SELECTED ANSWERS

Chapter 1

Activity 1.1 Exercises: 1. a. Weight is input, and height is output. **c.** Height is input, and weight is output. **3. a.** Yes, for each numerical grade there will correspond only one letter grade. **b.** No, for each letter grade there may correspond several different numerical grades. For example, an A may be based on 92% or 94%. **5. a.** Yes, in this table each elevation is paired with only one amount of snowfall. **b.** Yes, in this table each quantity of snow is paired with one elevation. **7. a.** Yes, each input value has only one output value. **b.** No, the one input 5 is paired with four different outputs. **9. a.** The input is x, the output is $g(x)$ or y. The function name is g, y equals g of x, **c.** The input is 6. The output is 3.527. The name is f, f of 6 equals 3.527, **e.** The input is price. The output is sales tax. The name is T. Sales tax is a function of price. **10. a.** 1600; 2400, **c.** $f(6) = 2400$;

Activity 1.2 Exercises: 1. x is the input, $h(x)$ is the output, h is the function, $h(x) = 0.08x$. **3.** $f(2) = -1$, $f(-3.2) = -11.4$, $f(\pi) \approx 1.2832$, $f(a) = 2a - 5$; **5.** $f(2) = 4$, $f(-3.2) = 4$, $f(\pi) = 4$, $f(a) = 4$;

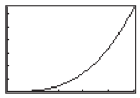
7.

x	$h(x)$
10	0.1
20	0.05
30	0.033
40	0.025

9. a. The distance traveled is 3 times the number of hours I have hiked. **b.** The input is hours. The output is distance. **d.** $h(t)$ is the dependent variable since distance is the output. **f.** $h(7) = 3(7) = 21$. (7, 21), **h.** The practical domain depends on the individual and is probably real numbers from 0 to about 8. Using this domain, the range is real numbers from 0 to 24. **10. a.** The domain is $-2 \le x \le 3$, and the range is $-1 \le y \le 2$. **c.** The domain is all real numbers. The range is $y \ge 0$. **11. a.** domain $\{-2, 0, 5, 8\}$, range $\{4, 3, 8, 11\}$; **12. a.** $0 \le C \le 100$; **b.** $32 \le F \le 212$;

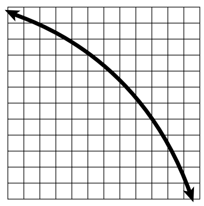
Activity 1.3 Exercises: 1. a. 3.7, 6.4, 9.1, 11.8, **b.** $f(2500) = 7.75$ inches of snow, **c.** $f(-2000) = -4.4$ It has no meaning in this context. -2000 would mean 2000 feet below sea level, but -4.4 inches of snow is not possible. **d.** Xmin = 0, Xmax = 5000, Ymin = 0, Ymax = 15, **e.** Yes, any vertical line will intersect the graph no more than once, **f.** increasing, **g.** It is the same, 7.75; **3. a.** 7238; 11,494; 17,157; 24,429, **c.** The practical domain is $0 \le r \le 25$. The practical range is $0 \le h \le 65{,}450$,

e. $f(r) = \frac{4}{3}\pi - r^3$, **g.**



i. Using the vertical line test, I can see that no vertical line crosses the graph more than once. The graph represents a function.

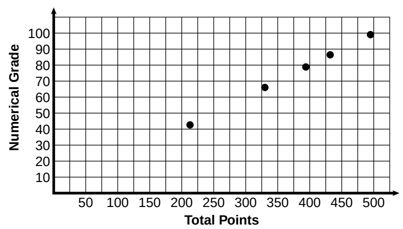
4. a.



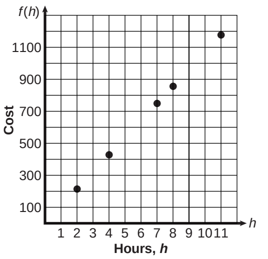
b. The graph is a horizontal line; **5. a.** This is a function. **b.** This is not a function. **6.** Xmin = -9, Xmax = 9, Ymin = $-254{,}000$, Ymax = 54,000 answers may vary

How Can I Practice? 1. a. Yes, because for each point total there is only one grade. **b.** Yes. For each numerical grade in the table, there is one value of total points. **c.** $f = \{(432, 86.4), (394, 78.8), (495, 99), (330, 66), (213, 42.6)\}$,

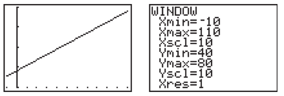
d.



e. $f(394) = 78.8$, **f.** 78.8, **g.** $f(213) = 42.6$, **h.** 42.6, **i.** $n = 330$; **2.** This is a function. **3.** This could be a function, depending on how activity level is measured. **4.** This is a function. **5.** This is not a function. **6.** This is a function. **7.** This is not a function. The input -3 has two different outputs. **8.** This is a function. **9.** This is a function. **10.** This is not a function. **11. a.** $c = 120h$, **b.** $f(h) = 120h$, **c.** 240, 480, 840, 960, 1320, **d.** \$360, (3, 300), **e.** $h = 5$ hours, **f.** $f(h)$ or c is the output variable. This is the variable that depends on the number of credits taken. **g.** h is the independent variable. It is the input variable. **h.** For each value of input, there is one value of output, **i.** Assuming there are no half-credit courses, the practical domain is all whole numbers from 0 to 11, depending on the college, **j.** The horizontal axis represents the input.



k. $f(h)$ is a function because the graph passes the vertical line test, **m.** \$963; **12. a.** $p(3) = 13$, **b.** $p(-4) = -1$, **c.** $p\left(\frac{1}{2}\right) = 8$, **d.** $p(0) = 7$; **13. a.** $t(2) = -3$, **b.** $t(-3) = 18 + 9 - 5 = 22$; **14. a.** 48, 59, 67, 73, 75, **b.** $f(85) = 0.27(85) + 48.3 = 71$. The life expectancy for a male born in 1985 is 71 years,

c. 

d. The graph is increasing. It is rising to the right. **e.** They are the same.

15. a. domain {3, 4, 5, 6}, range {5, 8, 10}, **b.** domain {0, 50, 100, 150, 200}, range {19.95, 23.45, 26.95, 30.45, 33.95}, **c.** domain $-3 \le x \le 4$, range $-1 \le y \le 3$, **d.** domain $-3 \le x \le 3$, range $0 \le y \le 4$, **e.** Domain is all real numbers, range is all real numbers; **16. a.** The net profit increases during the first two quarters of 1993. The net profit then decreases for about 2.5 quarters, and then it increases through the final quarter of 1994. **b.** The annual income rises rather steadily for 3 years; in the fourth year, it rises sharply. Then it suffers a sharp decline during the next year. During the last year, the income recovers to about the point it was originally.

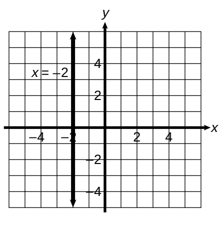
Activity 1.5 Exercises: 1. a. $\frac{27.1 - 22.8}{1990 - 1950} = \frac{4.3}{40} = 0.1075$ years/year, **b.** The median age of a man at the time of his first marriage is increasing at an average rate of .1075 years/year. **3.** $\frac{26.8 - 25.1}{90} = \frac{1.7}{90} \approx 0.019$ years/year; **5. a.** It means that the median age of a man at the time of his first marriage is decreasing. **b.** 1910–1920, 1920–1930, or 1940–1950, **c.** The graph would go down to the right. **8. a.** $\frac{1519 - 1476}{1998 - 1997} = 43$ new hotels/year, **b.** $\frac{1402 - 1519}{1999 - 1998} = -117$ new hotels/year, **c.** The rate of new hotel construction increased from 1997 to 1998 then decreased from 1998 to 1999. **d.** The graph is going down to the right. The rate of new hotel construction is decreasing.

9. a. $\frac{760 - 668}{1970 - 1960} = \frac{92}{10} = 9.2$ gal/year,
b. $\frac{520 - 668}{1990 - 1960} = \frac{-148}{30} \approx -4.93$ gal/year,
c. $\frac{550 - 530}{2003 - 1995} = \frac{20}{8} = 2.5$ gal/year,
d. $\frac{550 - 668}{2003 - 1960} = \frac{-118}{43} \approx -2.74$ gal/year,
e. It means that from 1960 to 1999, the average fuel consumption per year of a passenger car in the United States decreased by about 3 gal/year.

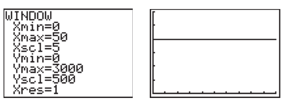
Activity 1.6 Exercises: 1. a. yes, linear; $m = 10$, **b.** no, not linear, **c.** yes, linear $m = \frac{-9}{4}$; **3. a.** Yes, the rate of change is a constant -3. **b.** No, between weeks 1 and 2 the slope is -5. Between weeks 2 and 3, the slope is -4. **c.** Yes, the slope is 0 for all pairs of points.
5. a. $m = \frac{5 - (-7)}{0 - 2} = \frac{12}{-2} = -6$, **b.** (0, 5), **c.** $f(x) = -6x + 5$, **d.** $\left(\frac{5}{6}, 0\right)$; **7. a.** Yes, the slope is a constant. **b.** $m = \frac{3000 - 3500}{20 - 0} = \frac{-500}{20} = -25$ ft/sec, **c.** The jet is losing altitude, **d.** (0, 3500), **e.** $h = -25t + 3500$, **f.** (140, 0); The jet lands in 140 seconds. **8. a.** $(-1/2, 0)$, **b.** (6, 0)

Activity 1.7 Exercises: 1. a. $y = \frac{1}{2}x - 1$, **b.** $y = -\frac{4}{3}x + 1$,
d. $m = \frac{6 - (-3)}{2 - (-4)} = \frac{6 + 3}{2 + 4} = \frac{9}{6} = \frac{3}{2}, y = \frac{3}{2}x + b$,
$6 = \frac{3}{2}(2) + b, 6 = 3 + b, b = 3, y = \frac{3}{2}x + 3$,
e. $-5 = 3(2) + b, b = -11, y = 3x - 11$; **2. a.** (0, 35); The vertical intercept occurs where the input $x = 0$.
b. $m = \frac{40 - 35}{100 - 0} = \frac{5}{100} = 0.05$; The mileage charges are \$0.05 per mile. **c.** $c = 0.05x + 35$;
3. a. $m = \frac{145 - 75}{4 - 2} = \frac{70}{2} = 35$ mph,
b. $d = 35t + b \quad 75 = 35(2) + b \quad 75 = 70 + b \quad b = 5$
$d = 35t + 5$; **4. a. i.** $m = 1$, **ii.** $(0, -2)$, **iii.** $y = x - 2$, **c. i.** $m = -2$, **ii.** (0, 6), **iii.** $y = -2x + 6$;
7. a. $m = \frac{31.42 - 0}{5 - 0} = 6.28$, b. (0, 0), **c.** $C = 6.28r$, **d.** $C = 2\pi r$, **e.** Yes, π is approximately 3.14, so 2π is approximately 6.28.

Activity 1.8 Exercises: 1. a. $y = 2x - 3, m = 2, (0, -3)$, **b.** $y = -x - 2, m = -1, (0, -2)$, **c.** $y = \frac{2}{3}x - \frac{7}{3}, m = \frac{2}{3}$, $\left(0, -\frac{7}{3}\right)$, **d.** $y = \frac{1}{2}x + 2, m = \frac{1}{2}$, (0, 2), **e.** $y = 4, m = 0, (0, 4)$;

3. a. 

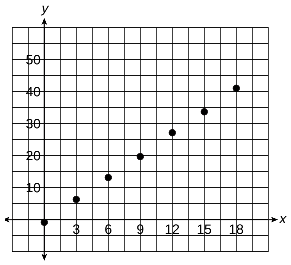
b. This is not a function. It does not pass the vertical line test; **c.** $x = -2$; **d.** The slope is undefined. **e.** vertical: none; horizontal: $(-2, 0)$; **5. a.** $f(x) = 2000$, **b.** 2000, 2000, 2000;

c. 

d. The slope is zero. This means the fee does not change. **e.** The graph is a horizontal line through (0, 2000). **6. a.** $250w$, **b.** $200d$, **c.** $250w + 200d = 10{,}000$, **d.** $d = \frac{10{,}000 - 250w}{200} = 50 - \frac{5}{4}w$, **e.** (40, 0); The maximum number of washers I can purchase is 40.

Activity 1.9 Exercises:

1. a.

