = 4$; $-x + 3 = 4x + 13$, $x = -2$; $7x = 6x + 4$, $x = 4$

1.3 Extra Practice

1. $x = -4$
2. $z = -1$
3. $k = 4$
4. $x = 1$
5. $q = -4$
6. $x = 2$
7. $a = 3$
8. $b = 4$
9. $r = 5$
10. $x = 6$
11. no solution
12. infinitely many solutions
13. $n = 0$; one solution
14. $j = 1$; one solution
15. $36x = 2(6x + 6x + 36)$, 6

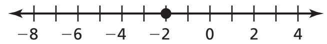
1.4 Explorations

1. a. The equation is true if the expression inside the absolute value symbol is 3 or -3; $x + 2 = 3$; $x + 2 = -3$

b. $x = 1$, $x = -5$

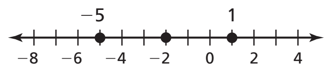
c. Set the expression inside the absolute value symbol equal to both the positive and negative of the constant value, then solve both equations.

2. a.



$x = -2$

b.



$x = 1$ and $x = -5$; They are the solutions of the equation.

c. Set the expression inside the absolute value symbol equal to 0 and solve. Plot the solution on a number line. Then plot the points that are the constant amount of units from that point. These last 2 points are the solutions to the original equation.

3. a. $x = 1$, $x = -5$

b. They are the same.

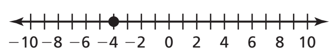
c. Have the spreadsheet calculate the value of the absolute value expression for many values of x, and find the ones that give the expected solution.

4. solving algebraic equations, graphically on a number line, or by trial and error with a spreadsheet

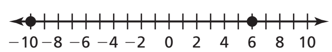
5. *Sample answer:* The algebraic method is favorable because it is the quickest method. The graphical method is also favorable because it helps to visualize absolute value. The numerical method is not favorable because setting up the spreadsheet is time consuming.

1.4 Extra Practice

1. $x = -4$

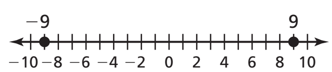


2. $y = 6$, $y = -10$

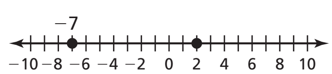


3. no solution

4. $d = -9$, $d = 9$



5. $x = -7$, $x = 2$



6. $x = -\frac{2}{3}$, $x = 1$
7. $p = -1$
8. $q = -5$, $q = -\frac{4}{3}$
9. $x = -\frac{1}{2}$

1.5 Explorations

1. a. $A = bh$

b. $30 = b \cdot 5$; Write the equation.

$6 = b$; Divide each side by 5.

c. $A = bh$; Write the formula.

$\frac{A}{h} = b$; Divide each side by h.

d. applied the same steps to solve; used variables instead of constants

2. a. $A = \frac{1}{2}h(b_1 + b_2)$; $h = \frac{2A}{b_1 + b_2}$; $h = 7$ cm

b. $C = 2\pi r$; $r = \frac{C}{2\pi}$; $r = 12$ ft

c. $V = Bh$; $h = \frac{V}{B}$; $h = 5$ yd

d. $V = \frac{1}{3}Bh$; $h = \frac{3V}{B}$; $h = 6$ m

3. Solve the formula for a different variable; *Sample answer:* (volume of a cylinder) $V = \pi r^2 h$; $h = \frac{V}{\pi r^2}$

1.5 Extra Practice

1. $y = 2x + 15$ **2.** $y = -4x + 2$

3. $y = x - 2$ **4.** $y = -x + 11$

5. $y = 3x + 4$ **6.** $y = -\frac{3}{4}x + \frac{3}{2}$

7. $x = \frac{1}{6}y$ **8.** $x = \frac{q}{3(1 + 3z)}$

9. $x = \frac{r - 4}{7 - s}$ **10.** $x = \frac{1}{6}y + 1$

11. $x = \frac{r - 4g}{2}$ **12.** $x = \frac{4z - 4}{3}$

13. $b = \frac{2A}{h}$ **14.** $h = \frac{3V}{\pi r^2}$

15. $R = \frac{V}{I}$ **16.** $R = \frac{PV}{nT}$

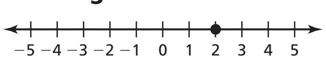
17. a. $r = \frac{A - P}{Pt}$

b. 0.04, or 4%

c. $P = \frac{A}{1 + rt}$

Chapter 2

Maintaining Mathematical Proficiency

1.


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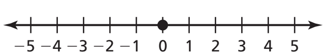

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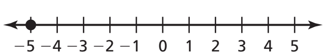

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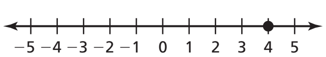


5. > **6.** <

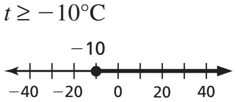
7. > **8.** <

9. = **10.** <

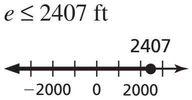
11. $-b$ **12.** $|-b|$

2.1 Explorations

1. a. $t \geq -10$°C



b. $e \leq 2407$ ft



2. a. $x \geq 1$; one and all numbers greater than one

b. $x > 1$; all numbers greater than one

c. $x \leq 1$; one and all numbers less than one

d. $x < 1$; all numbers less than one

3. An inequality can indicate the largest or smallest value for a quantity.

4. a. *Sample answer:* The judge's score is less than 3.5.

b. *Sample answer:* The time in the pool was at most 6 hours.

c. *Sample answer:* The temperature is greater than −2°C.

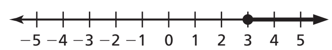
d. *Sample answer:* The profit was at least $10.

2.1 Extra Practice

1. $12 \geq 5n$ **2.** $\frac{1}{3}h < 15$

3. $7 \leq q - 6$ **4.** $u + 14 > 6$

5. no **6.** yes

7.


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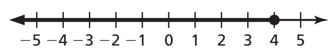

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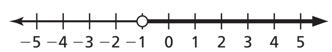

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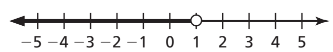


11. $x > 1$ **12.** $x < 0$

13. $x \geq -3$ **14.** $x \leq 3$

2.2 Explorations

1. a. no; It is also possible for the number of touchdowns to equal the number of completed passes.

b. yes; Completed and intercepted passes are both included in attempts.

c. no; It is also possible for the number of intercepted passes to equal the number of attempts.

d. yes; After subtracting completed passes from attempts, all remaining passes could be incomplete.

2. a. *Sample answer:* 25; 5; 100; 0; 10; negative numbers

b. *Sample answer:* 10; 9; 600; 4; 0; numbers greater than or equal to 150

c. *Sample answer:* 10; 7; 300; 2; 1; numbers greater than 170

3. Add or subtract the same number to or from each side of the inequality to create an equivalent inequality.

4. a. $x < 1$

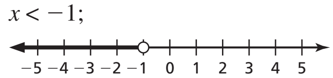
b. $x \geq 8$

c. $x < 6$

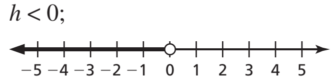
d. $x \geq -3$

2.2 Extra Practice

1. $x < -1$;

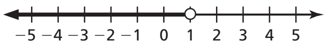


2. $h < 0$;

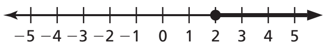


3. $s \geq 1$;

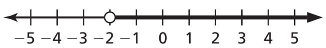
4. $u < 1$;



5. $c \geq 2$;



6. $p > -2$;



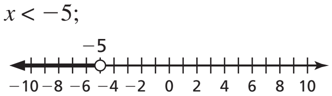
7. **a.** $m + 12.25 \leq 15$
   b. $m \leq 2.75$

2.3 Explorations

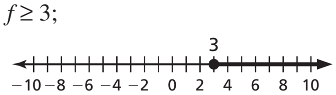
1. **a.** 0; 3; 6; 9; 12; 15; no; no; no; yes; yes; yes; right graph; $x > 2$
   b. **i.** $x < 2$
   ii. $x \leq 1$
   iii. $x < 4$
   iv. $x \leq 2$
   Dividing each side of an inequality by the same positive number produces an equivalent inequality.
2. **a.** 15; 12; 9; 6; 3; 0; -3; yes; yes; yes; no; no; no; no; left graph; $x < -2$
   b. **i.** $x > -2$
   ii. $x \geq -1$
   iii. $x > -4$
   iv. $x \geq -2$
   When dividing each side of an inequality by the same negative number, the direction of the inequality must be reversed to produce an equivalent inequality.
3. Divide each side of the inequality by the same number. If the number is positive, this produces an equivalent inequality. If the number is negative, the inequality must be reversed to be equivalent.
4. **a.** $x < -3$
   b. $x \geq 3$
   c. $x < -2$
   d. $x \geq 0$

2.3 Extra Practice

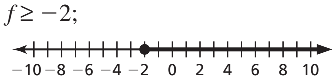
1. $x < -5$;



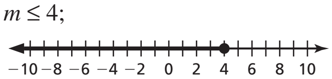
2. $f \geq 3$;



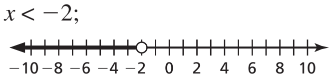
3. $f \geq -2$;



4. $m \leq 4$;

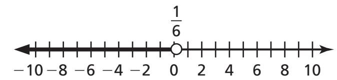


5. $x < -2$;

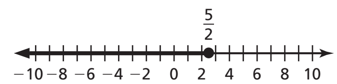


6. $y \leq -4$;

7. $x < \frac{1}{6}$;



8. $x \leq \frac{5}{2}$;



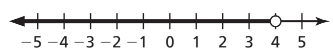
9. $r + \frac{1}{2}r \leq 36$, $r \leq 24$

2.4 Explorations

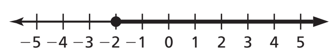
1. **a.** $x \leq 2$; Subtract x and 3 from each side; B
   b. $x < -2$; Subtract x and 3 from each side; Divide each side by -3; A
   c. $3 \geq x$; Divide each side by 9; E
   d. $-2 < x$; Add $6x$ to each side; Divide each side by 8; C
   e. $x > 3$; Add $3x$ and 9 to each side; D
   f. $x \geq -4$; Add $9x$ to each side; Divide each side by -2; F
2. Simplify each side, if possible, then use inverse operations to isolate the variable. Reverse the inequality symbol if multiplying or dividing by a negative number.
3. *Sample answer:* $3x + 4 < 1$, $-2x - 10 > -8$

2.4 Extra Practice

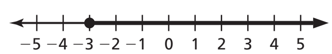
1. $x < 4$;



2. $a \geq -2$;

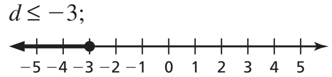


3. $b \geq -3$;



4. $c < 4$;

5. $d \leq -3$;



6. $n > \frac{3}{2}$
7. all real numbers
8. $p \geq 3$
9. no solution
10. no solution
11. $k = -3$
12. $k = -2$

2.5 Explorations

1. **a.** $x \geq -6$ and $x < 3$
   b. $x > -5$ and $x \leq 4$
   c. $x \geq -4$ and $x \leq 5$
   d. $x > -3$ and $x < 6$
   e. and; Both inequalities need to be true for values that are in the interval.
2. **a.** $x \leq -6$ or $x > 3$
   b. $x < -5$ or $x \geq 4$

c. $x \leq -4$ or $x \geq 5$

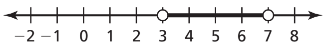
d. $x < -3$ or $x > 6$

e. or; Either inequality needs to be true for values that are in the interval.

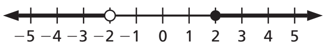
3. Write 2 inequalities joined by "and" or "or."

2.5 Extra Practice

1. $3 < u < 7$;

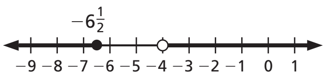


2. $d < -2$ or $d \geq 2$;



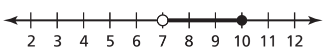
3. $-2.4 \leq s < 4.2$;

4. $c > -4$ or $c \leq -6\frac{1}{2}$;



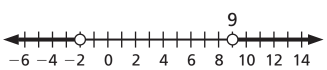
5. $-1.5 \leq c < 5.3$;

6. $7 < x \leq 10$;

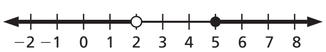


7. $-3 \leq g \leq 2$;

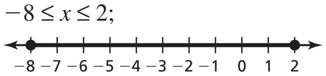
8. $z < -2$ or $z > 9$;



9. $t < 2$ or $t \geq 5$;



10. $-8 \leq x \leq 2$;



11. $20 \leq h \leq 80$

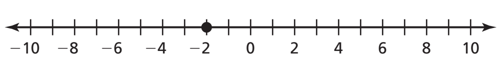
2.6 Explorations

1. a. The inequality is true if the distance between $x + 2$ and 0 is 3 or less; $x + 2 \leq 3$; $x + 2 \geq -3$

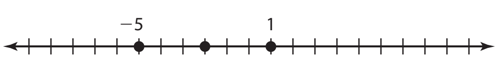
b. $-5 \leq x \leq 1$

c. Write a compound inequality representing the distance between the absolute value expression and 0.

2. a.



b.



They are solutions of the absolute value inequality.

c. Plot the distances to determine the endpoints of the solution.

3. a. $-5 \leq x \leq 1$

b. They are the same.

c. Have the spreadsheet calculate the value of the absolute value expression for many values of x, and find the ones that give the expected solution.

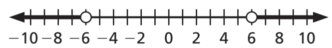
4. Solving algebraic equations, graphically on a number line, or by trial and error with a spreadsheet

5. *Sample answers:* The algebraic method is nice to use because it is the quickest method. The graphical method is nice to use because it helps to visualize absolute value. The numerical method is not favorable because setting up the spreadsheet is time-consuming.

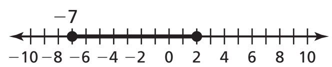
2.6 Extra Practice

1. $-10 < y < 6$;

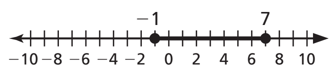
2. $q < -6$ or $q > 6$;



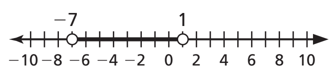
3. $-7 \leq a \leq 2$;



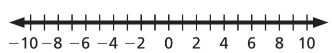
4. $-1 \leq y \leq 7$;



5. $-7 < r < 1$;

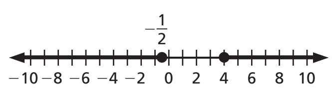


6. all real numbers;

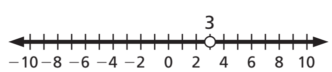


7. no solution

8. $x \leq -\frac{1}{2}$ or $x \geq 4$;



9. $k < 3$ or $k > 3$;

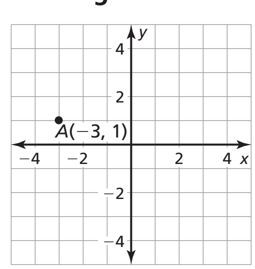


10. $|s - 25{,}000| \leq 1800$, $23{,}200 \leq s \leq 26{,}800$

Chapter 3

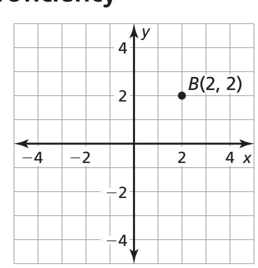
Maintaining Mathematical Proficiency

1.



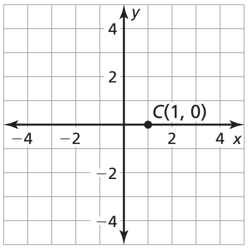
in Quadrant II

2.



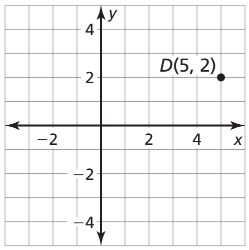
in Quadrant I

3.



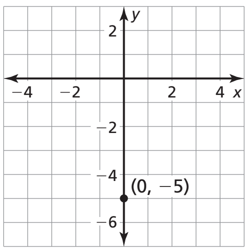
on positive x-axis

4.



in Quadrant I

5.



6. 7

7. 32

8. −17

9. −24

10. 6 ft

3.1 Explorations

1. a. Each x-coordinate is paired with exactly one y-coordinate.

b. *Sample answer:* (0, 8), (1, 6), (2, 4), (3, 2), (4, 0);

Input, *x*	0	1	2	3	4
Output, *y*	8	6	4	2	0

2. a. function; Each input value is paired with exactly one output value.

b. not a function; The input value of 8 is paired with more than one output value.

c. not a function; The input value of 3 is paired with more than one output value.

d. not a function; The input values of 5 and 7 are each paired with more than one output value.

e. function; Each input value is paired with exactly one output value.

f. not a function; The input value of −1 is paired with more than one output value.

g. function; Each input frequency is paired with exactly one output radio station.

h. not a function; Each input television station is paired with more than one output channel.

i. not a function; The input value of 2 is paired with every possible output value of y.

j. function; Each input value of x is paired with exactly one output value of y.

3. a relation that pairs each input with exactly one output

a. *Sample answer:* (0, 10), (1, 20), (2, 30); $y = -5x$

b. *Sample answer:* (0, 10), (0, 20), (0, 30); $x = -5$

3.1 Extra Practice

1. not a function; The input −2 has two outputs, 4 and 5.

2. function; Every input has exactly one output.

3. not a function; A vertical line can be drawn through (2, 2) and (2, 3).

4. function; No vertical line can be drawn through more than one point on the graph.

5. domain: 0, 1, 2, 3, 4, 5; range: 3, 4

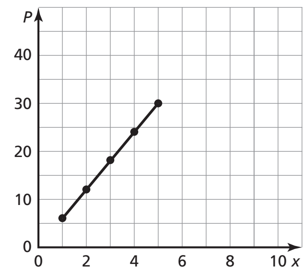
6. domain: $-3 \le x \le 3$; range: $0 \le y \le 3$

7. a. y is the dependent variable and x is the independent variable.

b. 12, 24, 36, 48

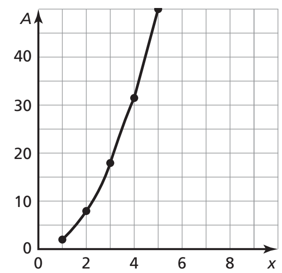
3.2 Explorations

1. a. 6, 12, 18, 24, 30;



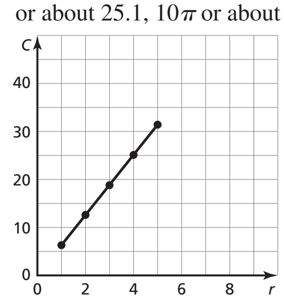
linear; The graph is a line.

b. 2, 8, 18, 32, 50;



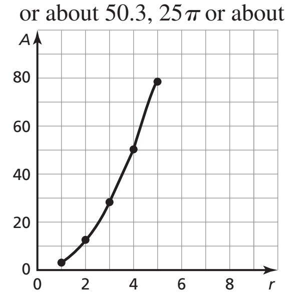
nonlinear; The graph is not a line.

c. 2π or about 6.3, 4π or about 12.6, 6π or about 18.8, 8π or about 25.1, 10π or about 31.4;



linear; The graph is a line.

d. π or about 3.1, 4π or about 12.6, 9π or about 28.3, 16π or about 50.3, 25π or about 78.5;



nonlinear; The graph is not a line.

2. No vertical line can be drawn through more than one point on any of the graphs.

3. Sketch the graph of the function. When the graph is a line, the pattern is linear. When the graph is not a line, the pattern is not linear.

4. *Sample answer:* Distance traveled during a time interval at constant speed is linear. Distance traveled during a time interval while accelerating is nonlinear.

3.2 Extra Practice

1. nonlinear; The graph is not a line.
2. linear; The graph is a line.
3. linear; As x increases by 1, y increases by 3. The rate of change is constant.
4. nonlinear; As x increases by 1, y varies by different amounts. The rate of change is not constant.
5. linear; It can be rewritten as $y = -2x + 3$.
6. nonlinear; It cannot be rewritten in the form $y = mx + b$.
7. $1 \le x \le 5$; continuous; The graph is a line segment.
8. 1, 2, 3; discrete; The graph consists of individual points.

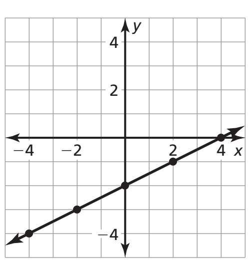
3.3 Explorations

1. **a.** B
   b. D
   c. A
   d. C
2. **a.** $(-1, 4)$
   b. $(0, 3)$
   c. $(1, 2)$
   d. $(2, 1)$
   Locate the x-coordinate, trace it up to the line, and then trace over to the y-axis to determine the y-coordinate.
3. Replace "y" with "$f(x)$" in the equation; They both give the rule for determining the output; Standard notation uses "y" to indicate the output, function notation uses "$f(x)$" to indicate the output.

3.3 Extra Practice

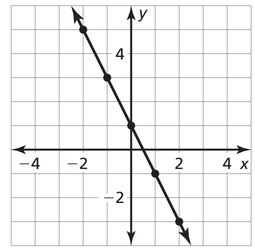
1. 8; 4; 2
2. -20; 0; 10
3. 15; 7; 3
4. 13; 12; 11.5
5. -8; 4; 10
6. 13; 5; 1
7. **a.** You have 8 DVDs before making any trips to the video store.
   b. After 3 trips to the video store, you have 14 DVDs.
   c. You have more DVDs after 5 trips to the video store than you do after 3 trips to the video store.
   d. After 7 trips to the video store, you have 10 more DVDs than you had after 2 trips.
8. $x = 7$
9. $x = 9$
10. $x = -10$
11. $x = -18$
12.

x	-4	-2	0	2	4
$s(x)$	-4	-3	-2	-1	0



13.