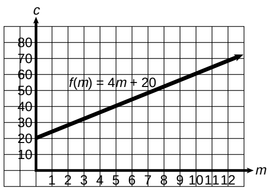


b. (Answers will vary.) Yes, the points are very close to a line. **c.** $f(x) = 2.299x - 0.761$, **d.** 22.229, **e.** 56.714,

f. $f(10)$ is more accurate; 10 is within the given data. 25 is not. $f(10)$ uses interpolation. $f(25)$ uses extrapolation; **2. b.** $f(t) = 1.150t + 8.579$, **c.** The slope of the line is 1.150. This means that the average debt per person is increasing at an average rate of $1150 per year. **d.** The regression line predicts an average debt of $13,179 in 1990. This is 179 above the actual, 13,000, an error of slightly less than 1.4%. **e.** $26,979, **f.** extrapolation;

How Can I Practice? 1. a. $g(x) = 2x - 3$, **b.** $h(x) = -2x - 3$, **c.** $x = 2$, **d.** none, **e.** $f(x) = -2x + 3$, **f.** $y = -2x$, **g.** $y = 2$, **h.** none, **i.** none; **2. a.** 28, 40, 52, 60, 68, **b.** yes, **c.** 4, **d.** $c = f(m) = 4m + 20$;

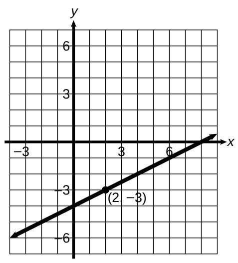
e.



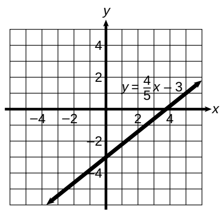
f. This represents the monthly charge. **g.** (0, 20); It indicates that the initial rental cost is $20. **h.** (−5, 0). It has no practical meaning in this case.

i. $65 = 4m + 20$ or $45 = 4m$ or $m = 11.25$. I can keep the graphing calculator for 11 months. **3. a.** 1.5, **b.** 1.5, **c.** $s(t)$ is a linear function because the rate of change is constant. **4.** $m = \frac{12 - 8}{-5 - 3} = -\frac{1}{2}$; **5.** $m = -4$; **6.** $m = \frac{2}{5}$; **7.** $y = -7x + 4$; **8.** $y = 2x + 10$; **9.** $y = 5$; **10.** $x = -3$; **11.** $y = -\frac{1}{2}x - 2$; **12.** $y = \frac{1}{3}x - 3$;

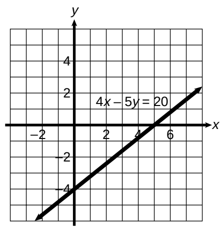
13.



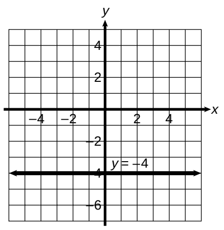
14.



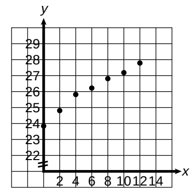
15.



16.

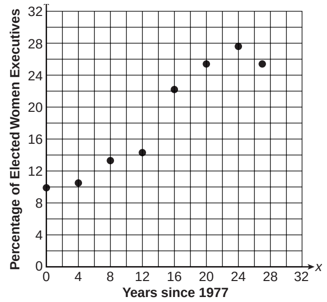


17. a.



b. $y = 0.322x + 24.156$, **c.** $y = 27.054$, **d.** $y = 30.596$;

18. a.



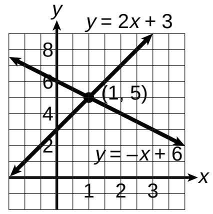
b. $f(x) = 0.728x + 8.472$, **c.** In 1986, $x = 9$; $f(9) = 15.0\%$. In 2010, $x = 33$; $f(33) = 32.5\%$, **d.** 1986 because it is interpolated from the data. The 2010 percentage was a result of extrapolation, which is usually less accurate.

Activity 1.10 Exercises:

1. a. Numerically

x	y_1	y_2
0	−3	7
1	2	12
2	7	17
3	12	22
4	17	27

Graphically



Algebraically (substitution method)

$y = 2x + 3 \quad y = -x + 6$

$$\begin{aligned} 2x + 3 &= -x + 6 \\ +x \quad & \quad +x \\ \hline 3x + 3 &= 6 \\ -3 &\quad -3 \\ 3x &= 3 \\ \frac{3x}{3} &= \frac{3}{3} \\ x &= 1 \end{aligned}$$

$y = -1 + 6$

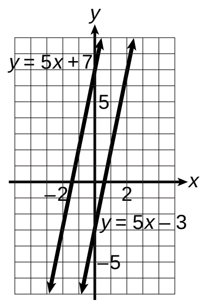
$y = 5$

The answer is (1, 5).

c. Numerically

x	y_1	y_1
0	−3	7
1	2	12
2	7	17
3	12	22
4	17	27

Graphically



Algebraically (substitution method)

$y = 5x - 3 \quad y = 5x + 7$

$$\begin{aligned} 5x - 3 &= 5x + 7 \\ -5x \quad & \quad -5x \\ \hline -3 &= 7 \text{ false} \end{aligned}$$

There is no solution.

2. a. $s = 17.2 + 1.5n$, **b.** $s = 9.6 + 2.3n$, **c.** in the year 2012; **3. a.** $c = 3560 + 15n$, **b.** $c = 2850 + 28n$, **c.** $n = 54.6$ or 55 months, **d.** dealer 1's system;

5. a.

t, NUMBER OF YEARS SINCE 1975	LIFE EXPECTANCY FOR WOMEN	LIFE EXPECTANCY FOR MEN
0	77.01	68.94
25	79.66	73.94
50	82.31	78.94
100	87.61	88.94
75	84.96	83.94
80	85.49	84.94
85	86.02	85.94
86	86.13	86.14

b. 86 years after 1975, year 2061, the life expectancy for both men and women will be 86 years. **c.** (85.8, 86.1), **d.** $E = 86.10$; **7. a.** $2 = x, y = 4$, **b.** $16 = y, x = -39$, **c.** $y = \frac{1}{2}, x = \frac{3}{4}$, **d.** $1 = -3$, no solution;

Activity 1.11 Exercises: 1. a. $x = -5$, **b.** $x = -2$, **c.** $\frac{4}{7} = x$; **3. a.** $y = 5$, (1, 5), **b.** $y = -3$, (2, −3);

5. a. $8x + 5y = 106$
$x + 6y = 24$,

b. $x = -6y + 24$

$$8(-6y + 24) + 5y = 106$$
$$-48y + 192 + 5y = 106$$
$$-43y = -86$$
$$y = 2$$

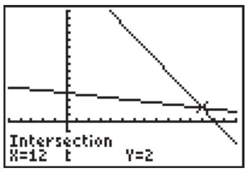
$x = -6(2) + 24 = 12$

(12, 2) Each centerpiece costs $12, and each glass costs $2.

c.

$$8x + 5y = 106 \qquad 8x + 5y = 106$$
$$-8(x + 6y) = -8(24) \qquad -8x - 48y = -192$$
$$-8x - 48y = -192$$
$$-43y = -86$$
$$y = 2$$
$$x + 6(2) = 24$$
$$x + 12 = 24$$
$$x = 12,$$

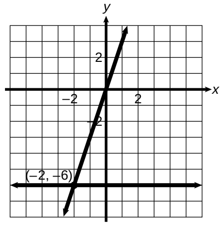
d.



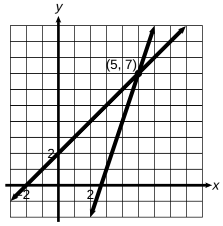
Activity 1.12 Exercises: 1. (0, −3, 5); **3.** (−5, 3, 1); **5. a.** dependent, **b.** inconsistent;

Activity 1.13 Exercises: 1. $l + w + d \le 61$; **3.** $C(A) < C(B)$; **5.** $24{,}650 < i \le 59{,}750$;

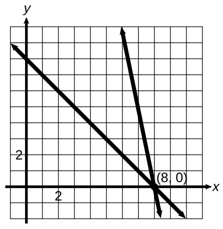
7. $x > -2$



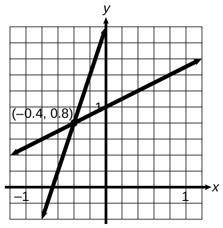
9. $x < 4$



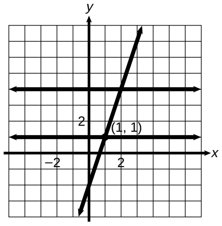
11. $x \ge 8$



13. $x \ge -0.4$



15. $1 < x < 2$



17. a. $-14.25t + 598.69 < 200$, **b.** $t > 27.98$; 28 years after 1985, the year 2013; **18. a.** $C = 5495 + 0.29n$, **b.** $C = 39.95 + 0.49n$, **c.** $39.95 + 0.49n < 54.95 + 0.29n$, **d.** $n < 75$; **19. a.** $150 + 60n$, **b.** $150 + 60n \le 1200$, **c.** $n \le 17.5$ The maximum number of boxes that can be placed in the elevator is 17. **20.** $57.5 \le w \le 70$; **21. a.** $-79.8 \le F \le 134$, **b.** $-79.8 \le 1.8C + 32 \le 134$;

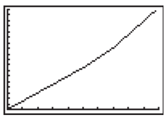
Activity 1.14 Exercises:

1. e. $1.20 + .90(11) = \$11.10$;

3. a.

$$f(x) = \begin{cases} 2.5x & x \le 15{,}000 \\ 37{,}500 + 3(x - 15{,}000) & 15{,}000 \le x \le 21{,}000 \\ 55{,}500 + 4(x - 21{,}000) & x > 21{,}000 \end{cases}$$

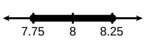
b.



d. 23,375 books;

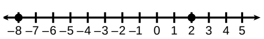
5. a. $f(x)$: 8, 7, 6, 5, 4, 3, 2, 1, 0, 1, 2; $g(x)$: 2, 1, 0, 1, 2, 3, 4, 5, 6, 7, 8;

Activity 1.15 Exercises: 1. a. 0.25 cm, **b.** $|x - 8| \le 0.25$, **c.**



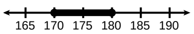
$7.75 \le x \le 8.25$;

4. a.



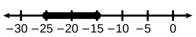
$x = -8$ or $x = 2$,

c.



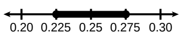
$170 \le x \le 180$,

e.



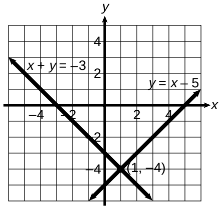
$-25 < x < -15$;

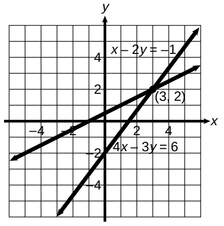
9. a. $|x - 0.25| \le 0.025$, **b.** $0.225 \le x \le 0.275$; acceptable thickness of the sheet of steel



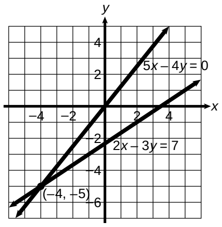
How Can I Practice?

1. a. (1, −4) **b.** (3, 2)

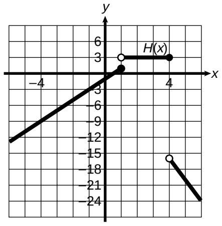




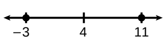
c. (−4, −5) **d.** −2 = 6 inconsistent; no solution;



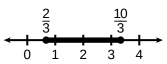
2. a. (1, −4), **b.** (3, 2), **c.** (−4, −5), **d.** inconsistent; **3.** (1, 5, −2); **4.**



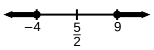
5. a. $x = 11$ or $x = -3$



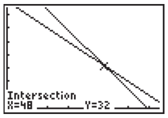
b. $2/3 \le x \le 10/3$



c. $x > 9$ or $x < -4$



6. a. $x \ge 1.8$, **b.** $x > -6$, **c.** $1 \le x < 5$; **7. a.** $t + d = 80$, $0.50t + 0.75d = 52$, **b.** $d = 48$, $t = 32$, **c.**

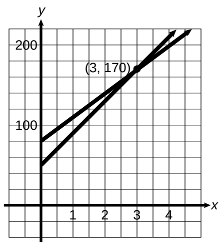


8. a. $y = 80 + 30x$, $y = 50 + 40x$,

b.

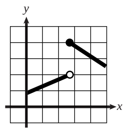
COLUMN 2	COLUMN 3
140	130
200	210
260	290
320	370

c.



d. 3 hours; the total cost is $170, **e.** $x = 3$, $y = 80 + 90 = 170$, **f.** I will use Towne Truck; its graph is below World Transport for $x = 6$; **9. a.** $y = 2x$, **b.** $x = 7$, $y = 14$, $z = 6$, **c.** It checks; **10. a.** $-5 < x \le 6$, **b.** $x < -5$ or $x \ge 3$, **c.** $-3 \le x < 4$; **11. a.** $x \ge 1367$, **b.** $1034 \le x \le 1500$; **12. a.** $|x - 8| \le 1.2$, **b.** $6.8 \le x \le 9.2$, **c.** $|x - 8| > 1.2$, **d.** $x > 9.2$ or $x < 6.8$;

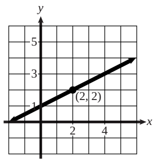
Gateway Review 1. a. Yes, it is a function. **b.** No, it is not a function. There are two different outputs paired with 2. **c.**



Yes, it is a function.

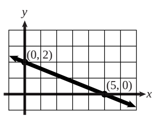
2. 20, 36, 44, 60, 76, **a.** Yes, for each input there is one output. **b.** The input is x, the number of hours worked. **c.** The dependent variable is $f(x)$, the total cost. **d.** Negative values would not be realistic domain values. A negative number of hours worked does not make sense. **e.** The rate of change is $8 per hour. **f.** The rate of change is $8 per hour. **g.** The rate of change between any two points is $8 per hour. **h.** The relationship is linear. **i.** $f(x) = 8x + 20$, **j.** The slope is the hourly rate I charge, $8 per hour, **k.** (0, 20) is the vertical intercept. The 20 represents the fertilizer cost. **l.** $f(4) = 8(4) + 20 = 52$, **m.** $8x + 20 = 92$ or $8x = 72$ or $x = 9$; I need to work 9 hours for the cost to equal exactly $92. **3. a.** $f(-2) = 14$, $g(-2) = 10$, **b.** $-6 + (-5) = -11$, **c.** $24 - 16 = 8$, **d.** $36(-2) = -72$; **4. a.** This represents a linear function. The constant slope is 4. **b.** This represents a linear function. **c.** This does not represent a linear function. **d.** This represents a linear function.

5. a. $m = \dfrac{9 + 3}{-4 - 5} = \dfrac{12}{-9} = \dfrac{-4}{3}$, **b.** $m = \frac{3}{7}$, **c.** $m = \frac{1}{2}$;



6. a. $y = 4$, **b.** $y = 2x + 5$, **c.** $-14 = -3(6) + b$, $b = 4$, $y = -3x + 4$, **d.** $-2 = 2(7) + b$, $b = -16$, $y = 2x - 16$, **e.** $x = 2$, **f.** $0 = -5(4) + b$, $b = 20$, $y = -5x + 20$, **g.** $16 = 4(2) + b$, $b = 8$, $y = 4x + 8$, **h.** $y = \frac{-1}{2}x + 5$;

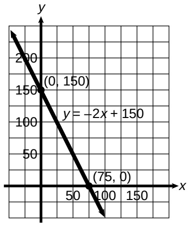
7.



$y = \frac{-2}{5}x + 2$;

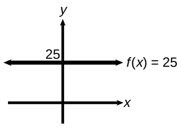
8. a. $f(x) = 300{,}000 - 10{,}000x$, **b.** $m = -10{,}000$. The building depreciates $10,000 per year. **c.** (0, 300,000); the original value is $300,000, **d.** (30, 0); it takes 30 years for the building to fully depreciate; **9. a.** (0, −3), **b.** (0, −3), **c.** (0, −3), **d.** The graphs all intersect at the point (0, −3). **e.** The results are the same. **10. a.** $m = -2$; (0, 1), **b.** $m = -2$; (0, −1), **c.** $m = -2$; (0, −3), **d.** The graphs are parallel lines. **e.** The results are the same. **11. a.** $m = -3$; (0, 2), **b.** $m = -3$; (0, 2) $m = -3$; (0, 2), **c.** $m = -3$; (0, 2), **d.** The graphs are all the same. **e.** the slopes, **f.** the slopes and the y-intercepts,

g. The results are the same. **12. a.** (0, 150), (75, 0),



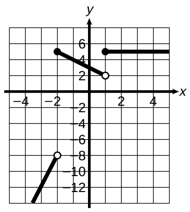
c. The domain and range are all real numbers. **d.** $w(t) = -2t + 150$, **e.** They are essentially the same. **f.** The vertical intercept is (0, 150). It indicates the person's initial weight of 150 pounds. The horizontal intercept (75, 0) indicates that after 75 weeks of weight loss, the person weighs nothing. **g.** The practical domain is $0 \le t \le 15$. The practical range is $120 \le w(t) \le 150$. **13. a.** $f(x) = 25$,

b.



horizontal line through (0, 25), **c.** The slope is 0.

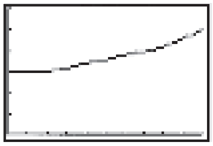
14.



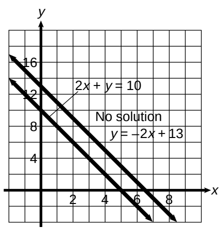
15. a.

$$f(x) = \begin{cases} 1500 & \text{if } x \le 10{,}000 \\ 1500 + 0.29(x - 10{,}000) & \text{if } 10{,}000 < x \le 40{,}000, \\ 2100 + 0.04(x - 40{,}000) & \text{if } x > 40{,}000 \end{cases}$$

b. Xmin = 0, Xmax = 50,000, Ymin = 0, Ymax = 3000, Xscl = 500



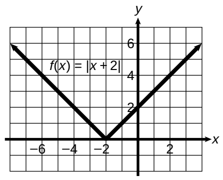
c. $f(25{,}000) = 1500 + 0.02(15{,}000) = 1800$, **d.** $x = 66{,}250$; **16. a.** $y = 1040x + 7900$ or $t(n) = 1040n + 7900$, **b.** 1040; the number of finishers increased at a rate of 1040 per year, **c.** (0, 7900); the model indicates that there were 7900 finishers in 1994, **d.** pretty well, **e.** 14,140, **f.** I used extrapolation because I am predicting outside the original data. **g.** No, 2024 is farther from the data than 2000. The farther removed we are from the data, the more likely our prediction is incorrect. **17. a.** (3, −1), **b.** (−1, 6), **c.**



d. 4 = 4; this is a dependent system. Any pair of numbers that satisfies one equation satisfies both equations.

18. $x = 4.50, y = 0.75$; **19. a.** (0, 1, 2), **b.** (−3, 1, 0), **c.** (0.5, 0.25, −0.5), **d.** (12, 7, 9); **20. a.** It is a good deal. **b.** Answers will vary. I would not take advantage of this. I don't give away many pictures.

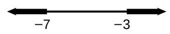
21. a.



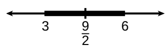
b. increasing $x > -2$, decreasing $x < -2$, **c.** The domain is all real numbers. **d.** The range is $y \ge 0$. **e.** g is the reflection through the x-axis. **f.** f shifts the graph of $y = |x|$ 2 units to the left. h shifts the graph of $y = |x|$ 2 units up. **22. a.** $x = 28$ or $x = 18$, **b.** $x = -5$ or $x = -19$, **c.** $x = \frac{11}{2}$ or $x = -\frac{1}{2}$, **d.** $x = \frac{1}{5}$ or $x = 1$;

23. a. $2.3 \le x \le 2.7$

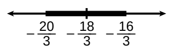
b. $x > -3$ or $x < -7$



c. $3 < x < 6$



d. $\dfrac{-20}{3} \le x \le \dfrac{-16}{3}$



24. a. $|x - 453| \le 8$, **b.** $445 \le x \le 461$.

Chapter 2

Activity 2.1 Exercises:

1. a.

COLUMN 2	COLUMN 3	COLUMN 4
100	250	350
100	500	600
100	750	850
100	1000	1100
100	1250	1350

b. $C(x) = 12.50x + 100$,

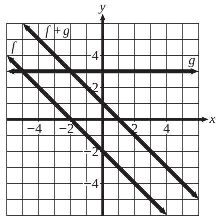
c.

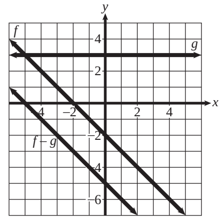
COLUMN 2	COLUMN 3	COLUMN 4
3	2,250	292.50
6	4,500	585
9	6,750	877.50
12	9,000	1,170
15	11,250	1,462.50

d. $R(x) = 0.13(750)(0.15x) = 14.625x$, **e.** $P(x) = 2.125x - 100$, **f.** $0 \le x \le$ the number of people the banquet room will accommodate. **g.** Set $P(x) = 0$ and solve for x, $x = 47.06$; 48 people must attend. **h.** Set the profit equal to 500 and solve for x; $500 = 2.125x - 100$; $x = 282.35$; 283 must attend. **3.** $(f + g)(x)$: 4, −6, 1, 6, 2, 8; $(f - g)(x)$: 2, −4, −1, 8, −4, 0; **5. a.** $5x - 2$, **b.** $x^2 + 3x - 8$, **c.** $-x + 30$, **d.** $-3x^2 + 8x - 3$, **e.** $15x - 15$, **f.** 11, **g.** $5x^2 + 5x - 9$, **h.** $-6x^2 + 15x - 4$, **i.** $-5x + 25$, **j.** $-33x - 10$; **7. a.** $4x^2 - x$, **b.** $4x^2 - 5x - 9$, **c.** $3 + 4x$, **d.** $4x^2 - 5x + 3$; **9. a.** 1, −9, −11, −5, 9, 31, **b.** $(f - g)(x) = x^2 + 5x - 5$, **c.** The answers check.

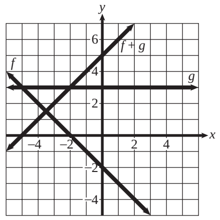
Activity 2.2 Exercises:

1. a. $= -x + 1$ **b.** $= -x - 5$

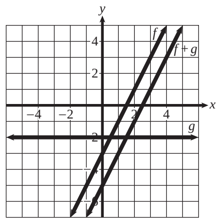


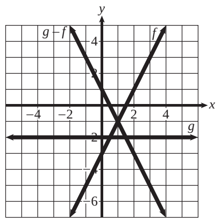


c. $= x + 5$

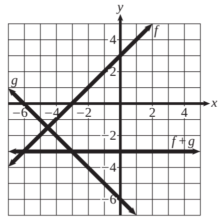


2. a. $= 2x - 5$ **b.** $= -2x + 1$

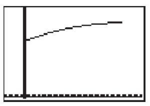




3.



Activity 2.3 Exercises: 1. a. $(3x)(2x) = 6x^2$, **b.** $2x - 3$, **c.** $(2x - 3)(3x) = 6x^2 - 9x$; **3. a.** $50 + x$, **b.** $7.50 - 0.05x$, **c.** $C(x) = (50 + x)(7.50 - 0.05x)$, **d.** The domain is $0 \le x \le 50$,
e.



f. $C(x) = -0.05x^2 + 5x + 375$,
g. The graphs are the same.

5.

	x^2	$3x$	-5
x	x^3	$3x^2$	$-5x$
3	$3x^2$	$9x$	-15

$x^3 + 6x^2 + 4x - 15$; **7. a.** $6x^2 + 19x + 10$, **b.** $6x^2 - 19x + 10$, **c.** $4x^2 + 5x - 6$, **d.** $4x^2 - 5x - 6$; **9. a.** $9x^2 - 12x + 4$, **b.** $25x^2 - 4$, **c.** $x^4 - 25$, **d.** The outer product and inner product are opposites. Their sum is 0. **10.** $f(x) \cdot g(x) = 2x^2 - x - 3$,

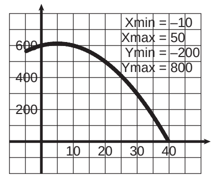
b.

x	$f(x)$	$g(x)$	$f(x)\ \ g(x)$
0	1	-3	-3
1	2	-1	-2
2	3	1	3
3	4	3	12
4	5	5	25

c. Answers may vary depending on the choices of x.

Activity 2.4 Exercises: 1. $7.29440445 \times 10^{11}$; **3. a.** 3×10^{21}, **b.** 4.5×10^{16}, **c.** 9,000,000,000,000,000,000,000,000,000, **d.** $\frac{9 \times 10^{27}}{4.5 \times 10^{16}} = 2 \times 10^{11}$; **5. a.** $\frac{6.35 \times 10^8}{2.27 \times 10^9}$, **b.** 2.797×10^{-1}; **7.** 1; **9.** 10; **11.** $\frac{4}{x^4}$; **15.** $\frac{3y^4}{5x^4}$; **17.** $3x^{-3} = \frac{3}{x^3}$; **19.** $\frac{-1}{2a^2b^3}$;

How Can I Practice? 1. a. $x = 30$, **b.** $N = f(t) = 30 + t$, **c.** $C = g(t) = 20 - 0.5t$, **d.** $N = f(t)$: 30, 32, 34, 36, 38, 40; $C = g(t)$: 20, 19, 18, 17, 16, 15, **e.** $R(t)$: 600, 608, 612, 612, 608, 600, **f.** $R(t) = f(t) \cdot g(t) = (30 + t)(20 - 0.5t) = -0.5t^2 + 5t + 600$,
g.



h. \$612.50 is the maximum revenue if 35 couples attend. **i.** 35 tickets must be sold to obtain the maximum revenue.