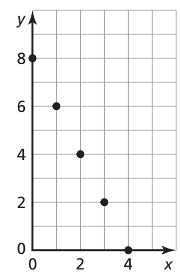
x	-2	-1	0	1	2
$t(x)$	5	3	1	-1	-3



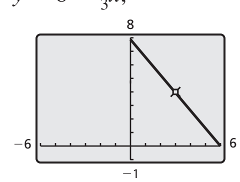
14. You have the best savings plan. Your account is linear, every month your balance increases by \$50. Your friend's account is also linear, every month your friend's balance increases by \$40. After 10 months you and your friend have the same balance. Each month after that your balance will keep increasing by \$10 more than your friend's balance.

3.4 Explorations

1. **a.** $4x + 2y = 16$
   b. 0, 1, 2, 3, 4; 8, 6, 4, 2, 0
   c.

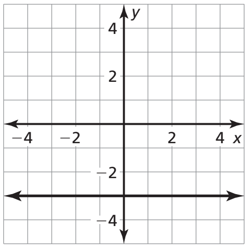


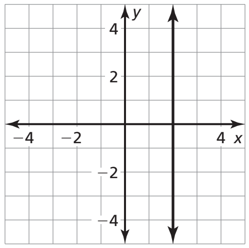
   The points create a line with a slope of -2. For each adult ticket sold, the number of child tickets sold decreases by 2.
   d. yes; The relationship can be expressed as an equation with 2 variables. If the value of one of the variables is known, the other can be found.
2. **a.** $8x + 6y = 48$
   b. $y = 8 - \frac{4}{3}x$;



   domain: $0 \le x \le 6$; range: $0 \le x \le 8$
   c. x-intercept: 6; y-intercept: 8
   d. To find the x-intercept, set $y = 0$ and solve for x, to find the y-intercept, set $x = 0$ and solve for y; Because the intercepts are where the graph crosses the axes, the y-coordinate of the x-intercept must be 0, and the x-coordinate of the y-intercept must be 0.
   e. The intercepts represent the maximum number of pounds of each type of cheese you can buy if you only buy one type of cheese.
3. a straight line
4. *Sample answer:* You sold a total of \$375 worth of DVDs. You forgot to record how many of each type you sold. TV season DVDs sold for \$30 each and movie DVDs sold for \$15 each.

3.4 Extra Practice

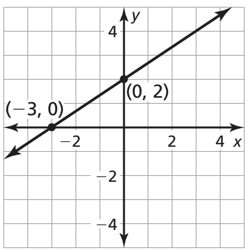
1. 

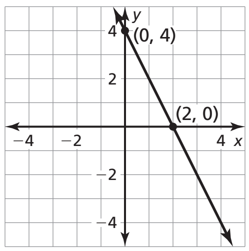
2. 

3. 4; 3

4. −16; −4

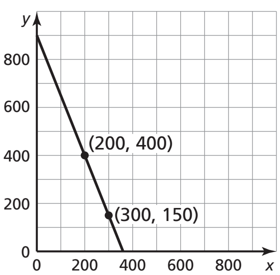
5. −6; 15

6. 

7. 

8. **a.** The x-intercept, 360, shows they can sell 0 baseball caps and 360 sweatshirts. The y-intercept, 900, shows they can sell 900 baseball caps and 0 sweatshirts.

   b. 255

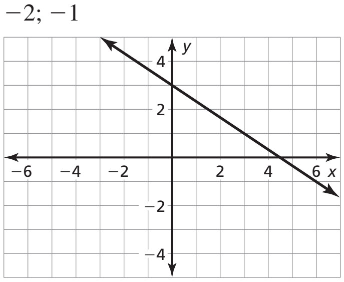
   c. 

   Sample answer: They can sell 200 sweatshirts and 400 baseball caps; They can sell 300 sweatshirts and 150 baseball caps.

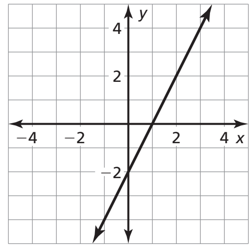
3.5 Explorations

1. **a.** $\frac{2}{3}$; 2

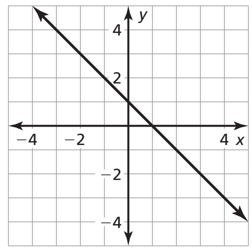
   b. −2; −1

2. **a.** 

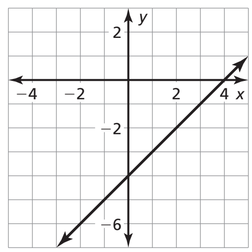
   line; $-\frac{2}{3}$; 3

   b. 

   line; 2; −2

   c. 

   line; −1; 1

   d. 

   line; 1; −4

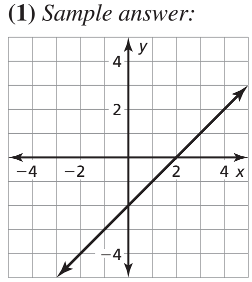
   In the graph of $y = mx + b$, m is the slope of the line and b is the y-intercept of the line.

3. a line with slope m and y-intercept b

   a. The value of m affects the steepness of the graph and whether the graph rises or falls from left to right.

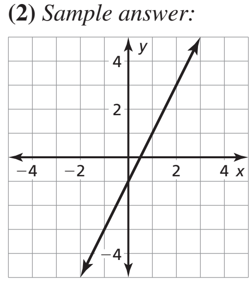
   b. The value of b affects the location of the y-intercept.

   c. **(1)** *Sample answer:*

   $y = x - 2$; slope: 1; y-intercept: −2

   (2) *Sample answer:*

   $y = 2x - 1$; slope: 2; y-intercept: −1

3.5 Extra Practice

1. undefined

2. positive; 2

3. negative; −1

4. 0

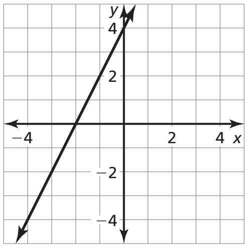
5. -4

6. slope: $-\frac{3}{2}$, y-intercept: 6

7. slope: $-\frac{3}{4}$, y-intercept: 2

8. slope: 5, y-intercept: 0

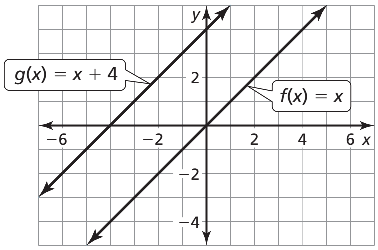
9.



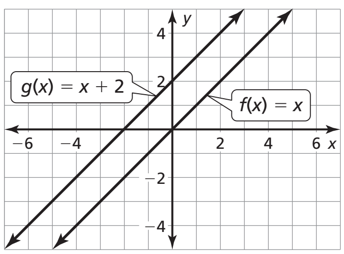
slope: 2, y-intercept: 4, x-intercept: -2

3.6 Explorations

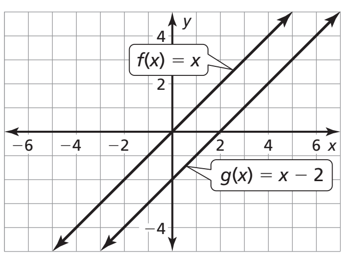
1. a.



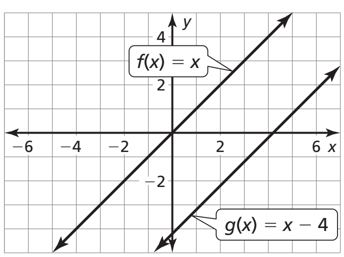
b.



c.

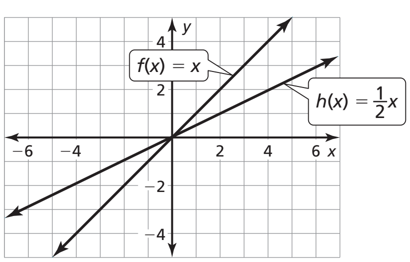


d.

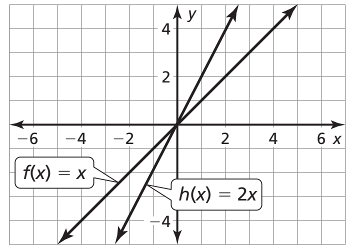


Adding or subtracting a constant to a function causes a vertical shift of the graph.

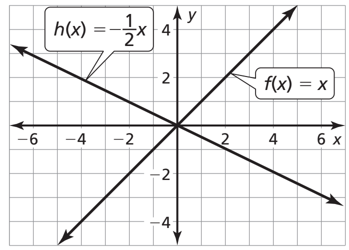
2. a.



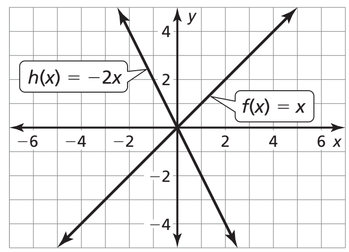
b.



c.



d.



The graph of $h(x) = cx$ has a steeper slope than the graph of $f(x) = x$ when $|c| > 1$, is not as steep as the graph of $f(x) = x$ when $|c| < 1$, and slopes downward from left to right when c is negative.

3. a. C; The graph is shifted down 4 units and further from the x-axis.

b. A; The graph is shifted up 2 units and further from the x-axis.

c. D; The graph is shifted up 4 units and closer to the x-axis.

d. B; The graph is shifted down 2 units and closer to the x-axis.

4. The graph of $g(x) = f(x) + c$ is shifted vertically from $f(x) = x$; The graph of $h(x) = f(cx)$ has a different slope than $f(x) = x$.

3.6 Extra Practice

1. The graph of g is a vertical translation 2 units down of the graph of f.

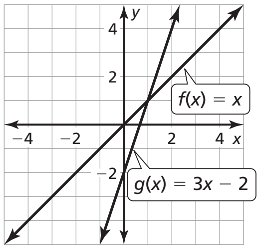
2. The graph of g is a horizontal translation 2 units right of the graph of f.

3. The graph of g is a reflection in the y-axis of the graph of f.

4. The graph of g is a horizontal stretch of the graph of f by a factor of 2.

5. The graph of g is a vertical stretch of the graph of f by a factor of 2.

6. The graph of g is a vertical shrink of the graph of f by a factor of $\frac{1}{2}$.

7. 

The transformations are a vertical stretch by a factor of 3 then a vertical translation 2 units down.

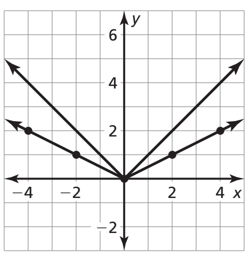
3.7 Explorations

1. **a.** D
   b. C
   c. E
   d. F
   e. A
   f. B
2. a stretches or shrinks the graph and determines whether the graph opens up or down; h translates the graph horizontally; k translates the graph vertically.
3. $g(x) = -|x + 1| + 1$

3.7 Extra Practice

1.

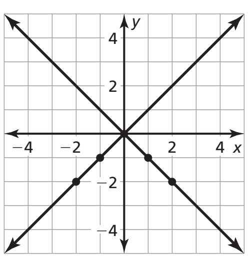
x	−4	−2	0	2	4
$t(x)$	2	1	0	1	2



The graph of t is a vertical shrink of the graph of f by a factor of $\frac{1}{2}$. The domain is all real numbers. The range is $y \geq 0$.

2.

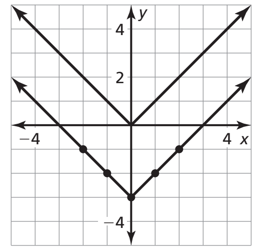
x	−2	−1	0	1	2
$u(x)$	−2	−1	0	−1	−2



The graph of u is a reflection in the x-axis of the graph of f. The domain is all real numbers. The range is $y \leq 0$.

3.

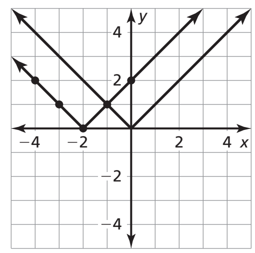
x	−2	−1	0	1	2
$p(x)$	−1	−2	−3	−2	−1



The graph of p is a vertical translation 3 units down of the graph of f. The domain is all real numbers. The range is $y \geq -3$.

4.

x	−4	−3	−2	−1	0
$r(x)$	2	1	0	1	2



The graph of p is a horizontal translation 2 units left of the graph of f. The domain is all real numbers. The range is $y \geq 0$.

Chapter 4

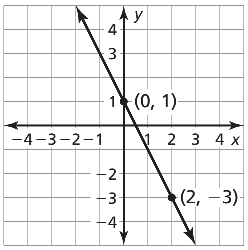
Maintaining Mathematical Proficiency

1. (2, 6)
2. (−2, 2)
3. (0, −4)
4. *F*
5. *D*
6. *G*
7. $y = x + 12$
8. $y = -2x + 4$
9. $y = \frac{3}{5}x + 3$
10. $y = 2x - 4$
11. $y = -x - \frac{2}{3}$
12. $y = \frac{1}{2}x - \frac{1}{2}$
13. $D(7, -2)$

4.1 Explorations

1. **a.** slope is 2; y-intercept is −1; $y = 2x - 1$
   b. slope is −1; y-intercept is 2; $y = -x + 2$
   c. slope is $-\frac{2}{3}$; y-intercept is 1; $y = -\frac{2}{3}x + 1$
   d. slope is $\frac{1}{2}$; y-intercept is −2; $y = \frac{1}{2}x - 2$
2. **a** 20; The base cost of the plan is \$20 per month.
   b. *Sample answer:* 0.03; Each megabyte of data costs \$0.03 to use.
   c. *Sample answer:* $y = 0.03x + 20$
3. Use the graph to find the slope and the y-intercept, and substitute these values into the slope-intercept form.

4. *Sample answer:*



$y = -2x + 1$

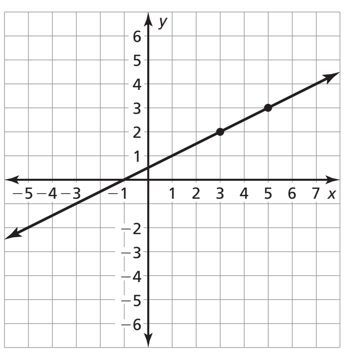
4.1 Extra Practice

1. $y = 9$
2. $y = -x$
3. $y = 2x - 3$
4. $y = -3x + 7$
5. $y = 4x - 2$
6. $y = \frac{1}{3}x + 2$
7. $y = -4x - 1$
8. $y = 2x$
9. $y = x + 1$
10. $y = -3x + 5$
11. $y = \frac{1}{2}x - 2$
12. $y = -\frac{3}{4}x + 3$
13. $y = x - 4$
14. $y = 4x - 7$
15. $y = \frac{1}{4}x + 2$
16. $y = -x - 5$
17. $y = -x + 8$
18. $y = -4x + 3$
19. $f(x) = \frac{1}{2}x - 5$
20. $f(x) = x + 10$
21. $f(x) = -x + 5$
22. $f(x) = -2x + 10$
23. $f(x) = 2x + 2$
24. $f(x) = -4x + 16$
25. **a.** $C = 35h + 50$

    b. \$35

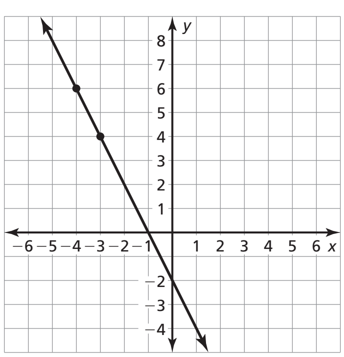
4.2 Explorations

1. **a.**



$\frac{1}{2}$; $y = \frac{1}{2}x + \frac{1}{2}$

b.



-2; $y = -2x - 2$

2. $m = \frac{y - y_1}{x - x_1}$; $y - y_1 = m(x - x_1)$
3. **a.** $A = 25t + 75$

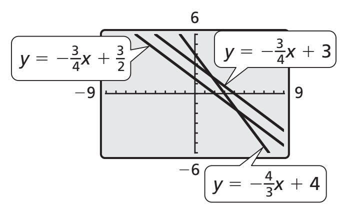
    b. Check students' work.
4. Substitute the slope for m and the coordinates of the point for x_1 and y_1 in $y - y_1 = m(x - x_1)$.
5. *Sample answer:* An equation of the line that passes through the point $(2, -9)$ and has a slope of $-\frac{1}{3}$ is $y + 9 = -\frac{1}{3}(x - 2)$.

4.2 Extra Practice

1. $y - 1 = -3(x + 2)$
2. $y - 5 = 2(x - 3)$
3. $y + 2 = -1(x + 1)$
4. $y = \frac{4}{3}(x - 5)$
5. $y - 4 = 7x$
6. $y - 2 = -\frac{1}{2}(x - 1)$
7. $y = 2x - 4$
8. $y = -x + 3$
9. $y = \frac{1}{2}x - 2$
10. $y = -\frac{1}{4}x$
11. $y = 3x - 6$
12. $y = -2x + 4$
13. $f(x) = 5x + 14$
14. $f(x) = 2x + 5$
15. $f(x) = \frac{1}{4}x + \frac{9}{4}$
16. $f(x) = \frac{1}{4}x - 2$
17. $f(x) = -8x + 8$
18. $f(x) = -x + 8$
19. yes; y increases at a constant rate; $y = 25x - 35$
20. Data cannot be modeled by a linear function.
21. $D(h) = 60h + 85$; 505 miles

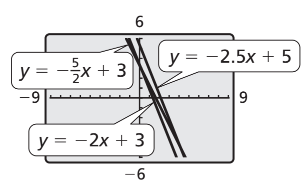
4.3 Explorations

1. **a.** $y = -\frac{3}{4}x + \frac{3}{2}$; $y = -\frac{3}{4}x + 3$; $y = -\frac{4}{3}x + 4$



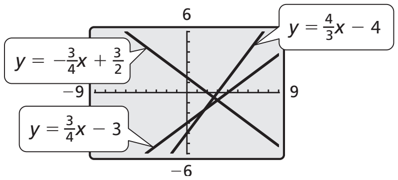
$3x + 4y = 6$ and $3x + 4y = 12$; *Sample answer:* The lines are always the same distance apart.

b. $y = -\frac{5}{2}x + 3$; $y = -2x + 3$; $y = -2.5x + 5$;



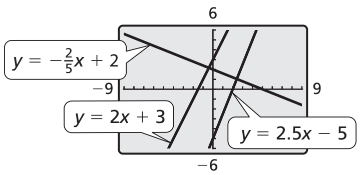
$5x + 2y = 6$ and $2.5x + y = 5$; *Sample answer:* The lines are always the same distance apart.

2. a. $y = -\frac{3}{4}x + \frac{3}{2}$; $y = \frac{3}{4}x - 3$; $y = \frac{4}{3}x - 4$;



$3x + 4y = 6$ and $4x - 3y = 12$; *Sample answer:* The lines intersect at a right angle.

b. $y = -\frac{2}{5}x + 2$; $y = 2x + 3$; $y = 2.5x - 5$;



$2x + 5y = 10$ and $2.5x - y = 5$; *Sample answer:* The lines intersect at a right angle.

3. Parallel lines are always the same distance apart; Perpendicular lines intersect at right angles.

4. Parallel lines have the same slope; The lines with the same slope in Exploration 1 were parallel.

5. Perpendicular lines have slopes that are negative reciprocals of each other; The lines with negative reciprocal slopes in Exploration 2 were perpendicular.

4.3 Extra Practice

1. lines b and c; They have the same slope.

2. lines a and c; They have the same slope.

3. lines a and c; They have the same slope.

4. none; None of the lines have the same slope.

5. lines b and c; They have the same slope.

6. lines a and b; They have the same slope.

7. $y = \frac{1}{3}x - 2$

8. $y = -2x$

9. Lines a and c are parallel; None are perpendicular; Lines a and c have the same slope, and none of the lines have slopes that are negative reciprocals of each other.

10. None are parallel; Lines a and b are perpendicular; None of the lines have the same slope, and the slope of line a is the negative reciprocal of the slope of line b.

11. None are parallel; None are perpendicular; None of the lines have the same slope, and none of the lines have slopes that are negative reciprocals of each other.

12. Lines a and b are parallel; None are perpendicular; Lines a and b have the same slope, and none of the lines have slopes that are negative reciprocals of each other.

13. None are parallel; Lines a and b are perpendicular; None of the lines have the same slope, and the slope of line a is the negative reciprocal of the slope of line b.

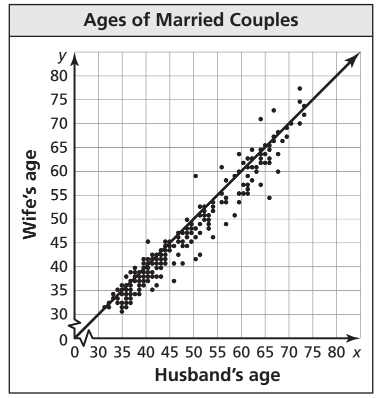
14. Lines a and c are parallel; None are perpendicular; Lines a and c have the same slope, and none of the lines have slopes that are negative reciprocals of each other.

15. $y = -\frac{3}{2}x - 1$

16. $y = -\frac{1}{2}x + \frac{5}{2}$

4.4 Explorations

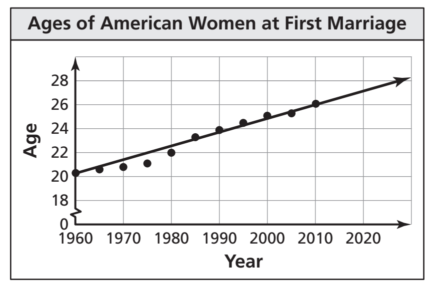
1. a. *Sample answer:*



$y = x$; Estimate a line through the middle of the plotted data, then use two points on the line to find the equation.

b. *Sample answers:* The ages of the husband and wife in a married couple tend to be about the same; The equation shows they are equal.