2. a. $3x - 1$, **b.** $-x + 5$, **c.** $2x^2 + x - 6$, **d.** 2, **e.** 0, **f.** $3x + 6$; **3. a.** $-3x + 5$, **b.** $x^4 - x^3 - 5x^2 + 9x - 4$, **c.** 0, **d.** $-x^2 - 7x + 14$; **4. a.** $5x - 2$, **b.** $2x^2 - 2x - 8$, **c.** $-2x + 12$, **d.** $2x^2 - 13x - 8$, **e.** $5x^2 - x + 2$; **5. a.** x^4, **b.** x^9, **c.** $6x^8$, **d.** x^5y^6z, **e.** $10x^6y^5z^8$, **f.** $-30a^5b^3$; **6. a.** $x^2 - 7x + 10$, **b.** $4x^2 + 25x - 21$, **c.** $4x^2 - 9$, **d.** $x^3 + x^2 - 11x + 10$, **e.** $2x^3 + x^2 + 3x + 2$, **f.** $-2x^2 - 5x - 21$, **g.** $11x^2 - 2x$, **h.** $-x^5 - x^3 + 3x^2 + 2x - 1$, **i.** $9x^2 + 30x + 25$, **j.** $4x^2 - 28x + 49$, **k.** $x^3 + 12x^2 + 48x + 64$, **l.** $25x^2 - 49$; **7. a.** 2650, 3025, 3400, 3775, 4150, **b.** $f(t) = 75x + 2650$, **c.** 1500, 2125, 2750, 3375, 4000, **d.** $f(t) = 125x + 1500$, **e.** 50, 50, 50, 50, 50, **f.** $h(t) = 50$, **g.** $k(t) = 200x + 4200$,

h.

$f(t)$	$g(t)$	$h(t)$	$k(t)$
2875	1875	50	4800
3550	3000	50	6600
4000	3750	50	7800
4525	4625	50	9200

i. It will equal \$10,000 in 2019. **8. a.** 17, −3, −7, 5, 33, 77, **b.** $(f - g)(x) = 2x^2 + 2x - 7$, **c.** The answers check. **9. a.** $\frac{2}{x^3}$, **b.** $9x^2$, **c.** $\frac{1}{3^4}$, **d.** 1, **e.** $2x^7$, **f.** $-6x^4y^8$, **g.** 4, **h.** $\frac{2}{3x^4}$, **i.** $\frac{5y^2}{x^4}$, **j.** $\frac{-15}{x^5}$, **k.** $-2x^6$, **l.** $\frac{a^4}{b^4c^5}$; **10. a.** 10,080,000, **b.** I own approximately 0.2 of a square mile. **c.** 3.4339×10^{14} cu mi; **11. a.** 2.75×10^8; 8.61×10^7, **b.** $\frac{2.75 \times 10^8}{8.61 \times 10^7} = \frac{2.75 \times 10}{8.61} = \frac{27.5}{8.61} = 3.20$ or approximately 1 in 3;

12. $\frac{7.198 \times 10^6}{3.636 \times 10^6} = \frac{7.2 \times 10^6}{3.6 \times 10^6} = 2 \times 10^0 = 2$. The zero property of exponents was used. **13. a.** $A = 35 + 12x + x^2$, **b.** $(7 + 4)(5 + 4) = 99$, or $35 + 12(4) + 4^2 = 99$; $99 - 35 = 64$ sq. ft., **c.** $A = \pi r^2$, for the umbrella $A = \pi(r + 2)^2$, or $A = \pi r^2 + 4\pi r + 4\pi$;

Activity 2.5 Exercises: 1. a. $g(2) = 200$. The radius of the slick is 200 ft. 2 hr. after the spill.
b. $f(g(2)) = f(200) = \pi(200)^2 = 125{,}664$. The area of the oil slick is 125,664 sq. ft. 2 hr. after the spill.
c. $f(g(10)) = f(1000) = \pi(1000)^2 = 1{,}000{,}000\pi$.
This is the area of the slick after 10 hr.
d. $f(g(t)) = f(100t) = \pi(100t)^2 = 10{,}000\pi t^2$,
e. $f(g(10)) = 10{,}000\pi(10)^2 = 1{,}000{,}000\pi$. The results are the same. **3.** $= -18x^2 + 18x - 3$, **b.** $= -6t^2 + 6t + 2$;
5. a. $L(x) = 0.99x$, **b.** $D(x) = 0.90x$,
c. $S(x) = L(D(x)) = L(0.90x) = 0.99(0.90x) = 0.891x$,
d. $S(500) = 0.891(500) \approx 446$, **e.** $D(x)$ needs to be improved because the air bags fail 10% of the time, whereas the seat belts fail only 1% of the time.

Activity 2.6 Exercises: 1. a. $f(x) = 5280x$,
b. $f(5) = 26{,}400$, **c.** $g(w) = 12w$,
d. $g(26{,}400) = 316{,}800$,
e. $g(f(x)) = g(5280x) = 12(5280x) = 63{,}360x$,
f. $g(f(5)) = 63{,}360(5) = 316{,}800$; 5 miles is equivalent to 316,800 inches; **3. a.** $f(x) = x - 1500$,
b. $g(x) = 0.9x$, **c.** $g(f(20{,}000)) = g(20{,}000 - 1500) = 0.9(18{,}500) = \$16{,}650$. The price of a \$20,000 car with a \$1500 rebate and a 10% discount is \$16,650; **5. a.** 8, **b.** 4, **c.** 15, **d.** 2;

Activity 2.7 Exercises: 1. a. $f(-1) = 6$, **b.** $g(12) = 9$,
c. $f(x - 3) = 2x + 2$, **d.** $g(2x + 8) = 2x + 5$;
3. $f(g(x)) = x^{18}$; $g(f(x)) = g(x^6) = -x^{18}$; **5. a.** 10,
b. 12, **c.** 4, **d.** 256, **e.** 1.903654, **f.** 4, **g.** $\frac{1}{\sqrt{25}} = \frac{1}{5}$,
h. $\frac{1}{(\sqrt[3]{27})^2} = \frac{1}{3^2} = \frac{1}{9}$; **7. a.** $x^{1/2}$, **b.** $x^{3/4}$,
c. $(x + y)^{1/3}$, **d.** $a^{(2/5)}b^{(3/5)}$; **9. a.** -4, **b.** 0, **c.** 3;
10. a. $t = f(L) = 2\pi\left(\frac{L}{32}\right)^{1/2}$, **b.** $t = 6.28\sqrt{\frac{4}{32}} \approx 2.22$ sec.;

Activity 2.8 Exercises: 1. a. 7, **b.** 4, **c.** x, **d.** x;
2. a. $h^{-1} = \{(3, 2), (4, 3), (5, 4), (6, 5)\}$,
b. $h(3) = 4$ $h^{-1}(h(3)) = 3$,
c. $h^{-1}(5) = 4$ $h(h^{-1}(5)) = 5$;

3. a.

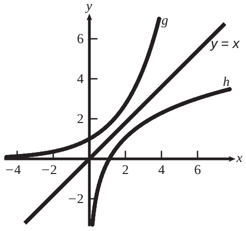
x	$r^{-1}(x)$
2	0
3	1
4	2
2	3

b. No, because the input value 2 is paired with two different output values, 0 and 3. **c.** No, the interchange of the input and output values does not result in a function.

5. a. $m = \frac{115.12 - 57.56}{50} = 1.1512$, **b.** You have 1.1512 Canadian dollars for one U.S. dollar. **c.** $f(x) = 1.1512x$,
d. $f(3000) = \$3453.60$. If I have \$3000 U.S., then I can exchange it for \$3453.60 Canadian.
e. $m = \frac{100 - 50}{115.12 - 57.56} \approx 0.8687$, **f.** You have 0.8687 U.S dollars for one Canadian dollar. **g.** $g(x) = 0.8687x$,
h. $g(6000) = \$5212.20$. If I have \$6000 Canadian, then I can exchange it for \$5212.20 U.S.
i. $f(g(x)) = f(0.8687x) = 1.1512(0.8687x) = x$,
$g(f(x)) = g(1.1512x) = 0.8687(1.1512x) = x$;

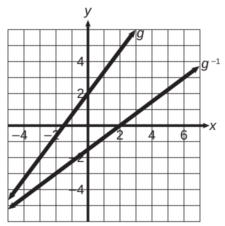
Activity 2.9 Exercises: 1. a. $P = f(S) = 0.05S + 250$,
b. $f(6000) = 0.05(6000) + 250 = 550$. The weekly salary for \$6000 worth of sales is \$550.
c. $S = g(P) = \frac{P - 250}{0.05}$, **d.** $g(400) = \frac{400 - 250}{0.05} = 3000$.
A weekly salary of \$400 means I sold \$3000 worth of merchandise. **e.** $g(f(8000)) = 8000$; **3. a.** $y = 3x - 4$ so $x = 3y - 4$ or $y = f^{-1}(x) = \frac{x + 4}{3}$, **b.** $z = \frac{w - 4}{2}$ or $w = g^{-1}(x) = 2z + 4$, **c.** $t = \frac{5}{s}$ or $s = \frac{5}{t}$;

5.



g and h are inverses. The graphs of g and h are symmetric with respect to the line $y = x$.

7. a. $g^{-1}(x) = \frac{3x - 6}{4}$, **b.**

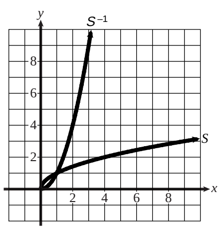


c. Yes, because the graphs are reflections in the line $y = x$.

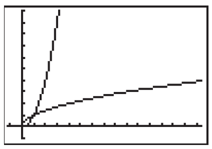
d. $g^{-1}\left(\frac{6 + 4x}{3}\right) = \frac{3\left(\frac{6 + 4x}{3}\right) - 6}{4} = \frac{4x}{4} = x$.

Yes, because $g^{-1}(g(x)) = x$.

9. a.



b.

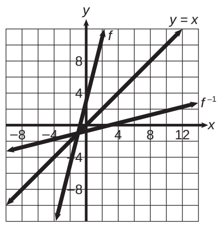


c. The area of the square is the input. The length of the side of the square is the output. **d.** The length of the side of the square is the input. The area of the square is the output. **e.** Given the length of the side, we can determine the area of the granite top.

How Can I Practice? 1. a. $f(-1) = -3$, **b.** $g(5) = 7$,
c. $f(x + 2) = (x + 2)^2 - 4 = x^2 + 4x$,
d. $g(x^2 - 4) = x^2 - 4 + 2 = x^2 - 2$,
e. $f(x^2 - 4) = (x^2 - 4)^2 = x^4 - 8x^2 + 12$,
f. $x = y + 2$ or $y = g^{-1}(x) = x - 2$;

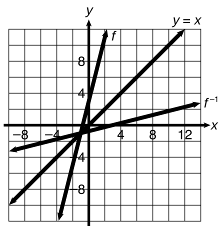
2. a. $f(-2) = -6$, **b.** $g(-1) = 2$, **c.** $g(-2) = -2$, **d.** $f(4 + x - x^2) = (4 + x - x^2) - 4 = x - x^2$, **e.** $= -x^2 + 9x - 16$, **f.** $x = y - 4$ or $y = f^{-1}(x) = x + 4$; **3.** $-1, 3, 2, 1, 0$; **4. a.** x^8, **b.** x^3y^3, **c.** $32x^{20}y^5$, **d.** $432x^{10}y^4$, **e.** 25, **f.** -25, **g.** $4x^2$, **h.** $-8x^3$, **i.** $-8x^{22}$, **j.** 125, **k.** 16, **l.** -3, **m.** $\frac{27}{64}$, **n.** 1.59, **o.** x^2y^4, **p.** $x^{7/6}$, **q.** $2x^{(1/3)}y^{(1/3)}$; **5. a.** $g(3x^2) = -2(3x^2)^3 = -54x^6$, **b.** $f(-2x^3) = 3(-2x^3)^2 = 12x^6$, **c.** $g(48) = -2(48)^3 = -221{,}184$; **6. a.** $s(4x - 1) = (4x - 1)^2 + 4(4x - 1) - 1 = 16x^2 - 8x + 1 + 16x - 4 - 1 = 16x^2 + 8x - 4$, **b.** $t(x^2 + 4x - 1) = 4(x^2 + 4x - 1) - 1 = 4x^2 + 16x - 5$, **c.** $x = 4y - 1$ or $y = T^{-1}(x) = \frac{x + 1}{4}$;
7. a. $p(\sqrt{x + 2})) = \frac{1}{\sqrt{x + 2}}$, **b.** $c\left(\frac{1}{x}\right) = \sqrt{\frac{1}{x}} + 2$, **c.** $x = \frac{1}{y}$ or $y = p^{-1}(x) = \frac{1}{x}$; **8.** $\{(6, 4), (-9, 7), (1, -2), (0, 0)\}$; **9.** $f(g(x)) = f\left(\frac{x + 3}{2}\right) = 2\left(\frac{x + 3}{2}\right) - 3 = x$ $g(f(x)) = g(2x - 3) = \frac{(2x - 3) + 3}{2} = x$. Because $f(g(x)) = g(f(x)) = x$, f and g are inverse functions.
10. a. $x = 4y + 3$ or $y = f^{-1}(x) = \frac{x - 3}{4}$,

b.



c. The intercepts of f are $(0, 3)$ and $\left(-\frac{3}{4}, 0\right)$. The intercepts of f^{-1} are $\left(0, -\frac{3}{4}\right)$ and $(3, 0)$. **d.** The slope of the graph of f is 4. The slope of the graph of the inverse is $\frac{1}{4}$.

e.