2. a. *Sample answer:*



$y = 0.1x + 20.1$; Estimate a line through the middle of the plotted data, then use two points on that line to find the equation.

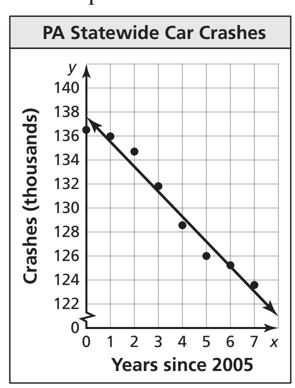
b. *Sample answer:* The median age at which American women first marry increases about 1 year every 10 years.

c. *Sample answer:* about 26.1 years old

3. Draw a line of fit on the scatter plot, find its equation, and interpret the slope and y-intercept.

4. *Sample answer:*

The data in the graph is from the Pennsylvania Department of Transportation.

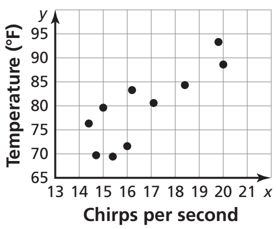


$y = -2.1x + 137.5$; Estimate a line through the middle of the plotted data, then use two points on that line to find the equation.

4.4 Extra Practice

1. **a.** 13.9 pounds
   b. 8 months
   c. increases
2. positive
3. negative
4. no
5. positive
6. **a.** *Sample answer:* $y = 1.5x + 6$
   b. *Sample answer:* The slope of 1.5 is the rate at which the tub is filling and the y-intercept of 6 is the depth of the water in the tub before the additional water started filling the tub.

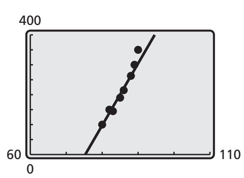
4.5 Explorations

1. **a.** The median age of American women at their first marriage in 1985 was 23.3.
   b. Check students' work.
   c. $y = 0.13x + 19.8$; The equations are similar.
2. Use a computer, spreadsheet, or graphing calculator that has a linear regression feature.
3. 

   $y = 3.27x + 25.0$; about 87.1°F

4.5 Extra Practice

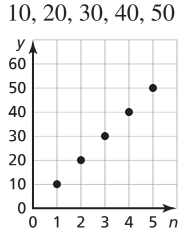
1. yes; The residual points are evenly dispersed about the horizontal axis.
2. no; The residual points form a ∪-shaped pattern, which suggests the data are not linear.
3. **a.** $y = 20.7x - 1558.7$

   b. $r = 0.995$; strong positive correlation
   c. The slope of 20.7 means that for every degree increase in temperature, the number of beach visitors increases by 20.7. The y-intercept of -1558.7 has no meaning in this context because the number of visitors to the beach cannot be negative.

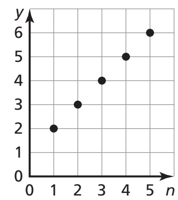
4.6 Explorations

1. **a.** 10, 20, 30, 40, 50

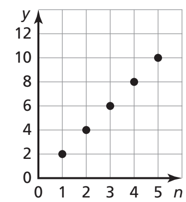
   The y-value increases by 10 each time.

   b. 2, 3, 4, 5, 6

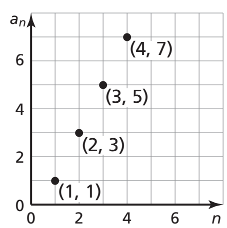
   The y-value increases by 1 each time.

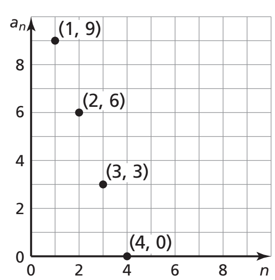
   c. 2, 4, 6, 8, 10

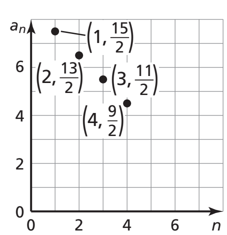
   

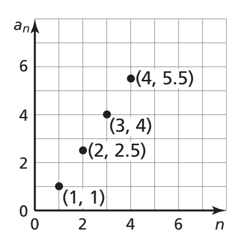
   The y-value increases by 2 each time.
2. An arithmetic sequence can describe a pattern in which the difference between consecutive terms is the same; *Sample answer:* The amount of money earned for selling candy bars at $2 each.
3. Each molecule added to the group increases the number of atoms by 3; 69 atoms

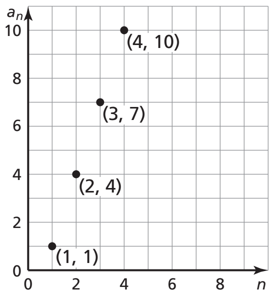
4.6 Extra Practice

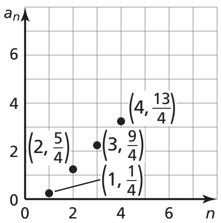
1. 29, 36, 43
2. −4, −10, −16
3. 48, 57, 66
4. 33, 40, 47
5. 19, 23, 27
6. 50, 62, 74
7. 

8. 

9. 

10. 

11. 

12. 

13. not an arithmetic sequence; Consecutive terms do not have a common difference.

14. arithmetic sequence; Consecutive terms have a common difference, 10.

15. arithmetic sequence; Consecutive terms have a common difference, −3.

16. $a_n = -1.2n - 4.2; -16.2$ **17.** $a_n = -5n + 48; -2$

18. $a_n = 4n + 2; 42$ **19.** $a_n = 2n - 13; 7$

20. $a_n = 3n + 31; 61$ **21.** $a_n = -\frac{1}{2}n + \frac{11}{4}; -\frac{9}{4}$

22. 126

4.7 Explorations

1. **a.** yes; No vertical line can be drawn through more than one point on the graph.

b. 0; The point (0, 0) is plotted.

c. $-x$

d. 2

e. $-x$; 2

2. **a.** yes; No vertical line can be drawn through more than one point on the graph.

b. −2; 0; 2; 4

3. Write the expression for each part of the function along with the part of the domain to which the expression applies.

4. $f(x) = \begin{cases} -x, & \text{if } x \le 0 \\ x, & \text{if } x > 0 \end{cases}$ or $f(x) = \begin{cases} -x, & \text{if } x < 0 \\ x, & \text{if } x \ge 0 \end{cases}$

4.7 Extra Practice

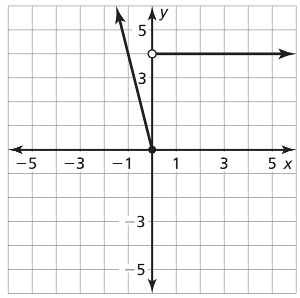
1. −1 **2.** 2

3. −9 **4.** −13

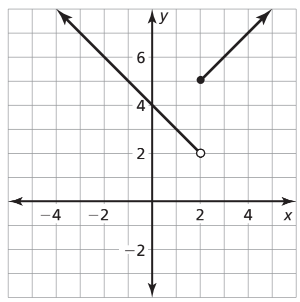
5. 2 **6.** −10

7. −3 **8.** −9

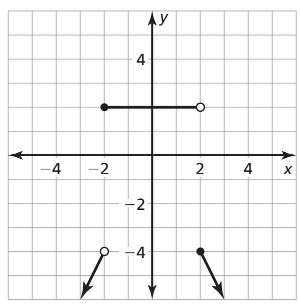
9. −16

10. 

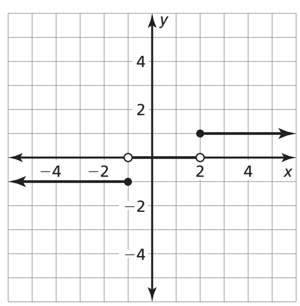
domain: all real numbers;
range: $y \ge 0$

11. 

domain: all real numbers
range: $y > 2$

12. 

domain: all real numbers
range: $y \le -4$ or $y = 2$

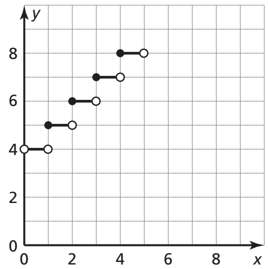
13. 

domain: all real numbers;
range: $\{-1, 0, 1\}$

14. $y = \begin{cases} -\frac{7}{5}x, & x < 0 \\ 3, & x \ge 0 \end{cases}$

15. $y = \begin{cases} 3, & -3 \le x < 0 \\ 4, & 0 \le x \le 1 \\ x, & 1 < x \le 5 \end{cases}$

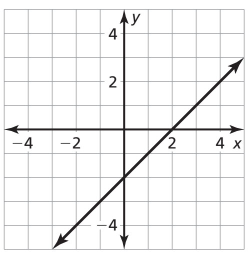
16. $y = \begin{cases} 4 & 0 < x < 1 \\ 5, & 1 \le x < 2 \\ 6, & 2 \le x < 3 \\ 7, & 3 \le x < 4 \\ 8, & 4 \le x < 5 \end{cases}$



Chapter 5

Maintaining Mathematical Proficiency

1.



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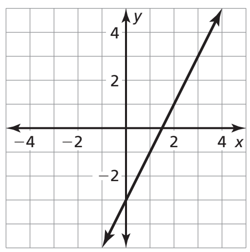

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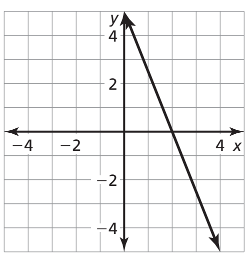

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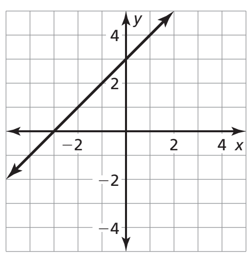

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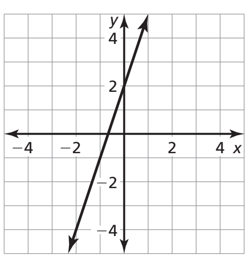

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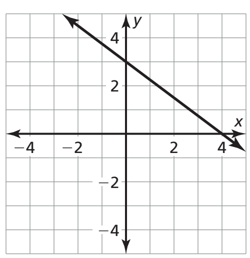
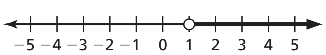
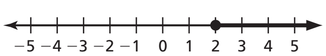


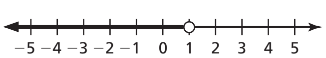
7. $a > 1$



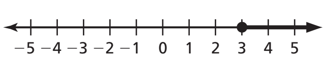
8. $c \ge 2$



9. $d < 1$



10. $r \ge 3$



5.1 Explorations

1. a. $C = 15x + 600$

b. $R = 75x$

c. $C = 15x + 600$

$R = 75x$

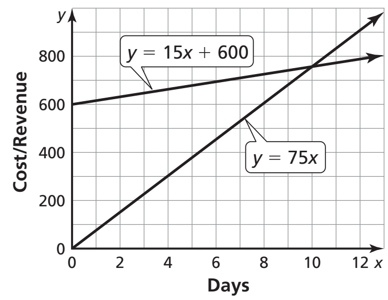
2. a.

x (nights)	0	1	2	3	4	5
C (dollars)	600	615	630	645	660	675
R (dollars)	0	75	150	225	300	375

x (nights)	6	7	8	9	10	11
C (dollars)	690	705	720	735	750	765
R (dollars)	450	525	600	675	750	825

b. 10 nights

c.



d. (10, 750); the point where both functions have the same x- and y-values; It is the same point; The break-even point is the point where both functions have the same x- and y-values.

3. Graph both equations and find the point of intersection; Substitute the x-coordinate for x in both of the equations and verify that both results are the y-coordinate of the point of intersection.

4. a. $(-1, 3)$; *Sample answer:* table because decimals are difficult to graph

b. $(2, 2)$; *Sample answer:* graph because it is easier to draw

c. $\left(-\frac{3}{2}, \frac{1}{2}\right)$; *Sample answer:* graph because it is easier to draw

5.1 Extra Practice

1. no

2. yes

3. yes

4. yes

5. no

6. yes

7. $(2, -2)$

8. $(-1, -3)$

9. $(4, 2)$

10. $(-1, 4)$

11. $(2, 3)$

12. $(0, -3)$

13. $(1, 4)$

14. $(-4, 2)$

15. $(1, -1)$

16. 15 true/false questions, 5 multiple choice questions

5.2 Explorations

1. a. $(-2, -5)$; yes; *Sample answer:* Method 2 because both equations can be solved for y easily.

b. $(1, 2)$; yes; *Sample answer:* Method 1 because the first equation can be solved for x easily.

c. $(-1, 3)$; yes; *Sample answer:* Method 2 because the first equation can be solved for y easily.

2. **a.** *Sample answer:* (2, 4)
   b. *Sample answer:* $y = x + 2$ and $3x - 4y = -10$
   c. *Sample answer:* $y = x + 2$ and $3x - 4y = -10$; (2, 4); Because the first equation is already solved for y, substitute that expression for y in the second equation.
3. Solve one of the equations for one of the variables. Substitute the expression for that variable into the other equation to find the value of the other variable. Substitute this value into one of the original equations to find the value of the remaining variable.
4. **a.** $(-5, -1)$; *Sample answer:* The first equation can be solved for x easily.
   b. $(-2, 2)$; *Sample answer:* The first equation can be solved for x easily.
   c. $(2, -2)$; *Sample answer:* The second equation can be solved for y easily.
   d. (3, 2); *Sample answer:* The second equation can be solved for x easily.
   e. $(1, -3)$; *Sample answer:* The second equation can be solved for x easily.
   f. $(-1, 3)$; *Sample answer:* The first equation can be solved for y easily.

5.2 Extra Practice

1. (0, 5)
2. $(1, -1)$
3. $\left(\frac{1}{2}, \frac{1}{2}\right)$
4. (1, 2)
5. $(2, -1)$
6. $(-2, 1)$
7. $(-2, 4)$
8. (4, 4)
9. (6, 4)
10. (2, 1)
11. (8, 5)
12. (1, 0)
13. $(0, -2)$
14. $(15, -3)$
15. (1, 1)
16. $(6, -3)$
17. (4, 18)
18. $\left(\frac{1}{4}, -\frac{1}{4}\right)$
19. $5

5.3 Explorations

1. **a.** Equation 1: $x + y = 4.5$; Equation 2: $x + 5y = 16.5$
   b. $4y = 12$; Solve the resulting equation for y. Then substitute the value of y into one of the original equations and solve for x; (1.5, 3); Drinks cost $1.50 and sandwiches cost $3.
2. **a.** $(1, -3)$; yes; *Sample answer:* method 2
   b. (2, 2); yes; *Sample answer:* method 2
   c. $(-1, 3)$; yes; *Sample answer:* method 1
3. **a.** no; *Sample answer:* Multiply each side of Equation 2 by –2.
   b. (2, 3)
4. Multiply, if necessary, one or both equations by a constant so one pair of like terms has the same or opposite coefficients. Add or subtract the equations to eliminate one of the variables. Solve the resulting equation. Then substitute the value of the variable found into one of the original equations and solve for the other variable.
5. When one of the variables has the same or opposite coefficients in both equations; *Sample answer:* $x + 3y = 2$ and $-x + 5y = 7$; when neither of the variables has the same nor opposite coefficients in both equations; *Sample answer:* $3x - 2y = 12$ and $2x - 3y = -15$
6. Multiplication Property of Equality; Multiplying each side of an equation by the same nonzero number produces an equivalent equation.

5.3 Extra Practice

1. (2, 5)
2. (3, 1)
3. $(-1, 4)$
4. $(3, -2)$
5. $(-4, -4)$
6. $(-1, -2)$
7. (6, 0)
8. $\left(\frac{1}{2}, 4\right)$
9. $\left(\frac{3}{8}, \frac{1}{8}\right)$
10. (6, 7)
11. (2, 4)
12. $\left(1, \frac{1}{2}\right)$
13. (3, 3)
14. $(-1, 2)$
15. (1, 1)
16. $(-1, -1)$
17. (0, 3)
18. $\left(\frac{1}{4}, -\frac{1}{4}\right)$
19. 14 and 8

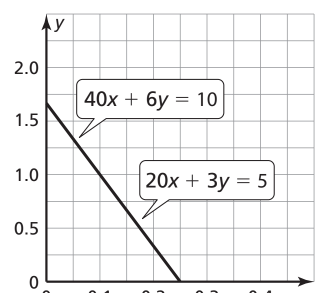
5.4 Explorations

1. **a.** $C = 450 + 20x$; $R = 20x$

***x* (skateboards)**	0	1	2	3	4
***C* (dollars)**	450	470	490	510	530
***R* (dollars)**	0	20	40	60	80

***x* (skateboards)**	5	6	7	8	9	10
***C* (dollars)**	550	570	590	610	630	650
***R* (dollars)**	100	120	140	160	180	200

   b. never; Both cost and revenue increase at the same rate, but have different initial values.
2. **a.** $40x + 6y = 10$; $20x + 3y = 5$
   b.



   They are the same line.
   c. no; Because the equations are equivalent, there are infinitely many solutions.
3. yes; *Sample answer:* The system $y = 3x$ and $y = 3x + 1$ has no solution. The system $y = 3x$ and $2y = 6x$ has infinitely many solutions.
4. **a.** one solution; The lines intersect at one point.
   b. no solution; The lines do not intersect.
   c. infinitely many solutions; The lines are the same line.

5.4 Extra Practice

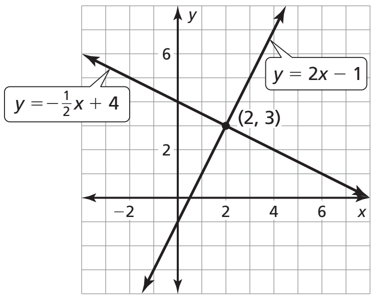
1. no solution
2. $\left(\frac{3}{5}, 2\right)$
3. infinitely many solutions
4. no solution
5. infinitely many solutions
6. (1, 1)
7. $(2, -1)$
8. no solution
9. infinitely many solutions
10. infinitely many solutions

11. (1, 0)
12. no solution
13. no solution
14. infinitely many solutions
15. $(-1, -1)$
16. (0, 1)
17. no solution
18. infinitely many solutions
19. your savings: $y = 5x + 15$
your friend's savings: $y = 5x + 25$;
no; The system of equations has no solution (the lines are parallel).

5.5 Explorations

1. **a.** $y = 2x - 1$; $y = -\frac{1}{2}x + 4$

b.



$x = 2$

c. The two sides of the equation are equal to each other. If you set one side of the equation equal to *y*, the transitive property allows you to set the other side of the equation equal to *y*.

2. **a.** $x = -4$; yes
b. $x = -3$; yes
c. $x = 3$; yes
d. $x = 2$; yes
e. $x = 1$; yes
f. $x = 0$; yes

3. Write two linear equations setting *y* equal to each side. Solve the system of linear equations. The *x*-value of the solution of the system of linear equations is the solution of the equation.

4. The algebraic method will always give the exact solution, but it is difficult to work with fractions as coefficients. The graphical method is easier with fractional coefficients of *x* because these are the slopes of the lines, but solutions may sometimes be estimates, especially when the solution does not fall on a grid line.

5.5 Extra Practice

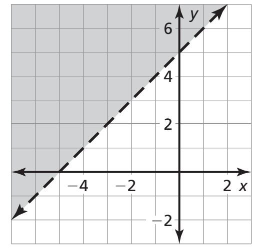
1. $x = 4$
2. $x = -2$
3. $x = -1$
4. $x = 2$
5. no solution
6. infinitely many solutions
7. $x = 10, x = -2$
8. $x = -1$
9. $x = -1$

5.6 Explorations

1. **a.** $y = x - 3$
b. all ordered pairs below the graph of $y = x - 3$
c. $y < x - 3$; <; *Sample answer:* The point (4, 0) is in the shaded region, and to make the inequality true for that point the < symbol is needed.

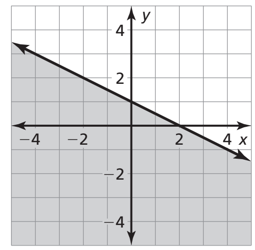
2. $0 \geq -3$

3. **a.**



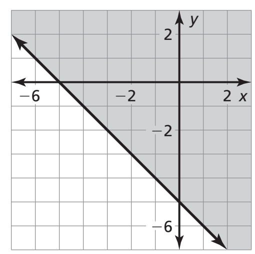
Sample answer: Graph $y = x + 5$ with a dashed line. Test the point (0, 0), which does not make the inequality true. Shade the half-plane that does not contain the point (0, 0).

b.



Sample answer: Graph $y = -\frac{1}{2}x + 1$ with a solid line. Test the point (0, 0), which does make the inequality true. Shade the half-plane that contains the point (0, 0).

c.



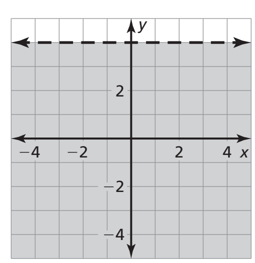
Sample answer: Graph $y = -x - 5$ with a solid line. Test the point (0, 0), which does make the inequality true. Shade the half-plane that contains the point (0, 0).

4. Graph the boundary line for the inequality. Use a dashed line for < or >. Use a solid line for ≤ or ≥. Test a point that is not on the boundary line to determine whether it is a solution of the inequality. When the test point is a solution, shade the half-plane that contains the point. When the test point is not a solution, shade the half-plane that does not contain the point.

5. *Sample answer:* You want to spend no more than \$15 at the deli for bologna at \$2.99 per pound and cheese at \$1.99 per pound. How many pounds of each can you purchase?

5.6 Extra Practice

1. no
2. yes
3. yes
4. no
5. no
6. yes
7.



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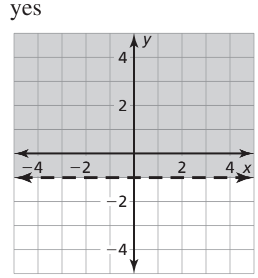

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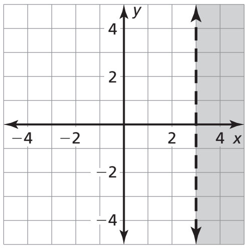

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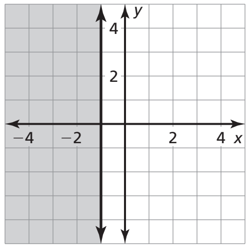

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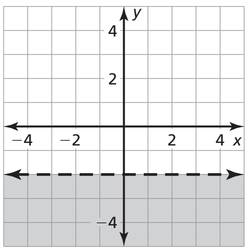

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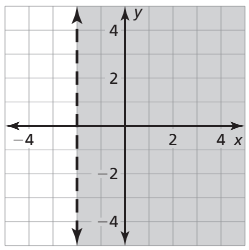

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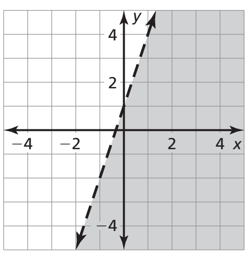

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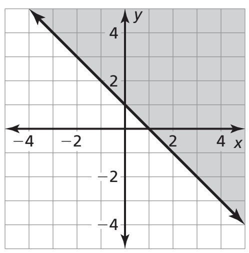

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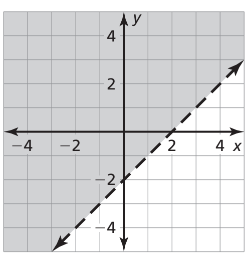

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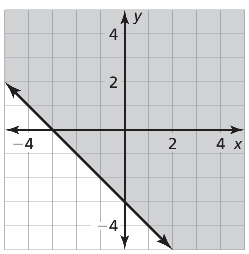

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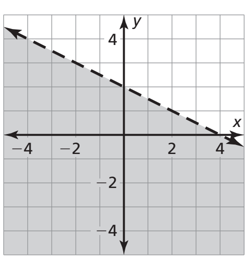

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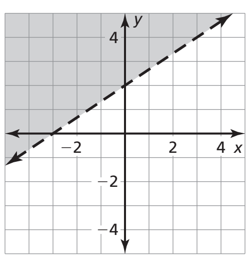
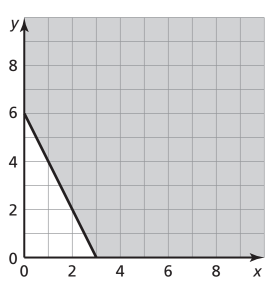


19. $100x + 50y \geq 300$

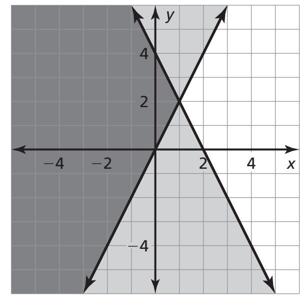


Sample answer: (3, 5); 3 digital cameras and 5 cell phones were purchased; (6, 4); 6 digital cameras and 4 cell phones were purchased.

5.7 Explorations

1. Inequality 1: A; The graph has a boundary line of $y = -2x + 4$; Inequality 2: B; The graph has a boundary line of $y = 2x$.

2. a.



Parts of the two half-planes overlap.

b. One shaded region is only shaded the first color, one shaded region is only shaded the second color, and one shaded region is shaded both colors; the values where both inequalities are false

3. Graph each inequality in the same coordinate plane. Find the intersection of the half-planes that are solutions of the inequalities. This intersection is the graph of the system.

4. the region where the shaded half-planes of the inequalities overlap

5. no; When the boundary lines are parallel, it is possible the shaded regions will not overlap.

6. $x \leq 2$ and $y \leq 3$

5.7 Extra Practice

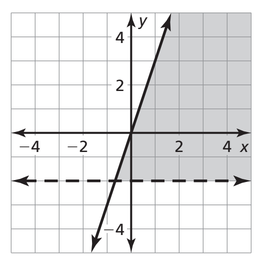
1. no

2. yes

3. no

4. yes

5.



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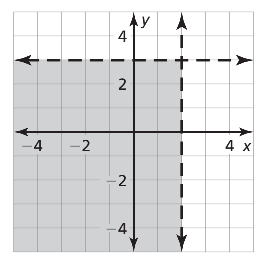

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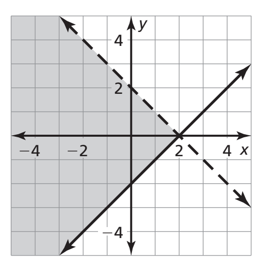

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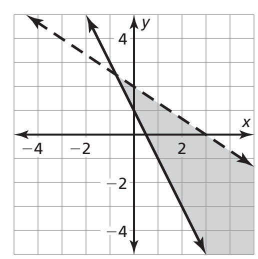


9. $y < 3$ and $x < 2$

10 $y < 3$ and $y > 1$

11. $y \geq x + 1$ and $y < -x + 1$

12. $y < -x + 1$ and $y > -x - 2$

Chapter 6

Maintaining Mathematical Proficiency

1. −29

2. 155

3. 69

4. 497

5. 193

6. 106

7. 6
8. -7
9. -15
10. 12
11. 13
12. 3
13. -4
14. ± 16
15. $a_n = 4n - 3$
16. $a_n = -6n + 27$
17. $a_n = 3n - 5$
18. $a_n = -2n + 10$
19. $a_n = 6n - 16$
20. $a_n = -8n + 24$

6.1 Explorations

1. a. $a^m a^n = a^{m+n}$
   i. 2^5
   ii. 4^6
   iii. 5^8
   iv. x^8

   b. $\frac{a^m}{a^n} = a^{m-n}$
   i. 4^1
   ii. 2^3
   iii. x^3
   iv. 3^0

   c. $(a^m)^n = a^{mn}$
   i. 2^8
   ii. 7^6
   iii. y^9
   iv. x^8

   d. $(ab)^m = a^m b^m$
   i. $2^2 \cdot 5^2$
   ii. $5^3 \cdot 4^3$
   iii. $6^2 a^2$
   iv. $3^2 x^2$

   e. $\left(\frac{a}{b}\right)^m = \frac{a^m}{b^m}$
   i. $\frac{2^2}{3^2}$
   ii. $\frac{4^3}{3^3}$
   iii. $\frac{x^3}{2^3}$
   iv. $\frac{a^4}{b^4}$

2. Try several examples to find a pattern, then express the pattern using variables.
3. 9^3

6.1 Extra Practice

1. 1
2. 1
3. $\frac{1}{81}$
4. $-\frac{1}{64}$
5. $\frac{1}{8}$
6. $-\frac{8}{9}$
7. $-\frac{1}{4}$
8. $\frac{1}{3}$
9. 1
10. $\frac{1}{a^8}$
11. $\frac{6}{b^2}$
12. $\frac{14}{m^4}$
13. $\frac{1}{9r^3}$
14. $\frac{64b^5}{a^3}$
15. 9
16. 4
17. 15,625
18. q^{15}
19. $\frac{1}{a^8}$
20. c
21. $256d^4$
22. $-\frac{1}{27f^3}$
23. $\frac{x^3}{64}$
24. a, c, d

6.2 Explorations

1. a. $\sqrt[3]{27}$ ft; 3 ft
   b. $\sqrt[3]{125}$ cm; 5 cm
   c. $\sqrt[3]{3375}$ in.; 15 in.
   d. $\sqrt[3]{3.375}$ m; 1.5 m
   e. $\sqrt[3]{1}$ yd; 1 yd
   f. $\sqrt[3]{\frac{125}{8}}$; 2.5 mm

   The cube in part (d) has the largest side length of 1.5 meters. The cubes in parts (a) and (e) have equal side lengths because 3 feet = 1 yard.

2. a. *Sample answer:* 2.2; C; 25 is between $2^4 = 16$ and $3^4 = 81$, and C is the only point on the graph between 2 and 3.
   b. *Sample answer:* 0.7; A; 0.5 is between $0^2 = 0$ and $1^2 = 1$, and A is the only point on the graph between 0 and 1.
   c. *Sample answer:* 1.2; B; 2.5 is between $1^5 = 1$ and $2^5 = 32$, and B is the only point on the graph between 1 and 2.
   d. *Sample answer:* 4.0; E; 65 is between $4^3 = 64$ and $5^3 = 125$, and E is the only point on the graph between 4 and 5.
   e. *Sample answer:* 3.8; D; 55 is between $3^3 = 27$ and $4^3 = 64$, and D is the only point on the graph between 3 and 4.
   f. *Sample answer:* 5.2; F; 20,000 is between $5^6 = 15{,}625$ and $6^6 = 46{,}656$, and F is the only point on the graph between 5 and 6.
3. Find what real number multiplied by itself n times gives you that number. If that is not possible, determine which nth powers the number is between and estimate the decimal part.
4. about 512.7 mm

6.2 Extra Practice

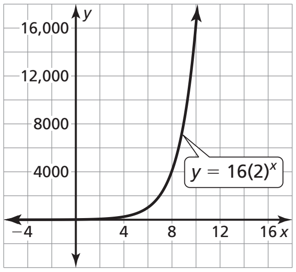
1. ± 8
2. 3
3. ± 4
4. 3
5. ± 2
6. ± 10
7. 5
8. -8
9. -6
10. -3
11. ± 3
12. not a real number
13. $4^{3/5}$
14. $(-8)^{2/3}$
15. $15^{7/4}$
16. $(\sqrt[5]{-3})^2$
17. $(\sqrt{6})^3$
18. $(\sqrt[4]{12})^3$
19. 4
20. not a real number
21. 49
22. 128
23. -243
24. not a real number
25. 10.9 m

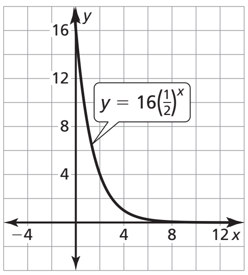
6.3 Explorations

1. 16, 32, 64, 128, 256, 512; 16, 64, 256, 1024, 4096, 16,384; Each value of x increases by the same amount; Each value of y is multiplied by the same factor.

2. 16, 8, 4, 2, 1, $\frac{1}{2}$; 16, 4, 1, $\frac{1}{4}$, $\frac{1}{16}$, $\frac{1}{64}$; yes; As the exponent increases by a constant amount, the base is multiplied by itself the same number of additional times.

3.

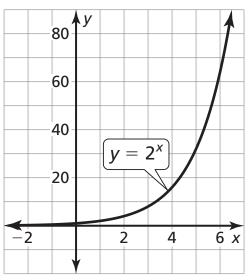




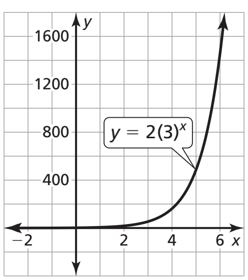
Both are curved and do not intersect the x-axis; The graph from Exploration 1 is increasing, the graph from Exploration 2 is decreasing.

4. *Sample answer:* curved shape, does not intersect the x-axis

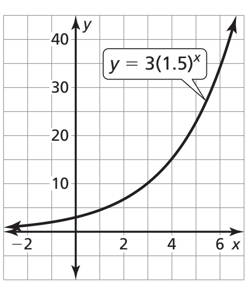
5. a.



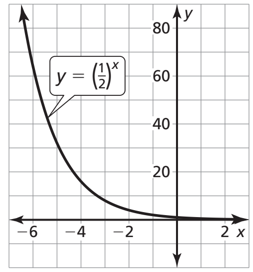
b.



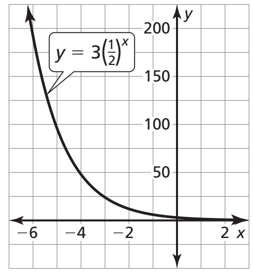
c.



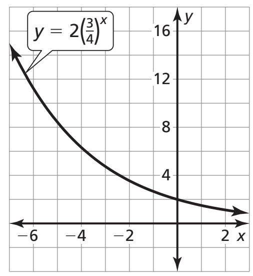
d.



e.



f.



yes; They have the same general curved shape, and they do not intersect the x-axis.

6.3 Extra Practice

1. exponential; As x increases by 1, y is multiplied by 0.5.

2. linear; As x increases by 1, y increases by 4. The rate of change is constant.

3. linear; As x increases by 1, y decreases by 3. The rate of change is constant.

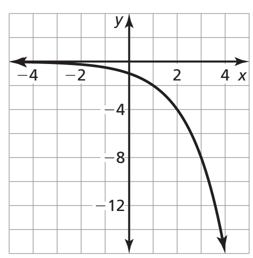
4. exponential; As x increases by 1, y is multiplied by 4.

5. 243

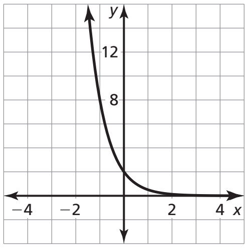
6. $\frac{1}{64}$

7. 768

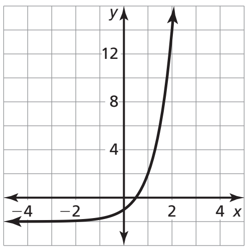
8.



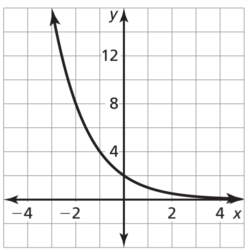
The graph of f is a reflection in the x-axis of the graph of $g(x) = 2^x$. The y-intercept of the graph of f, -1, is below the y-intercept of the graph of g, 1; domain: all real numbers, range: $y < 0$

9. 

The graph of f is a vertical stretch by a factor of 2 of the graph of $y = \left(\frac{1}{4}\right)^x$. The y-intercept of the graph of f, 2, is above the y-intercept of the graph of g, 1; domain: all real numbers, range: $y > 0$

10. 

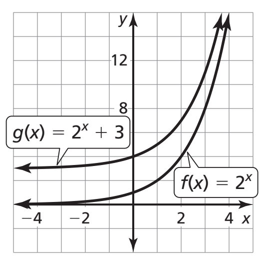
domain: all real numbers; range: $y > -2$

11. 

domain: all real numbers; range $y > 0$

12. $f(x) = 3(6)^x$

13. $f(x) = -\frac{1}{2}\left(\frac{1}{4}\right)^x$

14. 

The y-intercept of g is 3 units above the y-intercept of f. The domain of both functions is all real numbers. The range of g is $y > 3$ and the range of f is $y > 0$.

6.4 Explorations

1. As x increases by 5, y is multiplied by about 1.5; yes; 2036; The function can be approximately modeled by $y = 1188(1.5)^x$, where x represents the number of 5-year intervals since 1981. Setting y equal to 100,000 and solving for x gives 11 intervals, or 55 years.

2. a. 2/20.5 ≈ 9.8%

   b.

Time (*h*)	0	1	2	3	4	5	6
Temperature difference (°F)	38.6	34.8	31.4	28.3	25.5	23.0	20.7
Body temperature (°F)	98.6	94.8	91.4	88.3	85.5	83.0	80.7

   about 6 P.M.

3. As the independent variable changes by a constant amount, the dependent variable is multiplied by a constant factor.

4. a. *Sample answer:* the value of a CD each year that earns 2.5% interest compounded annually

   b. *Sample answer:* the worth of a farm tractor that depreciates at a rate of 10% per year

6.4 Extra Practice

1. a. $y = 100(1.11)^t$

   b. 806

2. exponential growth; As x increases by 1, y is multiplied by 1.5.

3. exponential decay; As x increases by 1, y is multiplied by $\frac{1}{4}$.

4. neither; As x increases by 1, y decreases by 10.

5. exponential growth; As x increases by 1, y is multiplied by 2.5.

6. exponential decay; 5%

7. exponential growth; 8%

8. exponential decay; 25%

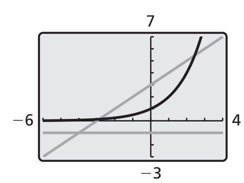
9. $y = 3000(1.015)^{4t}$

10. $y = 5000(1.006)^{12t}$

6.5 Explorations

1. $x = 5$; Graph $y = 2.5^{x-3}$ and $y = 6.25$. The x-coordinate of the point of intersection, 5, is the solution of the equation.

2. a–c. *Sample answer:*



   d. yes; yes; *Sample answer:* The graphs from parts (a)–(c) show that $2^x = -1$ has no solution and $2^x = x + 3$ has two solutions.

3. a. $x = -1$

   b. no solution

   c. $x = \frac{1}{2}$

   d. $x = 2$

   e. no solution

   f. $x = \frac{1}{4}$

   g. $x = -4$

   h. $x = -4$

   i. $x = 2, x = 4$

4. Form two new equations by setting each side of the original equation equal to y. Graph the new equations. The x-coordinate(s) of the point(s) of intersection is/are the solution(s).
5. 5 years

6.5 Extra Practice

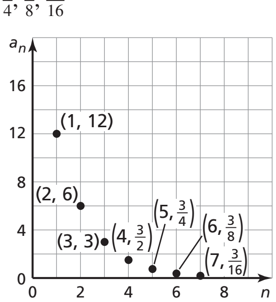
1. $x = 3$
2. $x = 15$
3. $x = \frac{5}{2}$
4. $x = 0$
5. $x = -3$
6. $x = 0$
7. $x = 3$
8. $x = 3.5$
9. $x = \frac{2}{7}$
10. $x = -\frac{4}{5}$
11. $x = 2$
12. $x = -1$
13. $x = -4$
14. $x = -\frac{8}{3}$
15. no solution
16. no solution
17. $x \approx 1.08$
18. no solution
19. $x \approx 6.78$
20. no solution
21. $x \approx 0.39$
22. **a.** $1500 = 1000(1.05)^t$ **b.** about 8.31 years

6.6 Explorations

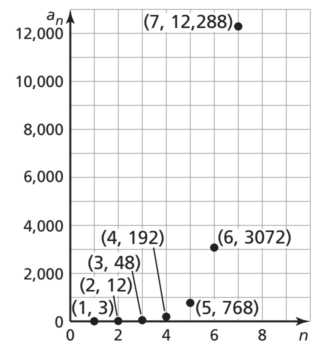
1. **a.** 2, 4, 8, 16, 32; Each number is twice the preceding number.
   b. 64; 32; 16; 8; 4; Each number is half of the preceding number.
   c. *Sample answer:* 10, 30, 90, 270, 810
   d. $\frac{1}{2}$; 3
2. **a.** 0.2 mm; 0.4 mm; 0.8 mm
   b. *Sample answer:* 6 times; 6.4 mm
   c. yes; The thickness is a geometric sequence that doubles with each fold. After 15 folds, the thickness would be 3276.8 millimeters, or 3.2768 meters, which is taller than a human being.
3. Indicate the common ratio between each consecutive pair of terms.
4. *Sample answer:* If you drop a tennis ball, the height after each bounce will be a common fraction of the height of the preceding bounce.

6.6 Extra Practice

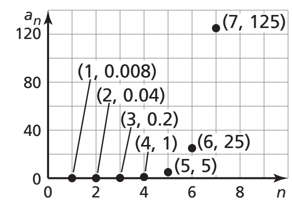
1. geometric; There is a common ratio of -4.
2. arithmetic; There is a common difference of 4.
3. neither; There is no common difference or common ratio.
4. neither; There is no common difference or common ratio.
5. geometric; There is a common ratio of 3.
6. arithmetic; There is a common difference of 8.
7. 567, 1701, 5103
8. 36, 18, 9
9. 80, -160, 320
10. $\frac{3}{4}, \frac{3}{8}, \frac{3}{16}$



11. 768, 3072, 12,288



12. 5, 25, 125



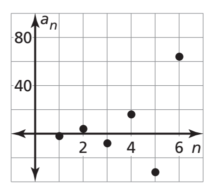
13. $a_n = 6561\left(\frac{1}{3}\right)^{n-1}$; $a_6 = 27$
14. $a_n = 8(-3)^{n-1}$; $a_6 = -1944$
15. $a_n = 3(5)^{n-1}$; $a_6 = 9375$
16. $a_n = 2916\left(\frac{1}{3}\right)^{n-1}$; $a_6 = 12$
17. $a_n = 11(4)^{n-1}$; $a_6 = 11{,}264$
18. $a_n = 2(3)^{n-1}$; $a_6 = 486$
19. $a_n = 3(2)^{n-1}$; $a_6 = 96$
20. $a_n = 8\left(-\frac{1}{2}\right)^{n-1}$; $a_6 = -\frac{1}{4}$

6.7 Explorations

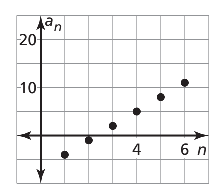
1. 8 pairs, 13 pairs, 21 pairs
2. 2, 3, 5, 8, 13, 21; They are the same.
3. Give the beginning term(s) of a sequence and a recursive equation that tells how a_n is related to one or more preceding terms.
4. Leonardo Fibonacci

6.7 Extra Practice

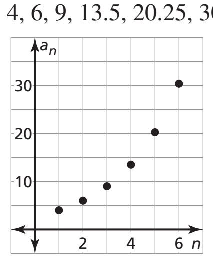
1. -2, 4, -8, 16, -32, 64



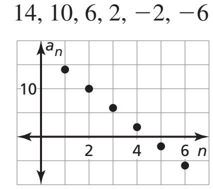
2. -4, -1, 2, 5, 8, 11



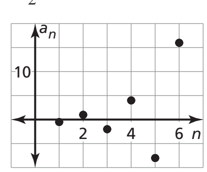
3. 4, 6, 9, 13.5, 20.25, 30.375



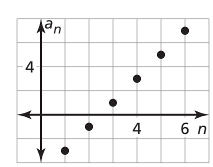
4. 14, 10, 6, 2, -2, -6



5. $-\frac{1}{2}$, 1, -2, 4, -8, 16



6. -3, -1, 1, 3, 5, 7



7. $a_1 = 324; a_n = \left(\frac{1}{3}\right)a_{n-1}$

8. $a_1 = 9; a_n = a_{n-1} + 5$

9. $a_1 = 3125; a_n = \left(\frac{1}{5}\right)a_{n-1}$

10. $a_1 = 8; a_n = -3a_{n-1}$

11. $a_1 = 7; a_n = a_{n-1} + 6$

12. $a_1 = 15; a_n = a_{n-1} - 3$

13. $a_1 = 20; a_n = \left(\frac{1}{5}\right)a_{n-1}$

14. $a_n = 4(3)^{n-1}$

15. $a_n = 11n - 5$

16. $a_n = -(5)^{n-1}$

17. $a_1 = 8; a_n = a_{n-1} + 6$

18. $a_1 = 1; a_n = (-3)a_{n-1}$

19. $a_1 = -1; a_n = a_{n-1} - 2$

20. $a_1 = 2, a_2 = 4, a_n = a_{n-1} + a_{n-2}$; 42, 68

21. $a_1 = 1, a_2 = 3, a_n = a_{n-2} - a_{n-1}$; −19, 31

22. $a_1 = 1, a_2 = 2, a_n = a_{n-1} \cdot a_{n-2}$; 256, 8192

Chapter 7

Maintaining Mathematical Proficiency

1. $8x - 6$

2. 3

3. $7s - 10$

4. $15m$

5. $-6p - 15$

6. $12z - 8$

7. $-6x - 16$

8. 24

9. $2z + 28$

10. 8

11. 5

12. 12

13. 4

14. 6

15. 1

16. Factor each number into primes. Find factors common to all 3 numbers.

$42 = \mathbf{2} \cdot 3 \cdot \mathbf{7}$

$70 = \mathbf{2} \cdot 5 \cdot \mathbf{7}$

$84 = \mathbf{2} \cdot 2 \cdot 3 \cdot \mathbf{7}$

The greatest common factor is $2 \cdot 7 = 14$.