11. a. 41, 42.8, 44.6, 47,

b.

41	42.8	44.6	47
0	3	6	10

c. $f^{-1}(x) = \frac{x - 41}{0.6}$, **d.** The population will be 46 million in 1998. **e.** The graphs are symmetrical about the line $y = x$. **f.** The horizontal intercept of the function interchanged, is the vertical intercept of its inverse. The vertical intercept of the function interchanged, is the horizontal intercept of its inverse.

HORIZONTAL INTERCEPT	VERTICAL INTERCEPT
$(-68.3, 0)$	$(0, 41)$
$(41, 0)$	$(0, -68.3)$

g. Function: $m = 0.6$; inverse function: $m = \frac{1}{0.6}$ or $\frac{5}{3}$. The slopes of the two functions are reciprocals.
h. The population will be 50 million in 2005.

12. a. 421.98 euros, **b.** \$428.02, **c.** $g(f(x)) = g(.007033x) = 1.2229(0.007033x) = 0.0086007x$, **d.** $g(f(60{,}000)) = 0.0086007(60{,}000) = \$516.04$; **13.** $x = \frac{4}{3}$; **14. a.** $b = f(x) = x^2$, $V = g(b) = 10b$, **b.** $V = g(f(x)) = g(x^2) = 10x^2$;

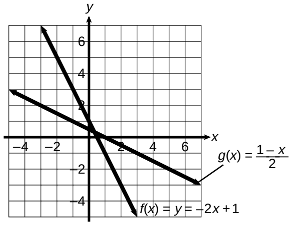
Gateway Review 1. $2x^2 - 2x - 1$, **b.** $-x^2 + 5x - 4$, **c.** $4x^2 - 13x + 3$, **d.** $x^3 - 7x^2 + 13x - 15$, **e.** $-11x + 11$, **f.** $2x^4 - 5x^3 + 4x^2 + 7x - 4$; **2. a.** $6x^8$, **b.** $16x^6y^2$, **c.** $-2x^5y^3$, **d.** $-10x^5y^5z^4$, **e.** $9x^6y^2$, **f.** $-125x^3y^3$, **g.** $2x^3$, **h.** 2, **i.** 1, **j.** $\frac{3y^3}{2z^3}$, **k.** $-5x^{-8} = \frac{-5}{x^8}$, **l.** $-4x^2$, **m.** $(-5)^3(x^{-3})^3 = -125x^{-9} = \frac{-125}{x^9}$, **n.** $x^{(4/5)+(1/2)} = x^{(8/10)+(5/10)} = x^{13/10}$, **o.** $x^{(2/3)\cdot 3} = x^2$; **3. a.** -20, **b.** $4x + 1$, **c.** $f(3) - g(3) = 16 - (-3) = 19$, **d.** $(6x - 2)(-2x + 3) = -12x^2 + 22x - 6$, **e.** $= -12x + 16$, **f.** $g(10) = -2(10) + 3 = -17$, **g.** $x = 6y - 2$ or $y = f^{-1}(x) = \frac{x + 2}{6}$; **4. a.** $x^2 - 4x + 5$, **b.** $= 3x^3 - 5x^2 + 11x - 6$, **c.** $= 9x^2 - 15x + 9$, **d.** $g(5) = 3(5) - 2 = 13$; **5. a.** 7, **b.** 4, **c.** 81, **d.** 3.214, **e.** 9, **f.** 32, **g.** $\frac{1}{16}$; **6. a.** $f(x) = 2(0.01)x^2 = 0.02x^2$, **b.** $g(x) = 4(0.004)(x)(3x) = 0.048x^2$, **c.** $(f + g)(x) = 0.02x^2 + 0.048x^2 = 0.068x^2$,

d.

$f(x)$	g	$(f + g)(x)$
0.08	0.19	0.27
0.32	0.77	1.09
0.72	1.73	2.45
1.28	3.07	4.35
2.00	4.80	6.80

e. $f(5) = 0.50$, $g(5) = 1.2$, $(f + g)(5) = 1.70$. For a box whose base is 5 in. by 5 in., the cost of the top and bottom of the box is \$0.50, the cost of the four sides is \$1.20, and the total cost of the box is \$1.70. **7. a.** $f(x) = 12x + 300$, **b.** $g(x) = 25.95x$, **c.** $h(x) = 25.95x - (12x + 300) = 13.95x - 300$, **d.** 22 hats must be sold, because 21 hats is not quite enough. The solution was obtained graphically. **e.** $f(50) = 900$. The cost of producing 50 hats is \$900. $g(50) = 1297.50$. The revenue from 50 hats is \$1297.50. $h(50) = 397.50$. The profit from selling 50 hats is \$397.50. **f.** The profit is the difference between the revenue and cost functions. **8. a.** $f(x) = 60(110) + x(110 - 2x)$, **b.** $f(x) = 6600 + 110x - 2x^2$, **c.** integers $0 \le x \le 30$, **d.** $f(15) = 7800$. At regular price the cost is \$8250, so the savings are \$450. **9. a.** -10, **b.** 41, **c.** 2, **d.** 5; **10. a.** integers $0 \le x \le 30$, **b.** $f(22) = 2864.40$, **c.** $f(3.75t) = 150(3.75t) - 0.9(3.75t)^2 = 562.50t - 12.65625t^2$, **d.** The input variable is t, **e.** $f(g(4)) = \$2047.50$, **f.** $3500 = 562.50t - 12.65625t^2$. t is about 7.5 hr. (determined graphically); **11. a.** $\frac{2y - 3}{5} = x$ or $y = f^{-1}(x) = \frac{5x + 3}{2}$, **b.** The slope of f is $\frac{2}{5}$. The slope of f^{-1} is $\frac{5}{2}$. The slopes are reciprocals.

12. $f(g(x)) = f\left(\frac{1-x}{2}\right) = -2\left(\frac{1-x}{2}\right) + 1 = x$;
$g(f(x)) = g(-2x+1) = \frac{1-(-2x+1)}{2} = \frac{2x}{2} = x$.
Since $f(g(x)) = g(f(x)) = x$, f and g are inverses.
b.



c. f and g are symmetric with respect to the line $y = x$;

13. a. Yes, the ratio (change in cost)/(change in number of tickets) is constant. **b.** $f(x) = 5.5x$, **c.** The cost of one ticket is \$5.50. This represents the slope.

d.

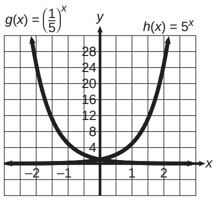
TOTAL COST	NUMBER OF TICKETS
\$11.00	2
\$27.50	5
\$38.50	7
\$66.00	12

e. $g(x) = \frac{2}{11}x$, **f.** The slope is 2/11. The slopes are reciprocals. **g.** $f\left(\frac{2}{11}x\right) = 5.5\left(\frac{2}{11}\right)x = x$; $g(5.5x) = \frac{2}{11}(5.5x) = x$. The functions are inverses because $f(g(x)) = g(f(x)) = x$.

Chapter 3

Activity 3.1 Exercises: 1. a. top table: 0.008, 0.04, 0.2, 1, 5, 25, 125; bottom table: 125, 25, 5, 1, 0.2, 0.04, 0.008,

b.



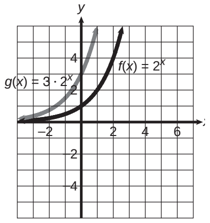
c.

BASE, b	GROWTH OR DECAY FACTOR	x-INTERCEPT	y-INTERCEPT	HORIZONTAL ASYMPTOTE	INCREASING OR DECREASING
5	growth	none	(0, 1)	$y = 0$	increasing
$\frac{1}{5}$	decay	none	(0, 1)	$y = 0$	decreasing

3. a. The graph of f is a decreasing exponential function with a decay factor of $\frac{3}{4}$. The graph of g is an increasing exponential function with a growth factor of $\frac{4}{3}$. The graphs of f and g are reflections in the y-axis. **b.** The graph of f is an increasing exponential function with a growth factor of 10. The graph of g is the graph of f reflected in the x-axis. **c.** The graph of f is an increasing exponential function with a growth factor of 3. The graph of g is a decreasing exponential function with a decay factor of $\frac{1}{3}$. The graphs of f and g are reflections in the y-axis. **5. a.** 24.948, 26.944, 29.099, **b.** 7.5, 5.625, 4.21875; **7. a.** The domain is all real numbers, and the range is $y > 0$, **b.** The domain is all real numbers, and the range is $y > 0$;

Activity 3.2 Exercises: 1. a. $P = 148.0(0.9973)^t$, **b.** Yes; substituting 5 for t yields $P = 148.0(0.9973)^5 = 146.01$. **c.** $P = 148.0(0.9973)^{12} = 143.3$ million; **2. a.** ii, **b.** i,

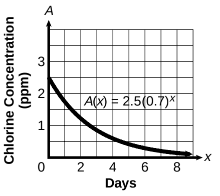
4. a.



b. For the same value of x, the graph of g is 3 times the distance from the x-axis than the graph of f is.

5. a. $f(-2) = \frac{3}{16}$, **b.** $f\left(\frac{1}{2}\right) = 6$, **c.** $f(2) = 48$, **d.** $f(1.3) \approx 18.1886$; **7. a.** 2.5 ppm, **b.** 2.5, 1.75, 1.225, 0.8575, 0.6003, 0.4202,

c.



d. $A(3) = 0.8575$ ppm, **e.** Chlorine should be added in 1.4 days.

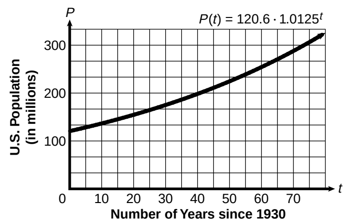
Activity 3.3 Exercises:

1.

GROWTH FACTOR	GROWTH RATE	DECAY FACTOR	DECAY RATE
1.02	2%	0.77	23%
1.029	2.9%	.32	68%
2.23	123%	0.953	4.7%
1.34	34%	.803	19.7%
1.0002	.02%	0.9948	.52%

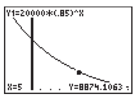
2. a. Bozeman: $P(t) = 27{,}509(1.0196)^t$, Butte: $P(t) = 32{,}370(0.9971)^t$, **b.** Bozeman: $P(5) = 27{,}509(1.0196)^5 = 30{,}313$; Butte: $P(5) = 32{,}370(0.9971)^5 = 31{,}903$, **c.** The population of Bozeman will be 55,018 when $t \approx 35.7$, **d.** The populations will be equal when $t \approx 7.3$;

4. a.



b. The growth factor is $b = 1.0125$; the growth rate is $0.0125 = 1.25\%$, **c.** $P(70) = 120.6(1.0125)^{70} = 287.7$ million. The prediction is a little higher.
5. a. $V(t) = 20{,}000(0.85)^t$, **b.** The decay rate is $15\% = 0.15$, **c.** The decay factor is 0.85, **d.** $V(5) = 20{,}000(0.85)^5 = 8874.11$,

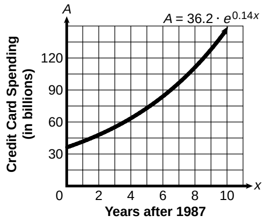
e.



f. The value will be \$10,000 when $t \approx 4.3$ years.