7.1 Explorations

1. $4x + 2 - 5$; $4x + (2 - 2) - 3$; $4x - 3$

2. $(x^2 + 2x + 2) + (-x + 1)$; $x^2 + 2x - x + 3$; $x^2 + x + (x - x) + 3$; $x^2 + x + 3$

3. Add or subtract like terms.

4. **a.** $3x^2$

b. $5x + 1$

c. $-2x^2 - 2x - 3$

d. $-x^2 + x - 4$

7.1 Extra Practice

1. 1

2. 1

3. 0

4. 3

5. 3

6. 6

7. 4

8. 0

9. $3x^2 + x + 5$; 2; 3; trinomial

10. $\sqrt{5}y$; 1; $\sqrt{5}$, monomial

11. $6x^8 + 3x^5$; 8; 6; binomial

12. $f^4 + f^2 - 2f$; 4; 1; trinomial

13. $2x - 5$

14. $4a + 3$

15. $9x + 1$

16. $t^3 + 3t^2 + 7t - 3$

17. $-2g + 2$

18. $-12h - 8$

19. $2x^2 + x + 3$

20. $k^3 + 4k^2 - 7k - 4$

7.2 Explorations

1. **a.** 1; The product of 1 and 1 is 1.

b. −1; The product of 1 and −1 is −1.

c. 1; The product of −1 and −1 is 1.

d. x; The product of any number and 1 is that number.

e. $-x$; The product of any number and −1 is the opposite of that number.

f. $-x$; The product of any number and 1 is that number.

g. x; The product of the opposite of a number and −1 is the number.

h. x^2; The product of any number multiplied by itself is the number squared.

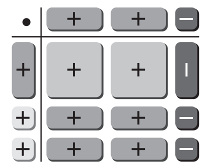
i. $-x^2$; The product of any number and its opposite is the opposite of the number squared.

j. x^2; The product of any number multiplied by itself is the number squared.

2. **a.** $x^2 + x - 6$

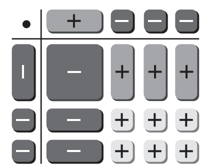
b. $4x^2 - 1$

c.



$2x^2 + 3x - 2$

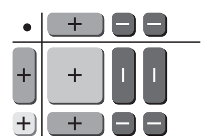
d.



$-x^2 + x + 6$

3. Multiply each term in one polynomial by each term in the other polynomial, then combine like terms.

4. *Sample answer:* $(x + 1)(x - 2) = x^2 - x - 2$



7.2 Extra Practice

1. $x^2 - 3x + 2$

2. $b^2 - b - 6$

3. $g^2 + 6g + 8$

4. $2a^2 + 3a - 5$

5. $3n^2 - n - 4$

6. $3r^2 + 11r + 6$

7. $x^2 - 5x + 6$

8. $y^2 - 5y - 6$

9. $q^2 + 10q + 21$

10. $2w^2 - 11w + 15$

11. $-12h^2 - 14h + 6$

12. $12j^2 + 7j - 12$

13. $x^2 - x - 6$

14. $z^2 + 5z + 6$

15. $h^2 + 2h - 8$

16. $2m^2 + 3m - 2$

17. $12n^2 + 13n - 4$

18. $-q^2 - 2q - 1$

19. $x^3 - x^2 - 3x + 2$

20. $-3a^3 + 3a^2 + 11a - 10$

21. $h^3 - 2h - 1$

22. $d^3 - d^2 - 11d + 3$

23. $6n^3 + 7n^2 - 8n - 5$

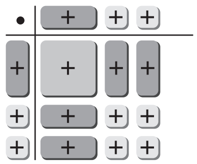
24. $6p^3 + p^2 - 10p + 3$

7.3 Explorations

1. **a.** $x^2 - 4$

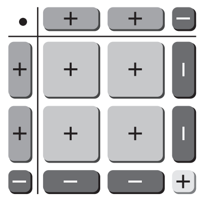
b. $4x^2 - 1$

2. a.



$x^2 + 4x + 4$

b.



$4x^2 - 4x + 1$

3. $(a + b)(a - b) = a^2 - b^2$; $(a + b)^2 = a^2 + 2ab + b^2$; $(a - b)^2 = a^2 - 2ab + b^2$

4. a. $x^2 - 9$

b. $x^2 - 16$

c. $9x^2 - 1$

d. $x^2 + 6x + 9$

e. $x^2 - 4x + 4$

f. $9x^2 + 6x + 1$

7.3 Extra Practice

1. $a^2 + 6a + 9$
2. $b^2 - 4b + 4$
3. $c^2 + 8c + 16$
4. $4x^2 - 4x + 1$
5. $9x^2 - 12x + 4$
6. $16p^2 + 24p + 9$
7. $9x^2 + 12xy + 4y^2$
8. $4a^2 - 12ab + 9b^2$
9. $16c^2 - 40cd + 25d^2$
10. $x^2 - 9$
11. $q^2 - 25$
12. $t^2 - 121$
13. $25a^2 - 1$
14. $\frac{1}{16}b^2 - 1$
15. $\frac{1}{4}c^2 - \frac{1}{9}$
16. $m^2 - 4n^2$
17. $9j^2 - 4k^2$
18. $-36a^2 + \frac{1}{4}b^2$
19. 396
20. 2499
21. $399\frac{21}{25}$
22. 961
23. 428.49
24. 11,881
25. $k = 4$

7.4 Explorations

1. a. C; 5

b. D; 1

c. A; 3

d. B; 4

e. E; 2

2.

	x =	1	2	3	4	5	6
a.	$(x - 1)(x - 2) = 0$	T	T	F	F	F	F
b.	$(x - 2)(x - 3) = 0$	F	T	T	F	F	F
c.	$(x - 3)(x - 4) = 0$	F	F	T	T	F	F
d.	$(x - 4)(x - 5) = 0$	F	F	F	T	T	F
e.	$(x - 5)(x - 6) = 0$	F	F	F	F	T	T
f.	$(x - 6)(x - 1) = 0$	T	F	F	F	F	T

If the product of two values is 0, then at least one of the values must be 0. If $(x - a)$ is a factor of an equation, then $x = a$ is a solution.

3. a. 0; Adding 0 does not change a value, but adding 1 increases the value.

b. 0; The product of 0 and any number is always 0, never 1.

c. both; $0^2 = 0$ and $1^2 = 1$

d. 1; The product of any number and 0 is 0, the product of any number and 1 is the number.

e. 0; The product of any number and 0 is 0, the product of any number and 1 is the number.

f. 0; Zero is neither positive nor negative, so it is its own opposite.

4. Set each polynomial factor equal to 0 and solve.

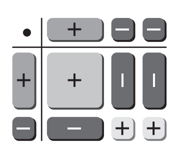
5. b; It describes what happens when you have a product that is equal to zero; It is used to solve polynomial equations by setting each polynomial factor equal to 0. It is important because it provides an easy way to solve polynomial equations.

7.4 Extra Practice

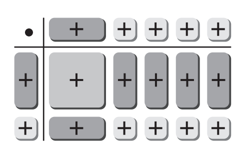
1. $x = 0, x = -5$
2. $a = 0, a = 12$
3. $p = 0, p = 2$
4. $c = 2, c = -1$
5. $b = 3, b = -6$
6. $s = \frac{3}{5}$
7. $x = 3$
8. $d = -\frac{7}{3}, d = \frac{6}{5}$
9. $t = -4, t = 4$
10. $w = -4, w = -1$
11. $g = 0, g = 2, g = -2$
12. $m = 4, m = -12, m = -\frac{2}{3}$
13. $3x(2x + 1)$
14. $4y^3(y - 5)$
15. $6u(3u^3 - 1)$
16. $z^6(7z + 2)$
17. $8h(3h^2 + 1)$
18. $15f(f^3 - 3)$
19. $k = 0, k = -\frac{1}{6}$
20. $n = 0, n = \frac{5}{7}$
21. $z = 0, z = -13$
22. $x = 0, x = -12$
23. $s = 0, s = 2$
24. $p = 0, p = 3$
25. $x = 0$ sec, $x = 5$ sec; The roots represent the time the ball is on the ground. At time $x = 0$ seconds, the ball was on the ground before being kicked. At time $x = 5$ seconds, the kicked ball hit the ground.

7.5 Explorations

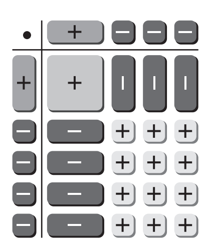
1. a. $(x - 1)(x - 2)$



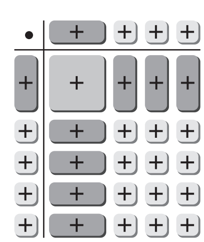
b. $(x + 1)(x + 4)$



c. $(x - 4)(x - 3)$



d. $(x + 4)(x + 3)$



2. Arrange algebra tiles that model the trinomial into a rectangular array, use additional algebra tiles to model the dimensions of the rectangle, then write the polynomial in factored form using the dimensions of the rectangle.

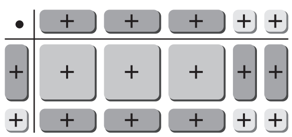
3. Find two integer factors of c that have a sum of b, then write the binomial factors by adding each integer factor to x.

7.5 Extra Practice

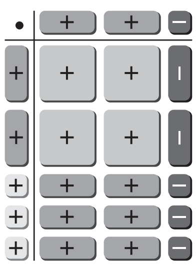
1. $(c + 1)(c + 7)$ **2.** $(a + 8)(a + 8)$
3. $(x + 2)(x + 9)$ **4.** $(d + 2)(d + 4)$
5. $(s + 1)(s + 10)$ **6.** $(u + 1)(u + 9)$
7. $(b - 6)(b + 9)$ **8.** $(y + 1)(y - 2)$
9. $(u - 3)(u + 6)$ **10.** $(z + 7)(z - 8)$
11. $(h - 4)(h + 6)$ **12.** $(f + 5)(f - 8)$
13. $g = 5, g = 8$ **14.** $k = 2, k = 3$
15. $w = 5, w = 2$ **16.** $x = 6, x = -5$
17. $r = 2, r = 1$ **18.** $t = 8, t = -1$
19. 4 mi, 8 mi **20.** 10 ft, 6 ft

7.6 Explorations

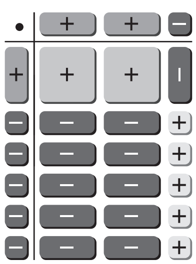
1. **a.** $(x + 1)(3x + 2)$



b. $(2x + 3)(2x - 1)$



c. $(x - 5)(2x - 1)$



2. Arrange algebra tiles that model the trinomial into a rectangular array, use additional algebra tiles to model the dimensions of the rectangle, then write the polynomial in factored form using the dimensions of the rectangle.

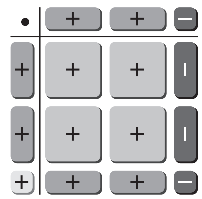
3. no; There is no way to model this expression as a rectangular array.

7.6 Extra Practice

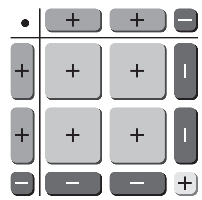
1. $2(c + 2)(c - 9)$ **2.** $4(a - 5)(a + 7)$
3. $3(x + 2)(x - 4)$ **4.** $2(d + 5)(d - 6)$
5. $5(s + 1)(s + 10)$ **6.** $3(q + 1)(q + 9)$
7. $(4g - 7)(3g - 4)$ **8.** $(2k - 1)(3k - 4)$
9. $(3w + 2)(3w + 1)$ **10.** $(4a - 1)(3a + 2)$
11. $(5b - 2)(3b + 4)$ **12.** $(t + 3)(5t - 3)$
13. $-(4b + 1)(3b - 2)$ **14.** $-(2x + 3)(3x - 5)$
15. $-(4g + 1)(15g - 1)$ **16.** $-(d + 2)(2d - 3)$
17. $-(r + 1)(3r + 1)$
18. $-(2x - 1)(4x - 5)$
19. length: 20 mi, width: 18 mi
20. 3, 5

7.7 Explorations

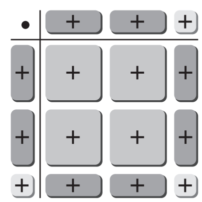
1. **a.** $(2x + 1)(2x - 1)$; yes, sum and difference pattern



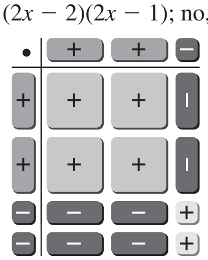
b. $(2x - 1)^2$; yes, square of a binomial pattern



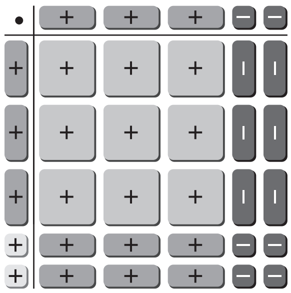
c. $(2x + 1)^2$; yes, square of a binomial pattern



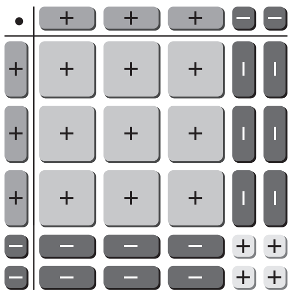
d. $(2x - 2)(2x - 1)$; no, not a special pattern



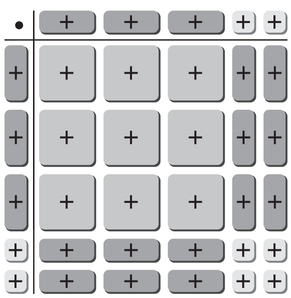
2.



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



$9x^2 - 12x + 4$; $(3x - 2)^2$



$9x^2 + 12x + 4$; $(3x + 2)^2$

3. *Sample answer:* The algebra tiles for special patterns will always form a square array, and the x^2 tiles will also form a square array. Factor special products by using the special patterns studied in Lesson 7.3, but in reversed order; For the sum and difference pattern, the number of x and $-x$ tiles will be the same, and there will only be -1 tiles to complete the array. For the square of a binomial pattern, the x tiles will either be all positive or all negative and there will only be $+1$ tiles to complete the array.

4. **a.** $(5x + 1)^2$
b. $(5x - 1)^2$
c. $(5x + 1)(5x - 1)$

7.7 Extra Practice

1. $(s + 7)(s - 7)$
2. $(t + 9)(t - 9)$
3. $(4 + x)(4 - x)$
4. $(2g + 5)(2g - 5)$
5. $(6h + 11)(6h - 11)$
6. $(9 + 7k)(9 - 7k)$
7. 440
8. 420
9. 528
10. 425
11. 1200
12. 340
13. $(x + 8)^2$
14. $(p + 14)^2$
15. $(r - 13)^2$
16. $(a - 9)^2$
17. $(6c + 7)^2$
18. $(10x - 1)^2$
19. $x = -12, x = 12$
20. $y = -\frac{7}{3}, y = \frac{7}{3}$
21. $c = -7$
22. $d = 2$
23. $n = -\frac{1}{3}$
24. $k = \frac{3}{5}$
25. $x = \frac{3}{2}$

7.8 Explorations

1. **a.** $(x + 1)(x + 1)(-2)$; $-2x^2 - 4x - 2$
b. $(x + 2)(x + 1)(-x)$; $-x^3 - 3x^2 - 2x$
c. $(x + 3)(x)(2)$; $2x^2 + 6x$
d. $(x + 1)(x - 1)(x)$; $x^3 - x$
e. $(-x + 1)(x + 1)(-x)$; $x^3 - x$
f. $(-x - 1)(x + 1)(-2)$; $2x^2 + 4x + 2$

2. **a.** J
b. A
c. D
d. G
e. N
f. B
g. F
h. L
i. I
j. E
k. M
l. O
m. K
n. H
o. C

Factor out the greatest common monomial factor first, then factor the remaining expression if possible.

3. Factor out the greatest common monomial factor first, then factor the remaining expression if possible.

4. **a.** $x(x + 1)(x + 3)$
b. $x(x - 3)^2$
c. $x(x + 3)^2$

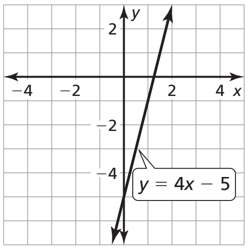
7.8 Extra Practice

1. $(b^2 + 1)(b - 4)$
2. $(a + b)(c + d)$
3. $(d + c)(d + 2)$
4. $(t^2 + 1)(5t + 6)$
5. $(s - 8)(8s^2 + 1)$
6. $(2a^2 - 5)(6a + 1)$
7. $(4x^2 - 5)(x - 3)$
8. $(3h^2 - 5)(7h + 6)$
9. $4c(c + 1)(c - 1)$
10. $25x^2(2x + 1)(2x - 1)$
11. $(2a - 1)(a + 2)$
12. unfactorable
13. $2(5p - 2)(2p + 3)$
14. $4(3x + 4)(x - 3)$
15. $(3s + 2)(s^2 - 7)$
16. $(2t + 1)(t^3 - 5)$
17. $x = 2, x = 5$
18. $y = 3, y = -2$
19. $c = 0, c = 9, c = -9$
20. $d = -1, d = 3, d = -3$
21. $n = 0, n = 16$
22. $x = -3, x = 4, x = -4$

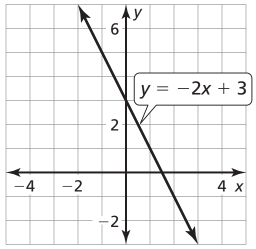
Chapter 8

Maintaining Mathematical Proficiency

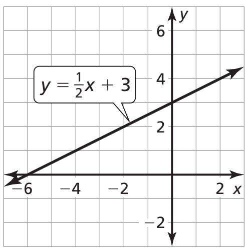
1.



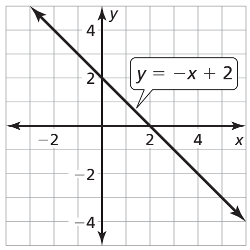
2.



3.



4.



5. 40

6. −32

7. −52

8. 92

9. 96

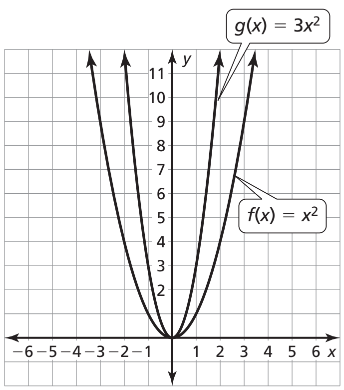
10. 119

11. −44

12. 42

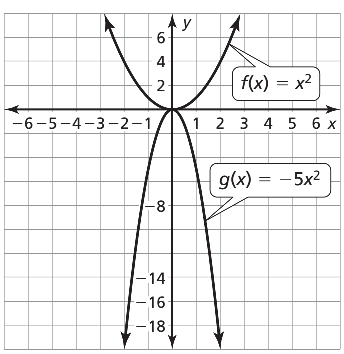
8.1 Explorations

1. a.



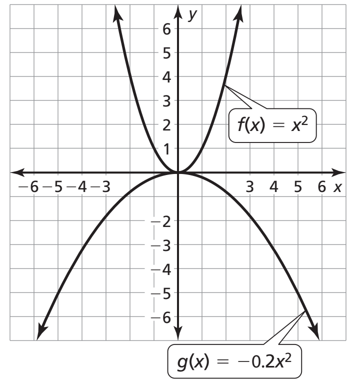
The graph of g is a vertical stretch by a factor of 3 of the graph of f.

b.



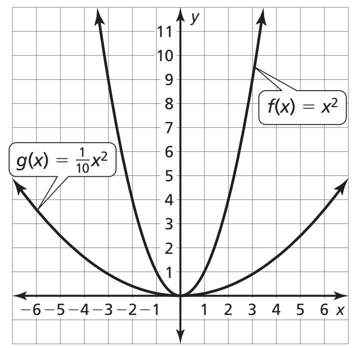
The graph of g is a vertical stretch by a factor of 5 and a reflection in the x-axis of the graph of f.

c.



The graph of g is a vertical shrink by a factor of 0.2 and a reflection in the x-axis of the graph of f.

d.



The graph of g is a vertical shrink by a factor of $\frac{1}{10}$ of the graph of f.

2. *Sample answer:* They are U-shaped and symmetric. They either open up with the lowest point at the origin, or they open down with the highest point at the origin.

3. *Sample answer:* When $0 < a < 1$ the graph of $f(x) = ax^2$ is a vertical shrink of the graph of $f(x) = x^2$, when $a > 1$ the graph of $f(x) = ax^2$ is a vertical stretch of the graph of $f(x) = x^2$, when $-1 < a < 0$ the graph of $f(x) = ax^2$ is a vertical shrink and a reflection in the x-axis of the graph of $f(x) = x^2$, and when $a < -1$ the graph of $f(x) = ax^2$ is a vertical stretch and a reflection in the x-axis of the graph of $f(x) = x^2$.

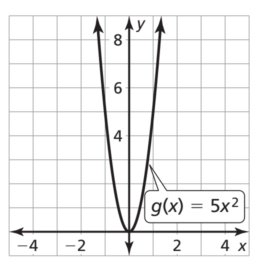
4. $0 < a < 1$; *Sample answer:* The graph is a vertical shrink of the graph of $f(x) = x^2$.

8.1 Extra Practice

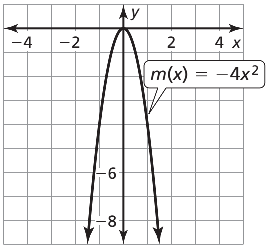
1. The vertex is $(-1, 1)$. The axis of symmetry is $x = -1$. The domain is all real numbers. The range is $y \geq 1$. When $x < -1$, y decreases as x increases. When $x > -1$, y increases as x increases.

2. The vertex is $(3, 4)$. The axis of symmetry is $x = 3$. The domain is all real numbers. The range is $y \leq 4$. When $x < 3$, y increases as x increases. When $x > 3$, y decreases as x increases.

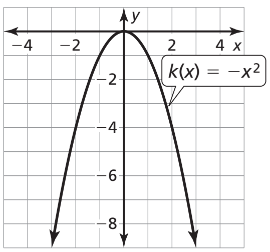
3.



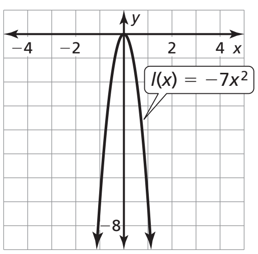
The graph of g is a vertical stretch of the graph of f.

4. 

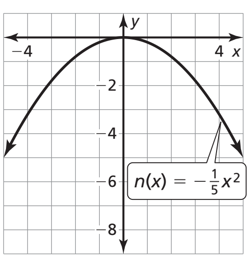
The graph of m is a vertical stretch with a reflection in the x-axis of the graph of f.

5. 

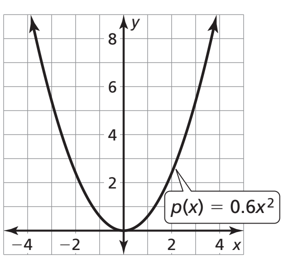
The graph of k is a reflection in the x-axis of the graph of f.

6. 

The graph of ℓ is a vertical stretch with a reflection in the x-axis of the graph of f.

7. 

The graph of n is a vertical shrink with a reflection in the x-axis of the graph of f.

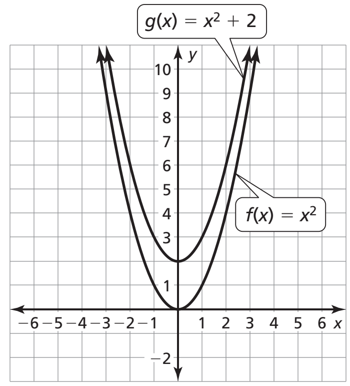
8. 

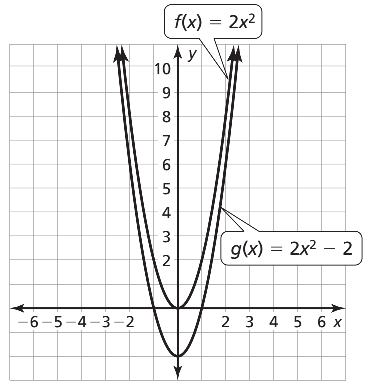
The graph of p is a vertical shrink of the graph of f.

9. sometimes; If $0 < a < 1$, the graph is narrower than the graph of f. If $a > 1$, the graph is wider than the graph of f.

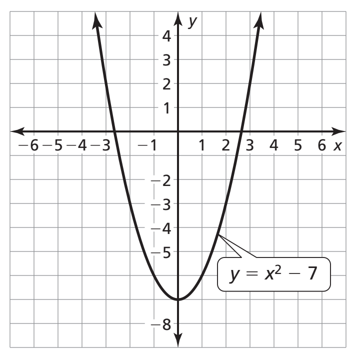
10. never; When $|a| < 1$, then $-1 < a < 1$. This means that the graph of g will be a vertical shrink of the graph of f, so it will be wider.

8.2 Explorations

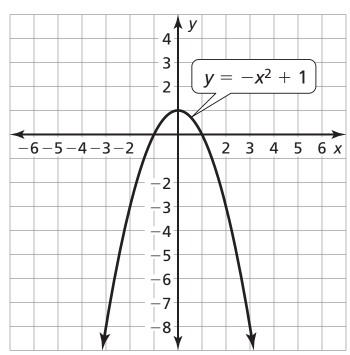
1. a. 

b. 

Sample answer: In $g(x) = ax^2 + c$, c causes a vertical shift in the graph of $f(x) = ax^2$.

2. a. 

$x = \sqrt{7} \approx 2.6$, $x = -\sqrt{7} \approx -2.6$

b. 

$x = 1$, $x = -1$

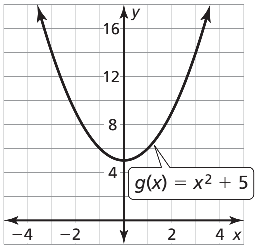
Sample answer: Estimate the points where the graph intersects the x-axis.

3. It causes a vertical shift of c units. When $c > 0$, the graph is translated up. When $c < 0$, the graph is translated down.

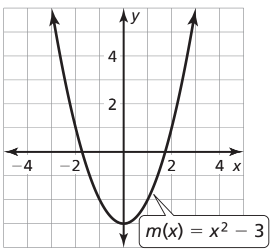
4. Check students' work.

5. *Sample answer:* $a > 1$, $c = 1$; The graph is narrower than $y = x^2$, so it is a vertical stretch. The vertex is 1 unit above the origin, so the graph is a vertical translation 1 unit up of the graph of $y = x^2$.

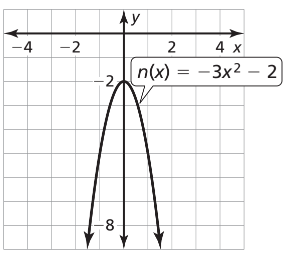
8.2 Extra Practice

1. 

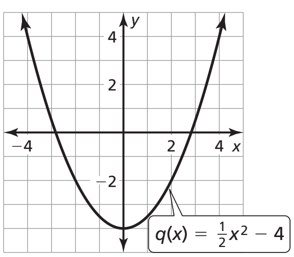
The graph of g is a vertical translation 5 units up of the graph of f.

2. 

The graph of m is a vertical translation 3 units down of the graph of f.

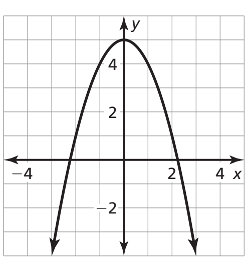
3. 

The graph of n is a vertical stretch by a factor of 3, a reflection in the x-axis, and a vertical translation 2 units down of the graph of f.

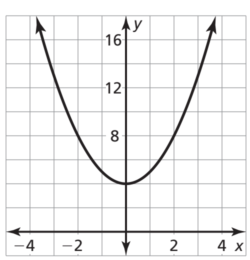
4. 

The graph of q is a vertical shrink by a factor of $\frac{1}{2}$ and a vertical translation 4 units down of the graph of f.

5. $x = 1, x = -1$
6. $x = 2, x = -2$
7. $x = 8, x = -8$
8. $x = \frac{1}{3}, x = -\frac{1}{3}$
9. *Sample answer:*



10. *Sample answer:*

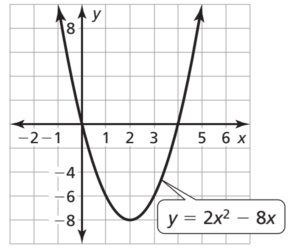


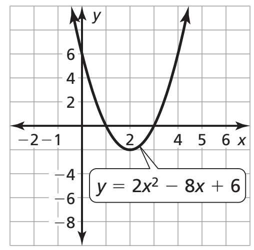
11. **a.** 5 sec

b. 1 sec

8.3 Explorations

1. **a.**





b. They are the same.

c. $x = 0, x = 4$

d. *Sample answer:* The value of the x-coordinate of the vertex is the average of the values of the x-intercepts.

2. **a.** $x = 0, x = -\dfrac{b}{a}$

b. $x = 0, x = -\dfrac{b}{a}$

c. 0, 0

3. $-\dfrac{b}{2a}$; $-\dfrac{b}{2a}$

4. *Sample answer:* Find the x-coordinate using $x = -\dfrac{b}{2a}$, then use the function to find the y-coordinate.

5. $(2, -1)$

8.3 Extra Practice

1. **a.** $x = 5$

b. $(5, -23)$

2. **a.** $x = 2$

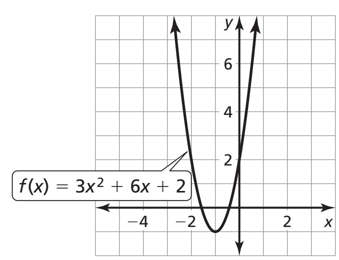
b. $(2, 16)$

3. **a.** $x = -2$

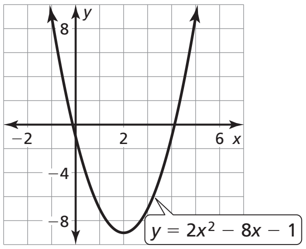
b. $(-2, 13)$

4. **a.** $x = 1$

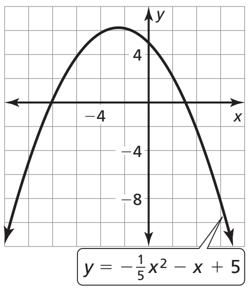
b. $(1, 4)$

5. 

domain: all real numbers, range: $y \geq -1$

6. 

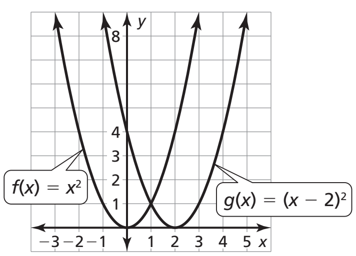
domain: all real numbers, range: $y \geq -9$

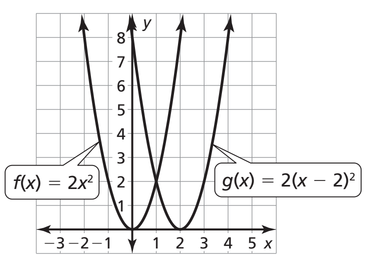
7. 

domain: all real numbers, range: $y \leq \frac{25}{4}$

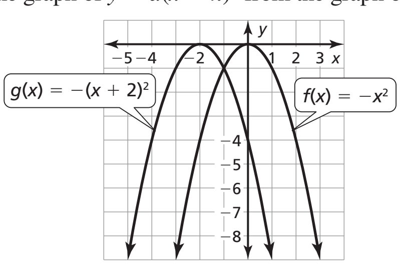
8. maximum value; $14\frac{1}{2}$
9. minimum value; -10
10. maximum value; -3
11. maximum value; $6\frac{3}{4}$
12. minimum value; 3
13. maximum value; -5
14. **a.** about 7.81 sec
    b. about 976.56 ft

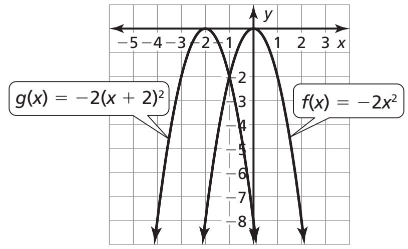
8.4 Explorations

1. **a.** 

   b. 

   Sample answer: The value of h causes a horizontal translation of the graph of $y = a(x - h)^2$ from the graph of $y = ax^2$.

2. **a.** 

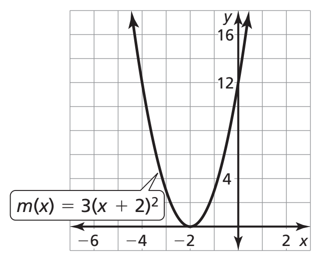
   b. 

   Sample answer: The value of h causes a horizontal translation of the graph of $y = a(x - h)^2$ from the graph of $y = ax^2$.

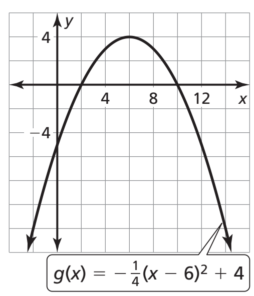
3. When $h > 0$, the graph of $f(x) = a(x - h)^2$ is a horizontal translation h units to the right of the graph of $f(x) = ax^2$. When $h < 0$, the graph of $f(x) = a(x - h)^2$ is a horizontal translation h units to the left of the graph of $f(x) = ax^2$.

4. **a.** The graph of $y = (x - 3)^2$ is a horizontal translation 3 units right of the graph of $y = x^2$.
   b. The graph of $y = (x + 3)^2$ is a horizontal translation 3 units left of the graph of $y = x^2$.
   c. The graph of $y = -(x - 3)^2$ is a horizontal translation 3 units right and a reflection in the x-axis of the graph of $y = x^2$.

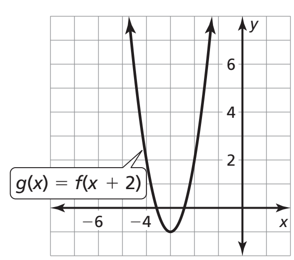
8.4 Extra Practice

1. odd
2. even
3. even
4. neither
5. $(2, 0)$; $x = 2$
6. $(-8, 0)$; $x = -8$
7. $(1, 4)$; $x = 1$
8. $(-1, -5)$; $x = -1$
9. 

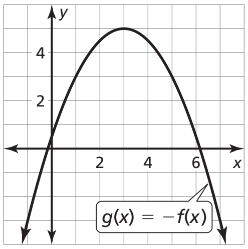
   The graph of m is a horizontal translation 2 units left and a vertical stretch by a factor of 3 of the graph of f.

10. 

   The graph of g is a vertical shrink by a factor of $\frac{1}{4}$, a reflection in the x-axis, and a translation 6 units right and 4 units up of the graph of f.

11. 

12.

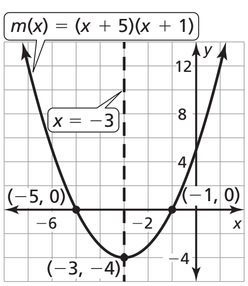


8.5 Explorations

1. **a.** $y = (x - 1)(x - 2)$; *Sample answer:* The graph opens up and the x-intercepts are 1 and 2.
   b. $y = -(x - 1)(x - 2)$; *Sample answer:* The graph opens down and the x-intercepts are 1 and 2.
   c. $y = x(x - 3)$; *Sample answer:* The graph opens up and the x-intercepts are 0 and 3.
   d. $y = x(x + 3)$; *Sample answer:* The graph opens up and the x-intercepts are 0 and -3.
   e. $y = -x(x + 3)$; *Sample answer:* The graph opens down and the x-intercepts are 0 and -3.
   f. $y = -x(x - 3)$; *Sample answer:* The graph opens down and the x-intercepts are 0 and 3.
   g. $y = (x + 1)(x - 2)$; *Sample answer:* The graph opens up and the x-intercepts are -1 and 2.
   h. $y = -(x + 1)(x - 2)$; *Sample answer:* The graph opens down and the x-intercepts are -1 and 2.
2. *Sample answer:* It is a parabola with x-intercepts p and q.
3. **a.** no; yes; *Sample answer:* The x-intercepts are still p and q; Changing the sign of a will also change the sign of the y-intercept when the y-intercept is not 0.
   b. yes; yes; *Sample answer:* One of the x-intercepts will change from the old value of p to the new value of p. The y-intercept is apq, so changing the value of p will change the value of the y-intercept when the y-intercept is not 0.

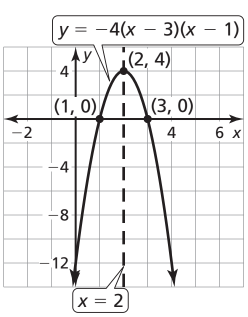
8.5 Extra Practice

1. $-2, 4; x = 1$
2. $2, 3; x = 2.5$
3.



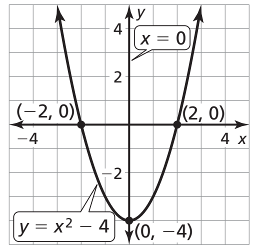
domain: all real numbers, range: $y \geq -4$

4.



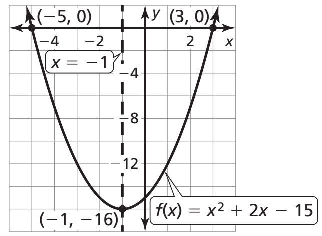
domain: all real numbers, range: $y \leq 4$

5.



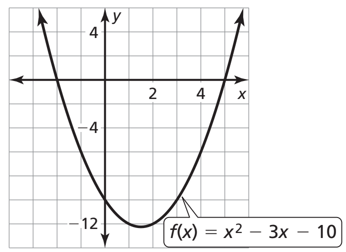
domain: all real numbers, range: $y \geq -4$

6.

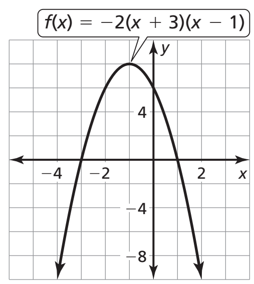


domain: all real numbers, range: $y \geq -16$

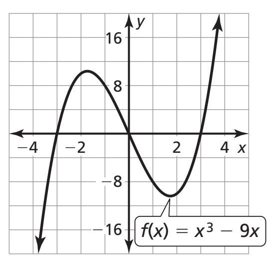
7. $-1, 1$
8. $-4, -5$
9.



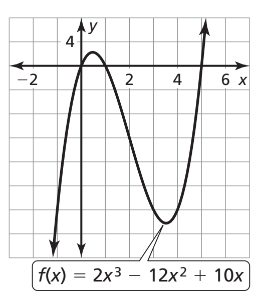
10.



11.

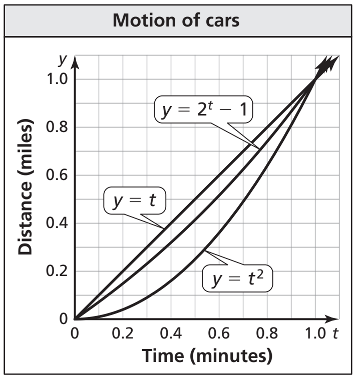


12.



8.6 Explorations

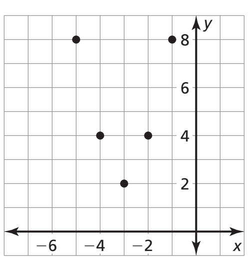
1. 0, 0.2, 0.4, 0.6, 0.8, 1.0; 0, 0.15, 0.32, 0.52, 0.74, 1.00; 0, 0.04, 0.16, 0.36, 0.64, 1.00



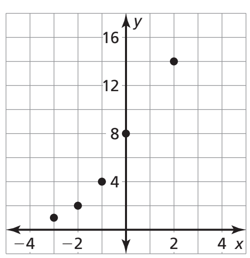
Sample answer: All three cars have the same average speed over the interval; first car; third car; The car modeled by a linear function is traveling at the same speed because it is traveling the same distance in each time interval. The car modeled by the quadratic function is accelerating the most because it has the greatest change in speed over each time interval.

2. 1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5; 1, 1.83, 3, 4.66, 7, 10.31, 15, 21.66, 31; 1, 2.25, 4, 6.25, 9, 12.25, 16, 20.25, 25; The first car has a constant speed. The second and third car are accelerating; The car modeled by the exponential function eventually overtakes the others.
3. *Sample answer:* Graph functions of each type in the same coordinate plane and compare the shapes of the graphs.
4. exponential; *Sample answer:* An exponential graph begins with a small change in each interval, but the change increases more rapidly as the value of the exponent increases.

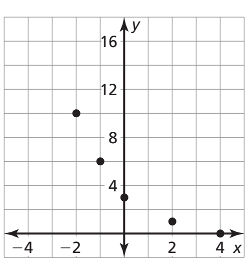
8.6 Extra Practice

1. 

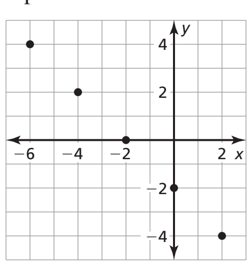
quadratic

2. 

exponential

3. 

exponential

4. 

linear

5. linear
6. quadratic
7. linear; $f(x) = 3x + 2$
8. quadratic; $f(x) = -3(x - 1)(x + 1)$
9. quadratic: The second differences are constant.