Activity 3.5 Exercises: 1. a. $A = 25{,}000\left(1 + \frac{0.045}{4}\right)^{4t}$, **c.** approximately 21.4 yr., **e.** approximately 21.2 yr.; **3. a.** $A = 1900e^{0.06 \cdot 2} = \$2142.24$, **b.** approximately 11.5 yr.; **5. a.** $b = \left(1 + \frac{0.048}{12}\right)^{12}$, **b.** $b = 1.04907$, **c.** $r_e = 4.907\%$; **7. a.** In 1996, $x = 9$, so $A = 36.2 \cdot e^{0.14 \cdot 9} = 127.62$ billion dollars,

b.

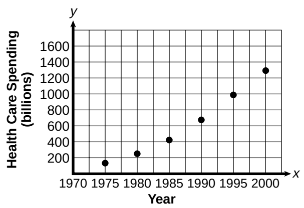


c. The vertical intercept is (0, 36.2). There was \$36,200,000,000 in holiday credit-card spending in 1987. **d.** 1993 ($x = 5$), **e.** approximately 4.95 yr.;

Activity 3.6 Exercises 1. a. The function is increasing because in the model, $b > 1$. **b.** It is a growth rate: $r = b - 1$; $r = 1.03 - 1 = 0.03 = 3\%$. **c.** The initial value is 397.4 thousand. According to the model, it is the population in thousands of Charlotte, North Carolina, in 1990. **d.** $k = 0.02956$, **e.** $y = 397.4.e^{03t}$, **f.** The population of Charlotte will be 716.2 thousand in 2010 if the growth continues at the same rate. **3. a.** The initial value is 33 and is increasing at the rate of 9.7%. **b.** The initial value is 97.8 and is decreasing continuously at the rate of 23%. **c.** The initial value is 3250 and is decreasing at the rate of 27%. **d.** The initial value is 0.987 and is increasing continuously at the rate of 7.6%.

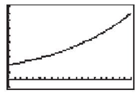
Activity 3.7 Exercises: 1. a. The data is not linear. The output seems to be increasing exponentially.

b.



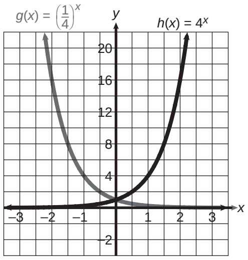
c. Yes; the scatterplot looks like an exponential function. **d.** $C = 155.3 \cdot 1093^t$, **e.** $C = \$919{,}550{,}000{,}000$, **f.** The growth factor, b, is 1.093, **g.** 0.093 or 9.34%, **h.** 1996 ($t = 21$), **i.** approximately 7.8 yr., **3. a.** the set of all real numbers, **b.** the set of all positive real numbers, **c.** $y = a \cdot b^x$ is positive for all values of x. **d.** $y = a \cdot b^x$ is never negative. **e.** $(0, a)$;

How Can I Practice? 1. a. $C = 17{,}000(1.04)^t$, **b.** The growth rate is 0.04; the growth factor is 1.04. **c.** $C = 17{,}000(1.04)^3 = 19{,}122.69$, **d.** 14.5 yr.; **2. a.** Graph i is function g, **b.** Graph ii is function h; **3.** Graph i is function g because it is decreasing and the only growth factor between 0 and 1 is 0.47 in function g. Graph ii is function h because it is positive and increasing with the growth factor of 1.47. Graph iii is function f because it is the only one that yields negative output. **4. a.** 13.01, 33.18, 84.61, **b.** 1.26, 0.76, 0.46, **c.** 216, 7776, 279,836; **5. a.** $y = 2(2.55)^x$, **b.** $y = 3.5(0.6)^x$, **c.** $y = \frac{1}{6}(36)^x$; **6. a.** $f(0) = 1.3$; decreasing, **b.** $f(0) = 0.6$; increasing, **c.** $f(0) = 3$; decreasing; **7. a.** Yes, **b.** The constant ratio is 2.5 or $\frac{5}{2}$, **c.** $y = 2(2.5)^x$; **8.** Plan 1: $S = 22{,}000 + 1000x$; plan 2: $S = 22{,}000(1.04)^x$, **b.** Plan 1: \$22,000, \$23,000, \$25,000, \$27,000, \$32,000, \$37,000; plan 2: \$22,000, \$22,800, \$24,747, \$26,766, \$32,565, \$39,621, **c.** It depends. If I plan to be with the company less than 10 years, I would take plan 1, because it takes plan 2 about 9 years to catch up. If I expect to be with the company for a long time, say 20 years, I would choose plan 2, because by then I would be better off by more than \$6000 per year. **9. a.** $N = f(t) = 2e^{0.075t}$, **b.** $N = f(8) = 2e^{0.075(8)} = 3.6442$ thousand, **c.**



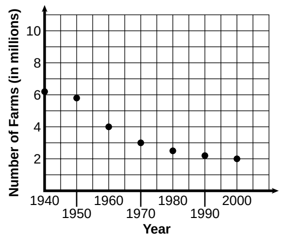
d. 14.6482 or about 15 wk.; **10. a.** top table: $\frac{1}{64}, \frac{1}{16}, \frac{1}{4}$, 1, 4, 16, 64; bottom table: 64, 16, 4, 1, $\frac{1}{4}, \frac{1}{16}, \frac{1}{64}$,

b.



c. Row 1: 4, growth, none, (0, 1), x-axis, increasing; row 2: $\frac{1}{4}$, decay, none, (0, 1), x-axis, decreasing; **11. a.** \$415, **b.** 0.0118 or 1.18% per month, **c.** 1.0118, **d.** $f(x) = 415(1.0118)^x$, **e.** (0, 415), **f.** This represents the initial balance on the card. **g.** \$466.65, **h.** With no payments, I exceed my credit limit during the sixteenth month; **12. a.** The ratios are all 1.02, **b.** 1.02, **c.** $w(t) = 12.50(1.02)^x$, **d.** 2%, **e.** \$14.94, **f.** about 35 yr.; **13. a.** $A = 10{,}000(1.01)^{12t}$, **b.** \$18,166.97, **c.** approximately 6 yr., **d.** $A = 10{,}000e^{0.12t}$, **e.** \$18,221.19, \$54.22 more than in part b;

14. a.



b. An exponential decay model would better model the data. The data is decreasing, but not at a constant rate. **c.** $y = 6.24(0.9795)^x$, **d.** $6.24(0.9795)^{70} = 1.46$ million farms, **e.** 0.9795, **f.** $0.9795 = 1 - r$; $r = 1 - 0.9795 = 0.0205$, or 2.05%, **g.** The number of farms is decreasing at a rate of 2.05% per year, **h.** 34 yr.;

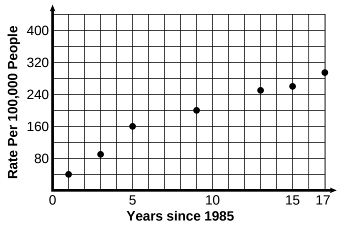
Activity 3.8 Exercises: 1. a. 5, **b.** 3, **c.** −1, **d.** −6, **e.** 0, **f.** 2, **g.** $\frac{1}{2}$, **h.** $\frac{1}{2}$, **i.** 0, **j.** 0, **k.** 5, **l.** −2, **m.** 0; **3. a.** $\log_3 9 = 2$, **b.** $\log_{121} 11 = \frac{1}{2}$, **c.** $\log_4 27 = t$, **d.** $\log_b 19 = 3$, **5. a.** $x = 0.512$, **b.** $x = 2.771$, **c.** $x = -5.347$;

Activity 3.9 Exercises: 1. a. $x > 0$, **b.** the set of all real numbers, **c.** $x > 1$, **d.** $0 < x < 1$, **e.** $x = 1$, **f.** $x = 10$; **3.** $y = \log_2 x$; **4. a.** $x > 0$, **b.** the set of all real numbers, **c.** $x > 1$, **d.** $0 < x < 1$, **e.** $x = 1$, **f.** $x = e$;

5. $n = \dfrac{\log(1000) - \log(34{,}000)}{\log(1 - 0.40)} \approx 6.9$ yr;

Activity 3.10 Exercises:

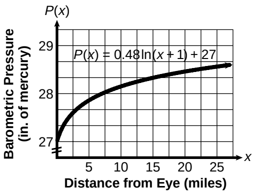
1. a.



b. It could very well be logarithmic. It increases more slowly as the input increases.

c. $R = 19.946 + 88.259 \ln t$, **d.** Yes, it is a very good fit, **e.** 2010 is 25 years after 1985, so evaluate R when $t = 25$. $R = 19.946 + 88.259 \ln 25 = 304$ per 100,000 population; **3. a.** $f(0) = 27$ in. This is the pressure in the eye of the storm.

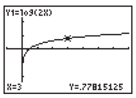
b.



c. As you move away from the hurricane's eye, the pressure increases quickly at first and then more slowly.

Activity 3.11 Exercises: 1. a. $\log_b 3 + \log_b 7$, **b.** $\log_3 3 + \log_3 13 = 1 + \log_3 13$, **c.** $\log_7 13 - \log_7 17$, **d.** $\log_3 x + \log_3 y - \log_3 3 = \log_3 x + \log_3 y - 1$;

3. a.



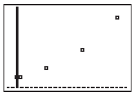
b. The graphs are the same. This is not surprising because the log of a product is the sum of the logs.

5. a. $7.4 \log(15) = 8.7$ or 9 cars, **b.** 9, 13, 21, **c.** The sum of the sales from the smaller ads exceeds the sales from the larger ad by 1. **d.** Pretty close. 15 times 50 equals 750, so I would have expected the sum of the sales from the smaller ads to equal the sales from the largest. The error is due to rounding. **e.** Forget about the giant ad. It is a waste of money. **7. a.** $\log_2 245$, **b.** $\log \sqrt[4]{\dfrac{x^3}{z^5}}$,

c. $\ln \dfrac{2^2 5^2 z^4}{5^3} = \ln \dfrac{4z^4}{5}$, **d.** $\log_5 \dfrac{x^2 + 3x + 2}{x^2 + 6x + 9}$;

Activity 3.12 Exercises: 1. a. 111,700 arrests in 2000, **b.** There will be 50,000 arrests 9 years after 1990, or 1999.

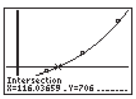
3. a. Yes



b. $A(t) = 352.65(1.006)^t$,

c. $t = \dfrac{\ln\left(\frac{705.3}{352.65}\right)}{\ln(1.006)} \approx 116$; 116 yr. after 1990 would be the year 2106.

d.



4. $x = \dfrac{\ln 14}{\ln 2} \approx 3.81$;

6. $t = \dfrac{\ln 2}{\ln(1.04)} \approx 17.7$;

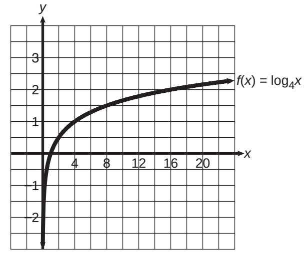
8. $x \approx 1.881$; **10. a.** $t = 8$ days,

b. $\frac{1}{5}P_0 = P_0 e^{-0.086t}$ or $t = \dfrac{\ln(0.2)}{-0.086} = 19$ days;

Activity 3.13 Exercises: 1. $x = 2^5 = 32$;
3. $x = 5^{5/3} - 2 = 12.62$; **5.** $x = 303.17$;
7. $m = 8.8 + 5.1 \log 200 = 20.5$;
9. $[H^+] = 10^{-2.4} = 0.00398$ mol/l;

How Can I Practice? 1. a. $\log_4 16 = 2$, **b.** $\log_{10}(0.0001) = -4$, **c.** $\log_3\left(\frac{1}{81}\right) = -4$;
2. a. $2^5 = 32$, **b.** $5^0 = 1$, **c.** $10^{-3} = .001$, **d.** $e^1 = e$;
3. a. $x = 4^{-3} = \frac{1}{64}$, **b.** $b = 2$, **c.** $y = 3$;
4. a. -1; -0.5; 0; 1; 2; 3,

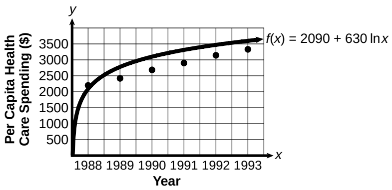
b.



d. (1, 0), **e.** $x > 0$, **f.** all real numbers, **g.** The y-axis ($x = 0$) is a vertical asymptote, **h.** $f(32) = 2.5$, **i.** $x = 90.5$;

5. a. $\log_b x + 2\log_b y - \log_b z$,
b. $\frac{3}{2}\log_3 x + \frac{1}{2}\log_3 y - \log_3 z$, **c.** $\log_5 x + \frac{1}{2}\log_5(x^2 + 4)$,
d. $\frac{1}{3}\log_4 x + \frac{2}{3}\log_4 y - \frac{2}{3}\log_4 z$; **6. a.** $\log \dfrac{x\sqrt[3]{y}}{\sqrt{z}}$,
b. $\log_3 (x + 3)^3 z^2$, **c.** $\log_3 \sqrt[3]{\dfrac{x}{y^2 z^4}}$; **7. a.** $\dfrac{\log 17}{\log 5} = 1.76$,
b. $\frac{1}{3} \cdot \dfrac{\log 41}{\log 13} = 0.4826$; **8. a.** $x \approx 0.0067$, **b.** $x = 646.08$;
9. a. $x = \dfrac{\log 17}{\log 3} = 2.5789$, **b.** $x = \dfrac{\ln 14}{1.7} \approx 1.55$;

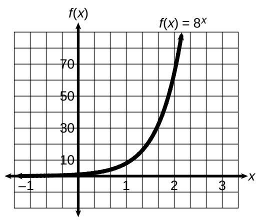
10. a.



c. $E = f(18) = 2090 + 630 \ln(18) = 3910.93$,
d. $x = 9.38$, which you round up to 10. The year is 1997.
e. $2090 + 630 \ln x = 3500$, **f.** $x = e^{2.238} = 9.38$. The year is 1997. It is the same.