Chapter 9

Maintaining Mathematical Proficiency

1. $(x - 3)^2$
2. $(x + 2)^2$
3. $(x - 7)^2$
4. $(x + 11)^2$
5. $(x - 12)^2$
6. $(x + 13)^2$
7. (2, 3)
8. (4, −3)
9. (−1, 1)
10. (−3, 0)
11. (1, 2)
12. (4, 5)

9.1 Explorations

1. **a.** no; no; Because $\sqrt{36} + \sqrt{64} \neq \sqrt{36 + 64}$, the general statement cannot be true.

   b. yes; yes; By the Power of a Product Property, $a^{1/2} \cdot b^{1/2} = (a \cdot b)^{1/2}$.

   c. no; no; Because $\sqrt{64} - \sqrt{36} \neq \sqrt{64 - 36}$, the general statement cannot be true.

   d. yes; yes; By the Power of a Quotient Property, $\dfrac{a^{1/2}}{b^{1/2}} = \left(\dfrac{a}{b}\right)^{1/2}$.

2. *Sample answer:* $\sqrt{9} + \sqrt{16} \neq \sqrt{25}$, $\sqrt{16} - \sqrt{9} \neq \sqrt{7}$
3. Multiply or divide the numbers inside the square root symbols and take the square root of the product or quotient.
4. *Sample answer:* $\sqrt{9} \cdot \sqrt{16} = \sqrt{9 \cdot 16} = \sqrt{144} = 12$, $\dfrac{\sqrt{16}}{\sqrt{4}} = \sqrt{\dfrac{16}{4}} = \sqrt{4} = 2$
5. **a.** $\sqrt{a} \cdot \sqrt{b} = \sqrt{a \cdot b}$

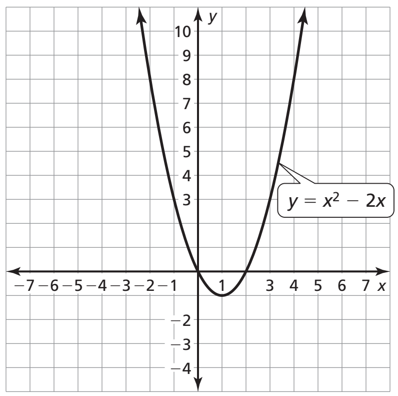
   b. $\dfrac{\sqrt{a}}{\sqrt{b}} = \sqrt{\dfrac{a}{b}}$

9.1 Extra Practice

1. $2\sqrt{6}$
2. $-4\sqrt{3}$
3. $9g^3\sqrt{2}$
4. $-16h^3\sqrt{2h}$
5. $\dfrac{5}{8}$
6. $-\dfrac{\sqrt{6}}{7}$
7. $-\dfrac{14}{r^2}$
8. $\dfrac{7x\sqrt{x}}{8y}$
9. $-3\sqrt[3]{5}$
10. 9
11. $4x\sqrt[3]{3x^2}$
12. $\dfrac{a^2\sqrt[3]{12b^2}}{8b^2}$
13. $\dfrac{\sqrt{3}}{10}$
14. $\dfrac{\sqrt{2}}{5}$
15. $\dfrac{\sqrt{15x}}{20}$
16. $2\sqrt[3]{4}$
17. $\dfrac{5 - 5\sqrt{3}}{6}$
18. $\dfrac{-3 + 3\sqrt{5}}{16}$
19. $\dfrac{-4\sqrt{2} - 20\sqrt{3}}{73}$
20. $\dfrac{\sqrt{15} - 5}{-2}$
21. 38 meters
22. $9\sqrt{2}$
23. $-6\sqrt{5} + 6\sqrt{2}$
24. $9\sqrt{2} + 12\sqrt{3}$
25. $2\sqrt{30} + 4\sqrt{5}$
26. 4
27. $6 - 3\sqrt[3]{10}$

9.2 Explorations

1. a.



b. the x-coordinate of a point where the graph crosses the x-axis; 2; 0, 2

c. a value of x that makes the equation true; 2; 0, 2

d. Substitute the solutions into the equation.

2. a. $x = 2, x = -2$

b. $x = 0, x = -3$

c. $x = 0, x = 2$

d. $x = 1$

e. no solution

f. no solution

3. Write the equation in standard form $ax^2 + bx + c = 0$, graph the related function $y = ax^2 + bx + c$, and find the x-intercepts.

4. Substitute the solutions into the equation.

5. The related graph will have no x-intercepts.

9.2 Extra Practice

1. $x = 0, x = -4$

2. $x = 1$

3. no solution

4. $x = 1, x = 4$

5. $x = -3$

6. no solution

7. $x = -3, x = 4$

8. $x = 5$

9. no solution

10. 0, 1, 2

11. −2, 1

12. −1, 1, 3

13. −3, −2, −1

14. 1, 2, 3

15. −1, 1, 3

16. about 0.4, about 2.6

17. about −1.3, about 2.3

18. about −5.7, about −2.3

9.3 Explorations

1. a. $x = 2, x = -2$

b. no solution

c. $x = 0$

d. $x \approx 2.2, x \approx -2.2$; The number of solutions is equal to the number of x-intercepts in the related graph.

2. a. −0.1159, −0.0716, −0.0271, 0.0176, 0.0625, 0.1076

b. −0.1159, −0.0716, −0.0271, 0.0176, 0.0625, 0.1076

$x \approx 2.24, x \approx -2.24$; The value 0.0176 is closest to 0.

3. a. yes; Adding 5 to each side of $x^2 - 5 = 0$ gives $x^2 = 5$.

b. $x \approx 2.236, x \approx -2.236$; The estimates in Exploration 2 were accurate to the hundredths place.

c. $x = \sqrt{5}, x = -\sqrt{5}$

4. Graph the related equation $y = ax^2 + c$. The number of solutions will be the same as the number of x-intercepts.

5. a. $x = \sqrt{2}, x = -\sqrt{2}; x \approx 1.41, x \approx -1.41$

b. $x = \sqrt{6}, x = -\sqrt{6}; x \approx 2.45, x \approx -2.45$

c. $x = \sqrt{8}, x = -\sqrt{8}; x \approx 2.83, x \approx -2.83$

9.3 Extra Practice

1. no real solutions

2. $x = 5, x = -5$

3. $x = 0$

4. no real solutions

5. $x = 6, x = -6$

6. $x = 0$

7. $x = 5, x = -5$

8. $x = 3, x = -3$

9. $x = \frac{5}{9}, x = -\frac{5}{9}$

10. $x = \frac{1}{4}, x = -\frac{1}{4}$

11. no real solutions

12. $x = 0$

13. $x = 4$

14. $x = 12, x = -16$

15. $x = 0, x = -7$

16. $x = \frac{17}{4}, x = \frac{7}{4}$

17. $x = -\frac{2}{27}, x = -\frac{16}{27}$

18. $x = \frac{11}{4}, x = -\frac{5}{4}$

19. $x \approx 1.4, x \approx -1.4$

20. $x \approx 3.9, x \approx -3.9$

21. $x \approx 4.9, x \approx -4.9$

22. $x \approx 2.4, x \approx -2.4$

23. $x \approx 1.6, x \approx -1.6$

24. $x \approx 0.7, x \approx -0.7$

25. 2.3 seconds

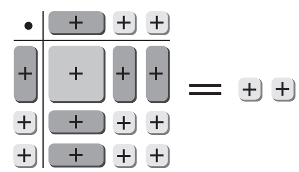
26. $r = \sqrt{\frac{3V}{\pi h}}$; 4.5 inches

9.4 Explorations

1. a. $x^2 + 4x = -2$

b. To be equivalent equations, the same number must be added to each side.

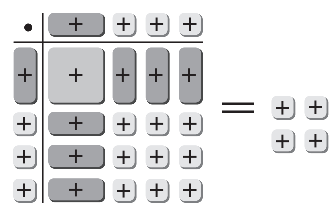
c.



d. $(x + 2)^2 = 2; x \approx -0.59, x \approx -3.41$

2. a. $x^2 + 6x = -5$

b.



c. $x = -1, x = -5$

d. $(-1)^2 + 6(-1) = -5; (-5)^2 + 6(-5) = -5$

3. Write the equation in the form $x^2 + bx = d$. Add $\left(\frac{b}{2}\right)^2$ to each side of the equation. Factor the resulting expression on the left side as the square of a binomial. Solve the resulting equation using square roots.

4. a. $x \approx 2.41, x \approx -0.41$

b. $x \approx 3.73, x \approx 0.27$

c. $x = -1, x = -3$

9.4 Extra Practice

1. $x^2 + 12x + 36; (x + 6)^2$

2. $x^2 - 14x + 49; (x - 7)^2$

3. $x^2 + 4x + 4; (x + 2)^2$

4. $x^2 + 18x + 81; (x + 9)^2$

5. $x^2 - 7x + \frac{49}{4}; \left(x - \frac{7}{2}\right)^2$

6. $x^2 + 11x + \frac{121}{4}; \left(x + \frac{11}{2}\right)^2$

7. $x = 5, x = 3$

8. $x = 1, x = -3$

9. $x = 3, x = -10$

10. $x \approx 25.7, x \approx 0.4$

11. $x \approx 12.8, x \approx -0.8$

12. $x \approx 16.1, x \approx -1.1$

13. $x \approx 11.2, x \approx 0.8$
14. $x \approx 0.7, x \approx -14.7$
15. $x = 9, x = -11$
16. $x = \frac{9}{5}, x = -\frac{1}{2}$
17. $x \approx 0.2, x \approx -2.2$
18. $x \approx -0.2, x \approx 0.9$
19. maximum value; 7
20. minimum value; 1
21. maximum value; 14
22. minimum value; -17
23. minimum value; $-\frac{7}{4}$
24. maximum value; 16
25. 5.56 feet; 0.19 seconds

9.5 Explorations

1. 2. Multiply each side by $4a$.
   3. Add b^2 to each side.
   4. Subtract $4ac$ from each side.
   5. Write the left side in factored form.
   6. Take the square root of each side.
   7. Subtract b from each side.
   8. Divide each side by $2a$.
2. **a.** $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$
   b. to obtain a perfect square trinomial on the left side of the equation
3. Complete the square of the general form of the quadratic equation, $ax^2 + bx + c = 0$.
4. **a.** $x = 1, x = -3$
   b. $x = 2$
   c. no real solution
5. The imaginary number, i, is $\sqrt{-1}$. Quadratic equations with no real solution have complex solutions, which include an imaginary part.

9.5 Extra Practice

1. $x = 8, x = 2$
2. $x = 2, x = -4$
3. $x = 1, x = -\frac{2}{3}$
4. no real solutions
5. $x \approx 2.5, x \approx -0.8$
6. $x \approx 2.6, x \approx -0.6$
7. 289 ft^2
8. two real solutions
9. one real solution
10. no real solutions
11. two x-intercepts
12. one x-intercept
13. no x-intercepts
14. $x = 6, x = -2$; *Sample answer:* The left side of the equation is a perfect square trinomial and the right side of the equation is a perfect square, so use square roots.
15. $x = 7, x = 1$; *Sample answer:* The equation is easily factorable, so use factoring.
16. $x \approx 1.14, x \approx -1.47$; *Sample answer:* The equation is not easily factorable and $a \neq 1$, so use the quadratic formula.

9.6 Explorations

1. $(-2, 0), (1, 3)$
2. **a.** A; $(-2, 0), (1, -3)$
   b. C; $(2, 2)$
   c. B; no solutions
   d. D; $(4, 6), (-1, -4)$
3. Graph the equations in the same coordinate plane and find the point(s) of intersection.
4. **a.** *Sample answer:* $y = x + 1, y = x^2 + 5$
   b. *Sample answer:* $y = 5, y = x^2 + 5$
   c. *Sample answer:* $y = x + 8, y = x^2 + 5$

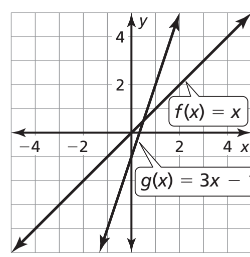
9.6 Extra Practice

1. $(-5, 6), (-1, 2)$
2. $(-2, -1), (2, 3)$
3. $(0, 1), (2, -1)$
4. $(-2, -4), (0.3, 0.7)$
5. $(0, -2), (3, -2)$
6. $(-1, -2), (0, -5)$
7. $(-2, 6), (2, 6)$
8. no solutions
9. $(-2, -6), (0, -4)$
10. no solutions
11. $(-2, -7), (2, 5)$
12. $(-4, 10), (4, 18)$
13. $(1, 8), (2, 2)$
14. $(4, 0), (2, 4)$
15. $(-1, -5), (2, 7)$
16. about $(0.23, 0.88)$, about $(4.27, -1.13)$
17. about $(-1.83, 2.67)$, about $(1.83, 2.67)$
18. about $(-0.53, -1.72)$, about $(1.55, 0.40)$

Chapter 10

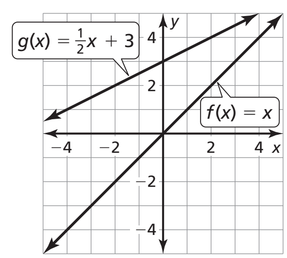
Maintaining Mathematical Proficiency

1. 40
2. $-\frac{21}{2}$
3. -19
4. -120
5. -27
6. 30
7. 8
8. 64
9.



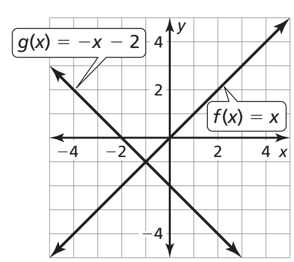
The graph of g is a vertical stretch by a factor of 3 then a vertical translation 1 unit down of the graph of f.

10.



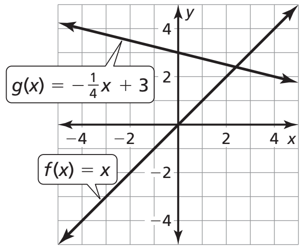
The graph of g is a vertical shrink by a factor of $\frac{1}{2}$ then a vertical translation 3 units up of the graph of f.

11.



The graph of g is a reflection in the x-axis then a vertical translation 2 units down of the graph of f.

12.

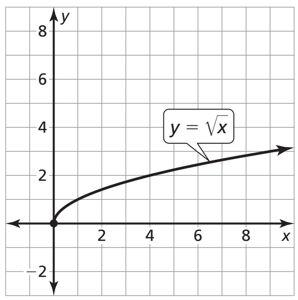


The graph of g is a vertical shrink by a factor of $\frac{1}{4}$, a reflection in the x-axis, then a vertical translation 3 units up of the graph of f.

10.1 Explorations

1. a.

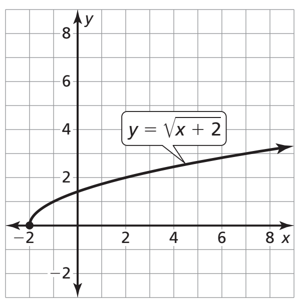
x	$f(x)$
0	0
1	1
4	2
9	3



$x \geq 0$; $y \geq 0$

b.

x	$f(x)$
−2	0
−1	1
2	2
7	3



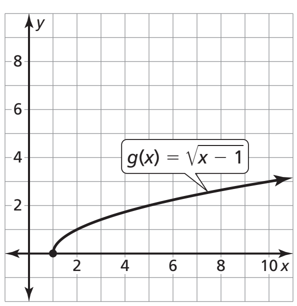
$x \geq -2$; $y \geq 0$

2. a. $y = \sqrt{x + 4}$; $1, \sqrt{2}, \sqrt{5}$

b. $y = \sqrt{x + 4} + 1$; $2, 1 + \sqrt{2}, 1 + \sqrt{5}$

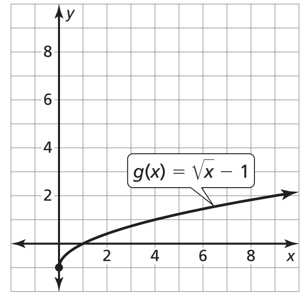
3. The graph of a square root function is half of a parabola opening to one side.

4. a.



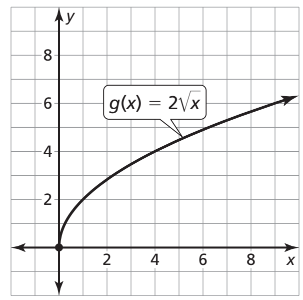
The graph of g is a translation 1 unit right of the graph of f.

b.



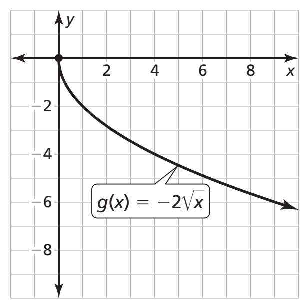
The graph of g is a translation 1 unit down of the graph of f.

c.



The graph of g is a vertical stretch by a factor of 2 of the graph of f.

d.



The graph of g is a vertical stretch by a factor of 2 and a reflection in the x-axis of the graph of f.

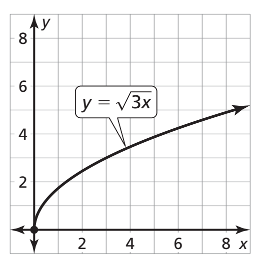
10.1 Extra Practice

1. $x \leq 0$

2. $x \geq 3$

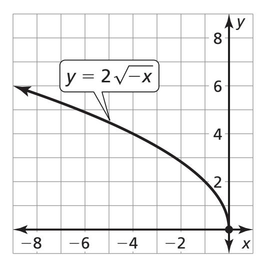
3. $x \geq 0$

4.



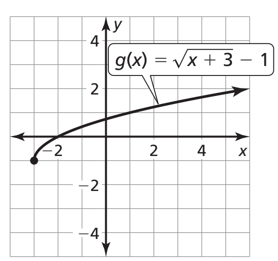
$y \geq 0$

5.



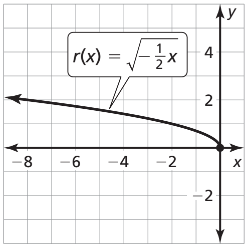
$y \geq 0$

6.



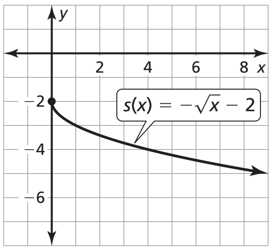
$y \geq -1$

7.



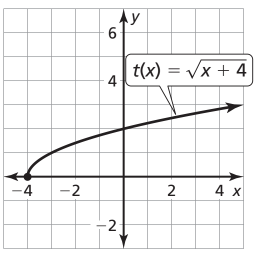
The graph of r is a horizontal stretch by a factor of 2 and a reflection in the y-axis of the graph of f.

8.



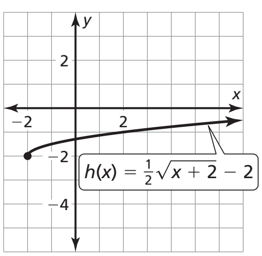
The graph of s is a reflection in the x-axis and a translation 2 units down of the graph of f.

9.

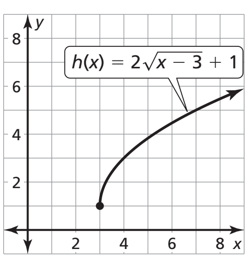


The graph of t is a translation 4 units to the left of the graph of f.

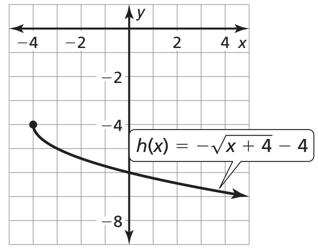
10. Translate 2 units left, shrink vertically by a factor of $\frac{1}{2}$, and translate 2 units down to obtain the graph of h.



11. Translate 3 units right, stretch vertically by a factor of 2, and translate 1 unit up to obtain the graph of h.



12. Translate 4 units left, reflect in the x-axis, and translate 4 units down to obtain the graph of h.

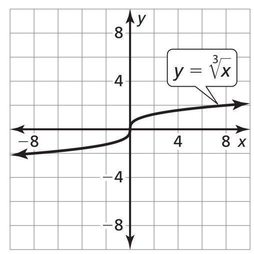


13. As skid mark lengths increase from 0 to 20 feet, the initial car speeds increase at an average rate of about 1.10 mile per hour per foot on Road Surface C and about 1.00 mile per hour per foot on Road Surface D.

10.2 Explorations

1. a.

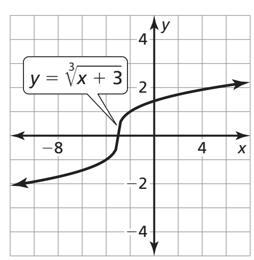
x	y
−8	−2
−1	−1
0	0
1	1
8	2



domain: all real numbers; range: all real numbers

b.

x	y
−11	−2
−4	−1
−3	0
−2	1
5	2



domain: all real numbers; range: all real numbers

2. **a.** $y = \sqrt[3]{x+4}$

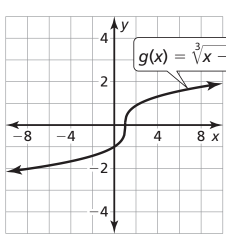
x	$f(x)$
−4	0
−3	1
−2	$\sqrt[3]{2}$
−1	$\sqrt[3]{3}$
0	$\sqrt[3]{4}$
1	$\sqrt[3]{5}$
2	$\sqrt[3]{6}$
3	$\sqrt[3]{7}$
4	2
5	$\sqrt[3]{9}$

b. $y = 1 + \sqrt[3]{x+4}$

x	$f(x)$
−4	1
−3	2
−2	$1 + \sqrt[3]{2}$
−1	$1 + \sqrt[3]{3}$
0	$1 + \sqrt[3]{4}$
1	$1 + \sqrt[3]{5}$
2	$1 + \sqrt[3]{6}$
3	$1 + \sqrt[3]{7}$
4	3
5	$1 + \sqrt[3]{9}$

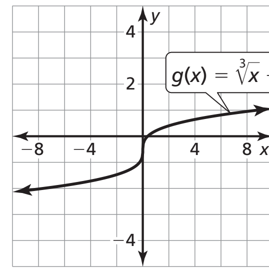
3. *Sample answer:* The graph has a center of rotation and looks somewhat like a parabola that opens to one side with the top half reflected over the y-axis.

4. **a.**



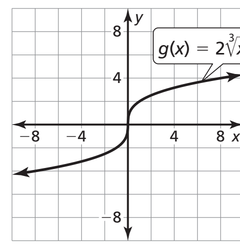
The graph of g is a translation 1 unit right of the graph of f.

b.



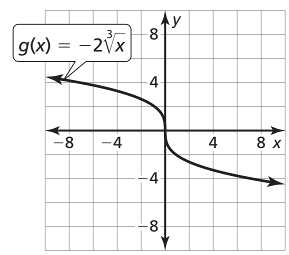
The graph of g is a translation 1 unit down of the graph of f.

c.



The graph of g is a vertical stretch by a factor of 2 of the graph of f.

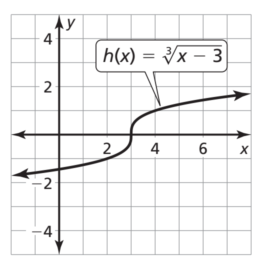
d.



The graph of g is a vertical stretch by a factor of 2 and a reflection in the x-axis of the graph of f.

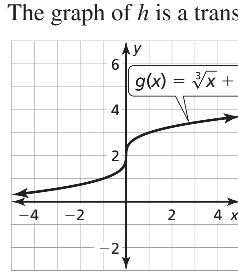
10.2 Extra Practice

1.



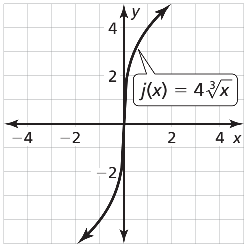
The graph of h is a translation 3 units right of the graph of f.

2.



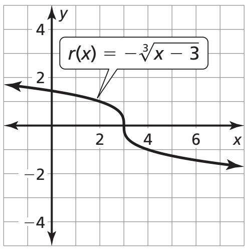
The graph of g is a translation 2 units up of the graph of f.

3.



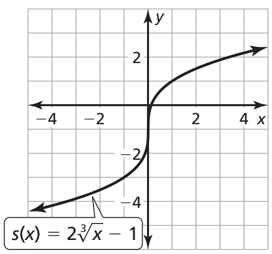
The graph of j is a vertical stretch by a factor of 4 of the graph of f.

4.



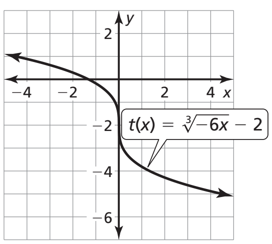
The graph of r is a reflection in the x-axis and a translation 3 units right of the graph of f.

5.



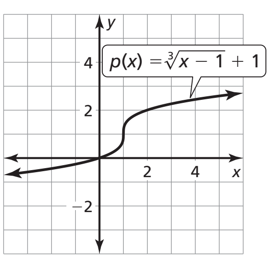
The graph of s is a vertical stretch by a factor of 2 and a translation 1 unit down of the graph of f.

6.

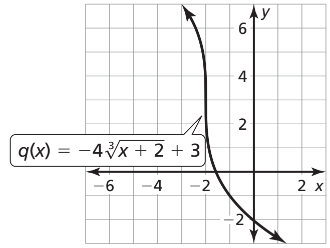


The graph of t is a horizontal shrink by a factor of $\frac{1}{6}$, a reflection in the y-axis, and a translation 2 units down of the graph of f.

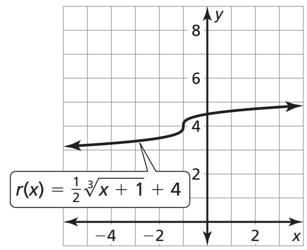
7. Translate 1 unit right and 1 unit up to obtain the graph of p.



8. Translate 2 units left, stretch vertically by a factor of 4, and translate 3 units up to obtain the graph of q.

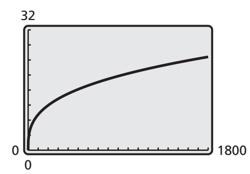


9. Translate 1 unit left, shrink vertically by a factor of $\frac{1}{2}$, and translate 4 units up to obtain the graph of r.



10. $1 \div \frac{1}{2} = 2$ times greater

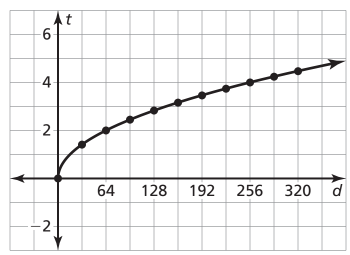
11.



about 1626.27 in.^{3}

10.3 Explorations

1. a.



b. about 3.9 sec

c. $t = \sqrt{\dfrac{d}{16}} = \sqrt{\dfrac{240}{16}} \approx 3.87$

d. 400 ft; Substitute 5 for t and solve for d.

2. a. 1 ft

b. 4 ft

c. 9 ft

3. Isolate the square root. Then square both sides of the equation to "undo" the square root and solve as usual.

4. a. $x = 5$

b. $x = 34$

c. $x = 1$

d. $x = \frac{9}{4}$

10.3 Extra Practice

1. $x = 16$

2. $n = 121$

3. $a = 9$

4. $s = 19$

5. $t = 6$

6. $x = 14$

7. $d = 2$

8. $c = 4$

9. $b = 4$

10. $z = \frac{27}{2}$

11. $v = 6$

12. $w = \frac{1}{3}$

13. $x = 125$

14. $x = -29$

15. $m = 2$

16. $k = -3$

17. no solution

18. $p = 10$

19. $r = 4$

20. no solution

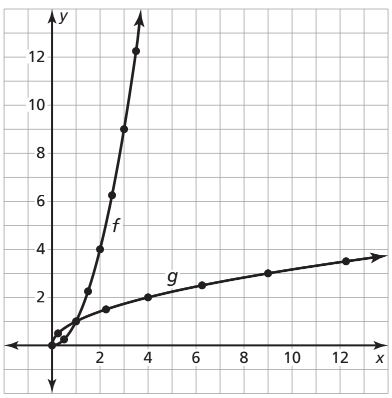
21. $k = 5, k = 2$

22. Yes, the length of a pendulum with a period of 16 seconds is $\frac{2048}{\pi^2} \div \frac{128}{\pi^2} = 16$ times as long as the length of a pendulum with a period of 4 seconds.

10.4 Explorations

1. The x-values in each table are the same as the function values in the other table.

2. **a–b.**



c. The graphs are reflections of each other in the line $y = x$.

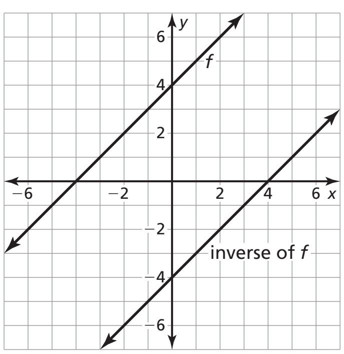
d. $f(x) = x^2, x \geq 0$; $g(x) = \sqrt{x}$

3. The x-coordinates of a function are the y-coordinates of its inverse function, and the y-coordinates of the function are the x-coordinates of its inverse function.

4.

x	1	2	3	4	5	6	7	8
$g(x)$	0	1	2	3	4	5	6	7

5.



$y = x - 4$; This is an equation of the line containing the points obtained by switching the inputs and outputs of f to get the inverse of f.

10.4 Extra Practice

1. $(-1, 1), (5, 2), (-2, 4), (8, 6), (9, 8)$

2.

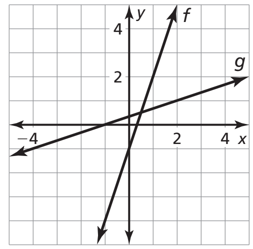
Input	4	2	2	5	3
Output	−3	−1	0	1	3

3. $x = y - 3$; 0

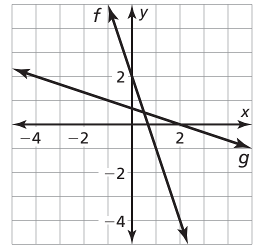
4. $x = \frac{y + 2}{3}$; $\frac{5}{3}$

5. $x = \pm\frac{\sqrt{y}}{2}$; $\pm\frac{\sqrt{3}}{2}$

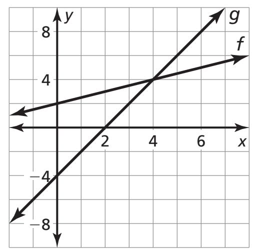
6. $g(x) = \frac{x + 1}{3}$



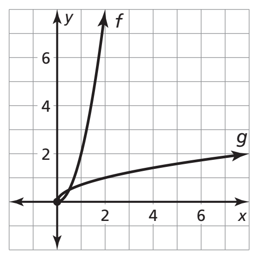
7. $g(x) = \frac{2 - x}{3}$



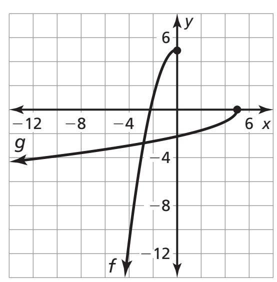
8. $g(x) = 2x - 4$



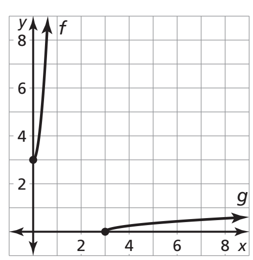
9. $g(x) = \sqrt{\frac{x}{2}}$



10. $g(x) = -\sqrt{5 - x}$



11. $g(x) = \frac{\sqrt{x - 3}}{4}$



12. yes; $g(x) = x^2 - 4, x \geq 0$

13. yes; $g(x) = \frac{x^2 + 9}{3}, x \geq 0$

14. yes; $g(x) = \frac{x^2}{4} + 4, x \geq 0$ **15.** no; $y = \pm\sqrt{\frac{x}{3}}$

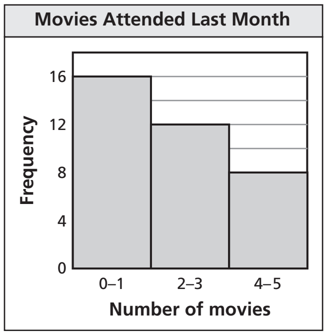
16. no; $y = \pm\sqrt{\frac{x+1}{5}}$

17. yes; $g(x) = \frac{(-x-5)^2 - 3}{2}, x \leq -5$

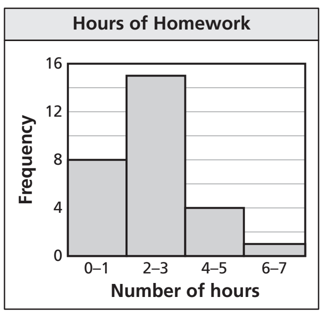
Chapter 11

Maintaining Mathematical Proficiency

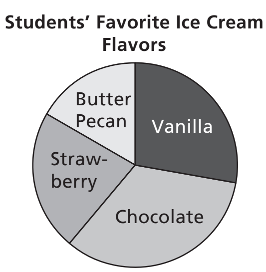
1.



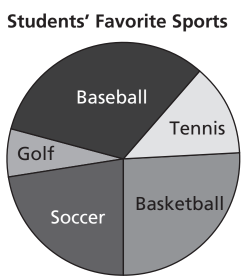
2.



3.



4.



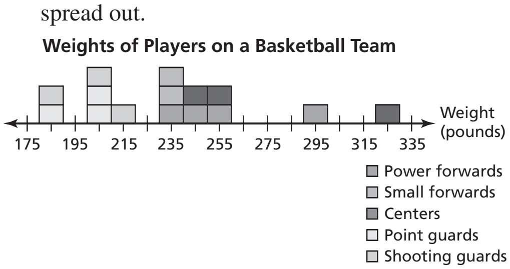
11.1 Explorations

1. a. The weights of the football players vary from the mean of about 245 pounds by up to 90 pounds. The weights of the baseball players vary from the mean of about 205 pounds by up to 40 pounds.

b. The weights of the football players vary from the mean much more than the weights of the baseball players.

c. yes; no; Each football position seems to be clustered around a similar weight; Each baseball position is more spread out.

2.



yes; Guards tend to be lighter, forwards tend to be heavier.

3. Describe how the data vary from the mean.

11.1 Extra Practice

1. a. mean: 5, median: 4, mode: 2

b. median; The mean is greater than most of the data and the mode is less than most of the data.

2. a. 44; The outlier decreases the mean and median and does not affect the mode.

b. *Sample answer:* The outlier could be the mass of a baby gorilla.

3. Team A: 30; Team B: 21; The range for Team A is greater.

4. a. about 8.7; The typical height differs from the mean by about 8.7 inches.

b. about 6.4; The typical height differs from the mean by about 6.4 inches.

c. The standard deviation for Team A is greater, so the heights are more spread out.

5. mean: 50, median: 48, mode: 46, range: 15, standard deviation: 4.9

11.2 Explorations

1. a. 0, 1, 3, 3, 3, 3, 5, 6, 8, 8, 9, 10, 10, 12, 13, 13, 14, 16, 18, 19, 23, 24, 32, 45; median: 10

b. least value: 0, first quartile: 4, third quartile: 17, greatest value: 45

c. The box represents the middle half of the data and the whiskers represent the bottom and top quarters of the data.

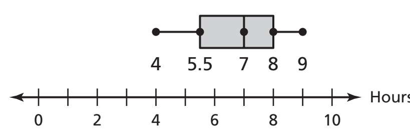
2. A box-and-whisker plot can be used to show the median, the first and third quartiles, and the least and greatest values of a data set.

3. a. The median is 21, the first quartile is 19, the third quartile is 22, the least value is 17, and the greatest value is 28.

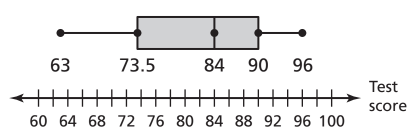
b. The median is 180 feet, the first quartile is 140 feet, the third quartile is 220 feet, the least value is 120 feet, and the greatest value is 240 feet.

11.2 Extra Practice

1.



2.



3. a. 16; The prices vary by no more than \$16.

b. 25% of the prices are between \$8.50 and \$11.25, 50% of the prices are between \$11.25 and \$15.75, and 25% of the prices are between \$15.75 and \$24.25.

c. 9; The middle half of the prices vary by no more than \$9.

d. above Q3; the whisker is longer

4. a. State A: symmetric; State B: skewed right

b. State B; The range and interquartile range are greater.

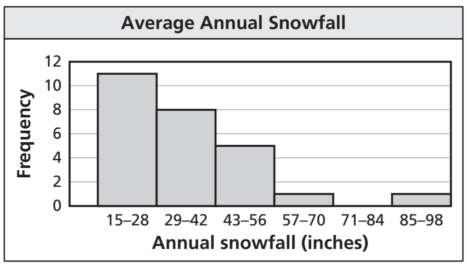
c. State A; The least value is 0.

11.3 Explorations

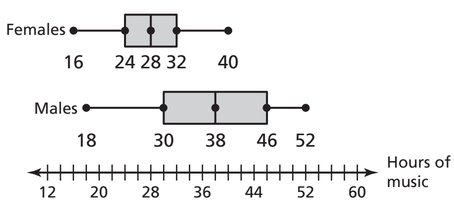
1. a. *Sample answer:* 77.5%; The green bars represent the data within 1 standard deviation of the mean.
   b. *Sample answer:* 96.7%; The green and blue bars represent the data within 2 standard deviations of the mean.
   c. *Sample answer:* 99.3%; The green, blue, and red bars represent the data within 3 standard deviations of the mean.
2. a. Adult female heights; The heights of adult females do not vary as far from the mean.
   b. *Sample answer:* 75%
3. *Sample answer:* Draw a curve through the tops of the bars.
4. a. Most of the data is clustered around the mean in the center of the data.
   b. The curve connecting the tops of the bars looks like a bell.
   c. *Sample answer:* standardized test scores; length of daylight each day over a year

11.3 Extra Practice

1. a.



   b. median, five-number summary; The distribution is skewed right.
   c. Most cities were not on the snowiest city list.
2. City B usually has greater monthly precipitation, and the monthly precipitation tends to differ more for city A.
3. a.



   The distribution of data for females is symmetric. The distribution of data for males is skewed left.
   b. The number of hours of music listened to by females tends to be less than the number of hours of music listened to by males.
   c. about 34 females
   d. about 95 females

11.4 Explorations

1. a. Beginning: 29; 29; 29; 29; 29; 25; 30; 35; 30; 25;
   End: 12; 16; 14; 11; 12; 20; 18; 14; 5; 8; 65
   b. For each shirt category, order the quantity equal to the difference between the number at the beginning of the season and the number at the end of the season.
2. a. *Sample answer:*

		Gender		
		Males	**Females**	**Total**
Hours	**0 hours per week**	145	145	290
	1–7 hours per week	110	115	225
	8+ hours per week	70	115	185
	Total	325	375	700

   b. *Sample answer:* More females work 8+ hours per week than males. Approximately equal numbers of males and females work 1–7 hours per week and 0 hours per week.
3. *Sample answer:* Rows and columns represent different categories, each entry represents the number in both categories.

11.4 Extra Practice

1. 218 of those surveyed attend college, 220 of those surveyed do not attend college, 230 males responded, 208 females responded, 438 were surveyed.
2. 99 students own a car, 273 students do not own a car, 190 males responded, 182 females responded, 372 students were surveyed.
3.

		Math Club		
		Yes	**No**	**Total**
Chess Club	**Yes**	20	12	32
	No	15	38	53
	Total	35	50	85

4.

		Read *Catcher in the Rye*		
		Yes	**No**	**Total**
Gender	**Male**	0.30	0.25	0.55
	Female	0.17	0.28	0.45
	Total	0.47	0.53	1

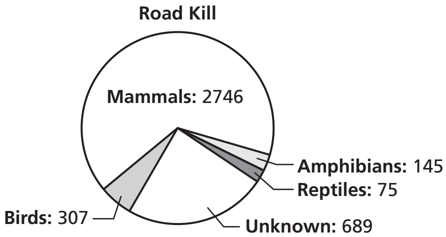
5.

		Seat	
		Upper	**Lower**
Game Time	**Day**	0.46	0.54
	Night	0.30	0.70

about 54%

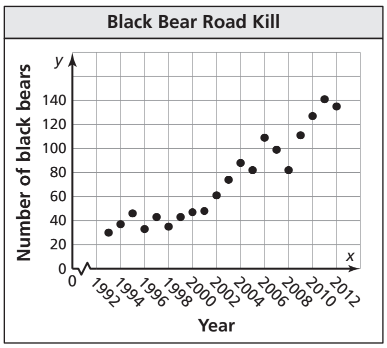
11.5 Explorations

1. a. *Sample answer:*



The circle graph shows the types of animals as parts of a whole.

b. *Sample answer:*



The scatter plot shows the relationship between the data.

c. *Sample answer:*

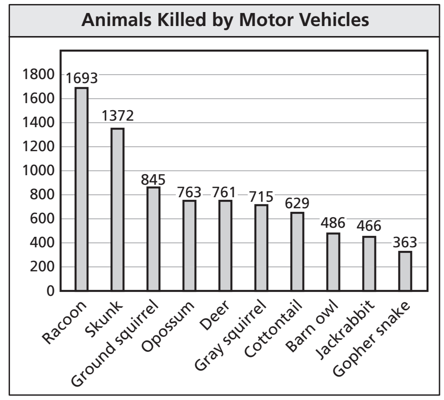
Raccoon Road Kill Weights

Stem	Leaf
9	4 5
10	
11	0
12	4 9
13	4 6 9
14	0 5 8 8
15	2 7
16	8
17	0 2 3 5
18	5 5 6 7
19	0 1 4
20	4
21	3 5 5 5
22	
23	
24	
25	4

Key: 9 | 4 = 9.4 lb

The stem-and-leaf plot shows how the raccoon weights are distributed.

d. *Sample answer:*



The bar graph shows the data in each specific category.

2. You can display data using different plots and graphs to make it easy to interpret and draw conclusions from the data.

3. Check students' work.

11.5 Extra Practice

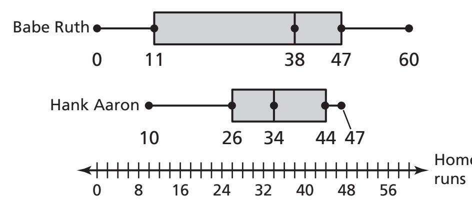
1. qualitative; Bookmarks are nonnumerical.

2. quantitative; Heights are numerical values.

3. quantitative; Number of kilobytes in a file is numerical.

4. qualitative; Radio station numbers are numerical, but they are labels. It does not make sense to compare or measure radio station numbers.

5. *Sample answer:*



A double box-and-whisker plot shows the distribution of the data.

6. *Sample answer:*

Points Scored Each Game

Stem	Leaf
3	0 0 3 7
4	0 0 1 4 4 5 7 8 9
5	2 6 9
6	2 5

Key: 5 | 2 = 52 points

A stem-and-leaf plot shows how the scores are distributed.

7. The first interval is twice as big as the other two intervals; Someone might compare the intervals as being the same.

8. The vertical axis starts at 60 not 0; Someone might think Bob's score was 3 times Carol's score.