Gateway Review 1. a. $\frac{1}{8}$, $\frac{1}{2}$; 1; 8; 16; 64; 512,

b.



c. The function is increasing, because $b = 8 > 1$, **d.** all real numbers, **e.** $y > 0$, **f.** There is no x-intercept. The y-intercept is (0, 1), **g.** There is one horizontal asymptote, the x-axis, $y = 0$,
h. The domain and range are the same. The graphs are reflections in the y-axis. f is increasing; g is decreasing.
i. f is moved upward 5 units to obtain h.
j. $x = 8^y$; $y = \log_8 x$;
2.

BASE, b	GROWTH OR DECAY FACTOR	x-INTERCEPT	y-INTERCEPT	HORIZONTAL ASYMPTOTE	INCREASING OR DECREASING
6	growth	none	(0, 1)	$y = 0$	increasing
$\frac{1}{3}$	decay	none	(0, 1)	$y = 0$	decreasing
2.34	growth	none	(0, 5)	$y = 0$	increasing
0.78	decay	none	(0, 3)	$y = 0$	decreasing
2	growth	(2, 0)	(0, −3)	$y = -4$	increasing

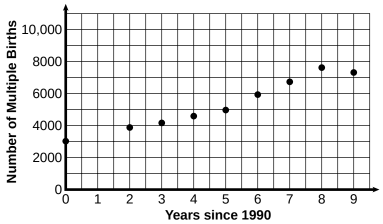
3.

all reals	all reals	all reals	$x > 0$	$x > 3$
$y > 0$	$y > 2$	$y > -5$	all reals	all reals

4. a. The table is approximately exponential. The growth factor is about 1.55. **b.** $y = 10 \cdot 1.55^x$; **5. a.** 15,000, 15,225, 15,453, 15,685, 15,920, 16,159, **b.** $y = 15{,}000(1.015)^x$, **c.** $y = \$16{,}897$; this is reasonable if you assume that 15,000 is a reasonable starting salary and that the 1.5% salary increase per year remains constant. **d.** $x = \log_{1.015} 2 = \dfrac{\ln(2)}{\ln(1.015)} = 46.6$ yr.;

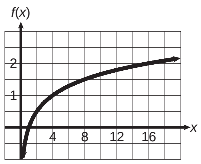
6. a. $A = 5000e^{0.065(8)} = \$8410.14$, **b.** $t \approx 13.5$ yr.;

7. a.

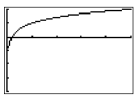


b. It would be better modeled by an exponential model. **c.** $f(x) = 3061(1.112)^x$, **d.** 1.112, **e.** 11.2%, **f.** $f(22) = 31{,}635$, **g.** approximately 6.5 yr.; **8. a.** 125, **b.** 27, **c.** $\frac{1}{32}$, **d.** 25, **e.** -2, **f.** 4, **g.** -3, **h.** 2; **9. a.** $\log_6 36 = 2$, **b.** $\log_{10} 0.000001 = -6$, **c.** $\log_2 \frac{1}{32} = -5$; **10. a.** $3^4 = 81$, **b.** $7^0 = 1$, **c.** $10^{-4} = 0.0001$, **d.** $e^1 = e$, **e.** $g^b = y$; **11. a.** $x = \frac{1}{125}$, **b.** $b = 4$, **c.** $y = 6$, **d.** $x = 8$; **12. a.** $-3, -2, -1, 0, 1, 2$

b.



c.



d. (1, 0), **e.** $x > 0$, **f.** all real numbers, **g.** It has a vertical asymptote at $x = 0$. The function gets closer and closer to the y-axis but does not cross it. **h.** $f(23) = 1.948$, **i.** $x = 52.416$;

13. a. $\frac{\log 21}{\log 7} = 1.56$, **b.** $\dfrac{\log\left(\frac{8}{9}\right)}{\log 15} = -0.0435$;

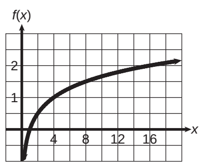
14. a. $3\log_2 x + \log_2 y - \left(\frac{1}{2}\right)\log_2 z$,

b. $\left(\frac{1}{3}\right)(4\log x + 3\log y - \log z)$; **15. a.** $\log \dfrac{x\sqrt[4]{y}}{z^3}$,

b. $\log \sqrt[3]{\dfrac{x}{y^2 z}}$; **16. a.** $3 + x = \frac{\log 7}{\log 3}$; $x = -1.23$,

b. $4x + 9 = 2^4$; $x = 1.75$, **c.** $x \approx 341.5$;

17. a.

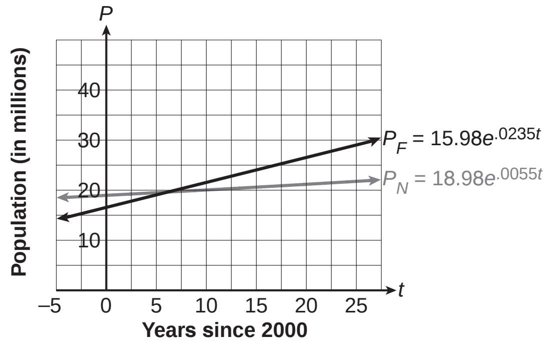


c. 2.87744,

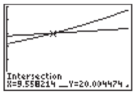
d. $2.319 = \frac{\log x}{2 \log 2}$; $x = 24.9$;

18. a. New York, 18.98 million; Florida, 15.98 million,

b.



c.



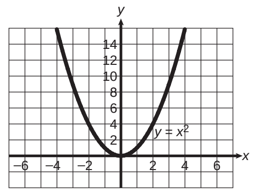
Florida's population will equal that of New York sometime in the year 2009.

d. $t = 19$ years; Florida's population will exceed 25 million in the year 2019.

Chapter 4

Activity 4.1 Exercises: 1. a. 9, 4, 1, 0, 1, 4, 9,

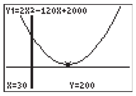
b.



c. yes, **d.** 1, **e.** The domain is all real numbers. The range is all real numbers greater than or equal to 0. **3. a.** $a = -2, b = 0, c = 0$, **b.** $a = \frac{2}{5}, b = 0, c = 3$, **c.** $a = -1, b = 5, c = 0$, **d.** $a = 5, b = 2, c = -1$; **5. a.** f opens upward; g opens downward; both pass through (0, 0), **b.** Both f and h open upward. **c.** h is g shifted up 2 units; both open upward. **d.** Both f and g open upward. The low point of f is 3 units below the x-axis; the low point of g is 3 units above the x-axis. **e.** f opens upward with a vertical intercept at (0, 1); h opens downward with a vertical intercept at (0, -1); both are symmetric with respect to the y-axis. **7. a.** downward, **b.** (0, -4); **9. a.** upward, **b.** (0, 3); **11. a.** downward, **b.** (0, -7); **13. a.** The graph of $y = \frac{3}{5}x^2$ is wider than the graph of $y = x^2$, **b.** The graph of $y = x^2$ would have a greater output value.

Activity 4.2 Exercises: 1. a. upward, **b.** $x = 0$, **c.** (0, -3), **d.** (0, -3); **3. a.** upward, **b.** $x = -2$, **c.** (-2, -7), **d.** (0, -3); **5. a.** upward, **b.** $x = -1.5$, **c.** (-1.5, 1.75), **d.** (0, 4); **7. a.** upward, **b.** $x = 0.25$, **c.** (0.25, -3.125), **d.** (0, -3); **9. a.** (1, 0), (6, 0), **b.** D: all real numbers; R: $g(x) \le 6.25$, **c.** $x < 3.5$, **d.** $x > 3.5$; **11. a.** (3.46, 0), (-3.46, 0), **b.** D: all real numbers; R: $y \ge -12$, **c.** $x > 0$, **d.** $x < 0$; **13. a.** (-1, 0), (3, 0), **b.** D: all real numbers; R: $g(x) \le 4$, **c.** $x < 1$, **d.** $x > 1$; **15. a.** (0.2, 0), (1, 0), **b.** D: all real numbers; R: $y \le 0.8$, **c.** $x < 0.6$, **d.** $x > 0.6$; **17. a.** 149 ft., **b.** 6.05 sec., **c.** It indicates the height of the arrow when it is shot, **d.** The practical domain is 0 sec. $\le x \le 6.05$ sec. The practical range is 0 ft. $\le h(x) \le 149$ ft., **e.** (-0.05, 0), (6.05, 0); the first has no meaning; the second indicates the time in seconds it takes for the arrow to hit the ground.

19. a. (30, 200),

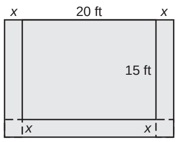


b. $x = -\frac{b}{2a} = \frac{120}{4} = 30$, $C(30) = 200$; the vertex is (30, 200), **c.** They are the same. **d.** minimum point, **e.** The cost of production is minimized when 30 statues are produced. **f.** (0, 2000); it costs \$2000, even if no statues are produced.

Activity 4.3 Exercises: 1. $x = 6$ or $x = -2$; **3.** $x = 9$ or $x = -5$; **5.** $x = -11$ or $x = -1$; **7.** $x = \pm 5$; **9.** $x = -3$ or $x = 1$; **11.** $x = 7$ or $x = -4$; **13. a.** $-2 < x < 6$, **b.** $x < -2$ or $x > 6$; **15. a.** $d(55) = 181.5$ ft., **b.** $0.04v^2 + 1.1v = 200$; $v \approx 58$ mph;

Activity 4.4 Exercises: 1. $6x^5(2 - 3x^3)$; **3.** $2x(x^2 - 7x + 13)$; **5.** $(x + 3)(x - 2)$; **7.** $(x + 5y)(x + 2y)$; **9.** $(6 + x)(2 + x)$; **11.** $(3x - 2)(x + 7)$; **13.** $5b^2(4b + 3)(b - 4)$; **14.** $x = 3$ or $x = 2$; **16.** $x = 3$ or $x = -2$; **18.** $x = \frac{1}{3}$ or $x = -4$; **20.** $x = 9$ or $x = -2$;

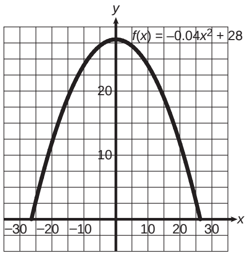
22. a.



b. $A = (20 + 2x)(15 + x) - 15(20) = 300 + 20x + 30x + 2x^2 - 300 = 2x^2 + 50x$, **c.** $2x^2 + 50x = 168$, **d.** $x + 28 = 0$ or $x - 3 = 0$, $x = -28$ or $x = 3$; the solution is 3 ft. −28 ft. makes no sense in this situation.

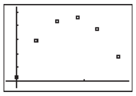
Activity 4.5 Exercises:

1. a.



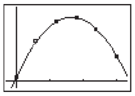
b. (0, 28) represents the vertex or turning point of the arch. **c.** $x \approx \pm 26.5$; the intercepts are (26.5, 0) and (−26.5, 0), **d.** The intercepts are the same. **e.** The river is approximately 2(26.5) or 53 ft. wide. **f.** No; the highest point of the arch is 28 ft. above the water. **g.** $-0.04x^2 + 28 = 20$, **h.** $x = \pm 14.14$ ft. Place the pole 14.14 ft. to the right or left of the center. **3.** $x = -\frac{1}{2}$; **5.** $x = \frac{6 \pm \sqrt{12}}{4} = 2.37$ or 0.63; **7.** $x = \frac{-3 \pm \sqrt{33}}{4} = 0.69$, or -2.19; **9.** (0, 0) and (−2, 0); **11.** $\left(\frac{1 + \sqrt{41}}{4}, 0\right)$ and $\left(\frac{1 - \sqrt{41}}{4}, 0\right)$; **13. a.** $d = 2.5$ million particles per ft.^{3} **b.** The minimum occurs at the vertex. $r = \frac{-b}{2a} = \frac{16}{4} = 4$ or 400 rpm; $d = 2(4)^2 - 16(4) + 34 = 2$ million particles per ft.^{3} **c.** $r = 11$; 1100 rpm is the speed of the engine.

Activity 4.6 Exercises: 1. a.



b. $h(t) = -15.9752t^2 + 52.8875t + 2.5536$,

c.



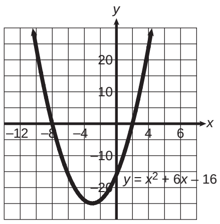
Yes; the curve touches nearly every data point. **d.** all real numbers from 0 to 3.36 sec., **e.** real numbers from 0 to 46.33 ft., **f.** The ball reaches 35 ft. on the way up after 0.81 sec. It reaches 35 ft. again on the way down, approximately 2.50 sec. after it was struck. **g.** There are only two solutions, so I got them all. **3. a.** $y = 0.086x^2 - 0.842x + 32.487$, **b.** approx. 650 ft., **c.** $0 = 0.086x^2 - 0.842x - 247.513$; using the quadratic formula, a speed of 58.8 mph requires a stopping distance of 280 ft.

How Can I Practice?

1.

VALUE OF a	VALUE OF b	VALUE OF c
5	0	0
$\frac{1}{3}$	3	−1
−2	1	0

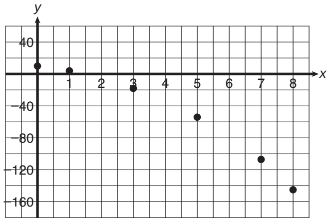
2. a. downward, **b.** $x = 0$, **c.** (0, 4), **d.** (0, 4); **3. a.** upward, **b.** $x = 0$, **c.** (0, 0), **d.** (0, 0); **4. a.** downward, **b.** $x = 1$, **c.** (1, 10), **d.** (0, 7); **5. a.** upward, **b.** $x = \frac{1}{2}$, **c.** $\left(\frac{1}{2}, -1\right)$, **d.** (0, 0); **6. a.** upward, **b.** $x = -3$, **c.** (−3, 0), **d.** (0, 9); **7. a.** upward, **b.** $x = \frac{1}{2}$, **c.** $\left(\frac{1}{2}, \frac{3}{4}\right)$, **d.** (0, 1); **8. a.** (−2, 0), (2, 0), **b.** D: all real numbers; R: $y \le 4$, **c.** $x < 0$, **d.** $x > 0$; **9. a.** (2, 0), (3, 0), **b.** D: all real numbers; R: $y \ge -0.25$, **c.** $x > 2.5$, **d.** $x < 2.5$; **10. a.** (0.91, 0), (−2.91, 0), **b.** D: all real numbers; R: $y \le 11$, **c.** $x < -1$, **d.** $x > -1$; **11. a.** none, **b.** D: all real numbers; R: $y \ge 1.427$, **c.** $x > 1.61$, **d.** $x < 1.61$; **12.** (0.75, 26.125); **13. a.** $9a^2(a^3 - 3)$, **b.** $6x^2(4x - 1)$, **c.** $4x(x - 5)(x + 1)$, **d.** cannot be factored, **e.** $(x - 8)(x + 3)$, **f.** $(y + 5)^2$; **14. a.** 5, 6.05, 7.2, 8.45, 9.8, 11.25, $x \approx 1.2$, **b.** 6.75, 6.16, 5.59, 5.04, 4.51, −1, $x \approx 0.8$, **c.** 0, −2, 2, 12, 28, 50, $x = 2$; **15. a.** $x = 1.2, -1.2$, **b.** $x = 0.8, 6.2$, **c.** $x = -\frac{1}{3}, 2$; **16. a.** $-8 < x < 2$, **b.** $x < -8$ or $x > 2$;



17. a. $x = 0, 2$, **b.** $x = 9, -2$, **c.** $x = 3, 1$, **d.** $x = 4, 4$, **e.** $x = 6, -4$, **f.** $y = 5, -3$, **g.** $a = 3, -2$, **h.** $x = \frac{1}{4}, -2$; **18. a.** 105 ft., **b.** Using the calculator to solve $-16t^2 + 80t + 5 = 0$, $t \approx 5.06$ sec., **c.** $-16t^2 + 80t + 5 = 101$, **d.** $t = 2, 3$; the ball reaches a height of 101 ft. after 2 sec. on the way up and 1 sec. later on the way down.

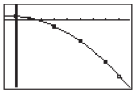
19. a. $0 \le x \le 100$, **b.** $h(50) = 0.01(50)^2 - 50 + 35 = 10$ m;

20. a.



b. $y = -2.096x^2 - 2.25x + 9.038$,

c.



d. Predicted values are very close to the actual values, **e.** $-33.5, -181$, **f.** $x = 4.330, -5.403$;

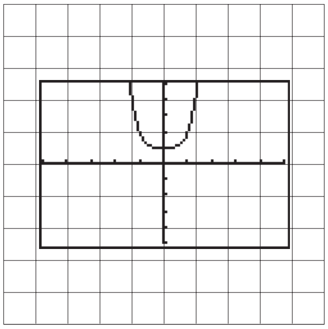
Activity 4.7 Exercises: 1. $5i$; **3.** $6i$; **5.** $4i\sqrt{3}$; **7.** $\frac{3}{4}i$; **9.** $-5 + 10i$; **11.** $3 - 2i$; **13.** $10 + 5i$; **15.** $x = \frac{1}{3} \pm \frac{\sqrt{80}}{6}i$; **17.** $x = 1, -3.5$; **19.** 2 real solutions; **21.** 1 real solution; **23.** 2 complex solutions;

Activity 4.8 Exercises: 1. a. Length: 225, 200, 175, 150, 125, 100, 75, 50, 25; Area: 5625, 10,000, 13,125, 15,000, 15,625, 15,000, 13,125, 10,000, 5625; **b.** 125 ft by 125 ft; **c.** $l = 250 - w$; **d.** $A = f(w) = w(250 - w)$; **e.** $w = 125$; $f(125) = 15{,}625$; **f.** $w(250 - w) = 0$, $w = 0$ or $w = 250$ There can be no rectangle constructed with these dimensions; **g.** domain: $0 < w < 250$; range: $0 < A < 15{,}625$; **3.** 4 mph north, 6 mph east;

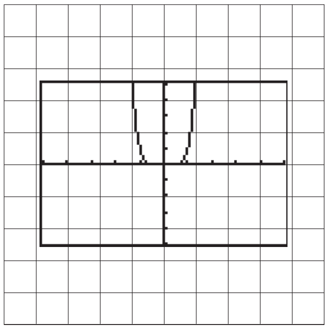
How Can I Practice? 1. $7i$; **2.** $3i\sqrt{5}$; **3.** $11i$; **4.** $i\sqrt{15}$; **5.** $4i\sqrt{7}$; **6.** $5i\sqrt{5}$; **7.** $\frac{4}{5}i$; **8.** $\sqrt{\frac{4}{7}}i = \frac{2}{\sqrt{7}}i$; **9.** $4 + 3i$; **10.** $-5 + 6i$; **11.** $6 - 4i$; **12.** $-12 - 24i$; **13.** $5 + 10i$; **14. i.** $a = 3, b = -1, c = -7$; $b^2 - 4ac = 85$; two real solutions; $x = 1.70, -1.37$, **ii.** $a = 1, b = -4, c = 10$; $b^2 - 4ac = -24$; two complex solutions; $x = 2 \pm i\sqrt{6}$, **iii.** $a = 2, b = -5, c = -3$; $b^2 - 4ac = 49$; two real solutions; $x = 3, -0.5$, **iv.** $a = 9, b = -6, c = 1$; $b^2 - 4ac = 0$; one real solution; $x = \frac{1}{3}$; **15. i.** The discriminant is 0. The graph only touches the x-axis indicating that there is one, real solution, **ii.** The discriminant is negative. The graph does not intersect the x-axis, indicating that there is no real solution, **iii.** The discriminant is positive. The graph intersects the x-axis twice, indicating that there are two real solutions; **16. a.** $(20 + x)(30 + 1.5x)$, **b.** $A(x) = 1.5x^2 + 60x + 600$, **c.** $1.5x^2 + 60x$, **d.** $1.5(2)^2 + 60(2) = 126 \text{ ft}^2$, **e.** $1.5x^2 + 60x = 264$, **f.** $x = -\frac{132}{3}$ or $x = 4$ Reject the negative; the answer is $x = 4$ feet, **g.** No, the negative value does not make sense.

Activity 4.10 Exercises: 1. a. 2, 32, 64, $y = kx$ and $8 = k1$, so $k = 8$ or $y = 8x$, **b.** $\frac{1}{8}$, 27, 216, $y = kx^3$ and $1 = k1^3$, so $k = 1$ or $y = x^3$; **3.** $y = kx^2$ and $12 = k2^2$, so $k = 3$. So $y = 3x^2$. When $x = 8$, $y = 3(8)^2 = 192$; **5.** $d = kt^2$ and $20 = k(2)^2$, so $k = 5$. Now $d = 5t^2$, so in 2.5 seconds the skydiver travels $d = 5(2.5)^2$ or 31.25 meters;

7.



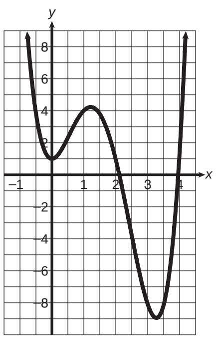
9.



11. $f(x)$ is increasing for $x > 0$; **13.** $y = x^2$ is rising more slowly than $y = x^3$ for $x > 1$. Multiplying x^2 by x gives x^3, and this makes a larger output when $x > 1$; **15.** $y = -2x^3$ is decreasing and goes through (0, 0), whereas $y = 2x^3 + 1$ is increasing and does not pass through the origin. Both have a similar S-like shape.

Activity 4.11 Exercises: 1. $f(x) = x(x + 2)(x + 1)$, (0, 0), (−1, 0), (−2, 0); **3.** $h(x) = (x^2 - 4)(x^2 - 9)$ $h(x) = (x + 2)(x - 2)(x + 3)(x - 3)$, (2, 0), (−2, 0), (3, 0), (−3, 0);

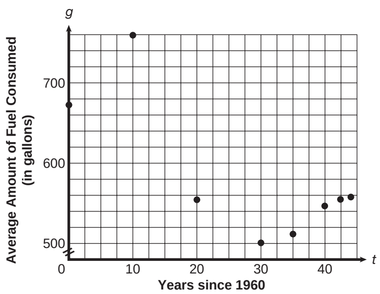
5.



There are two minimum points (0, 1) and (3.28, −8.91) and one maximum point (1.22, 4.23). **7.** No; as x increases without bound, y increases without bound; **9. a.** increase, **b.** decreasing, **c.** 1;

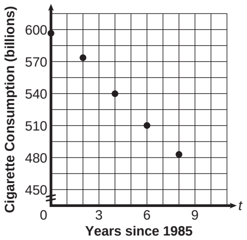
Activity 4.12 Exercises:

1. a.



The data does not appear to be linear because as the input increases, the output increases and decreases. No line would be close to all of the points. **b.** quadratic: $g = 0.073t^2 - 7.333t + 718.889$; cubic:
$g = 0.019t^3 - 1.171t^2 + 13.188t + 681.013$;
quartic: $g = -0.001357t^4 + 0.140t^3 - 4.534t^2 + 41.355t + 668.899$;

3. a.

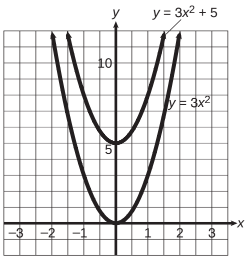


b. $y = -14.15x + 597.4$;

c. $y = -0.125x^2 - 13.15x + 596.4$; **d.** There appears to be no difference between the two models. Both fit closely to the data. **e.** The linear model predicts 314.4, and the quadratic predicts 283.4. **f.** We are predicting quite far outside our practical domain, so I am not very confident in either model's prediction.

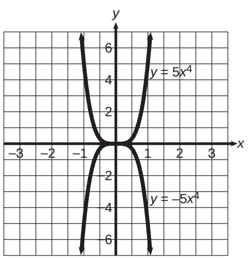
How Can I Practice? 1. $y = kx^2$ and $45 = k3^2$, so $k = 5$ $y = 5(6)^2 = 180$; **2. a.** double, **b.** $k = 1080$; k represents the speed at which the sound of thunder travels in feet per second. **3.** $v = kt$ and $60 = k3$ so $k = 20v = 20(4) = 80$ ft/sec;

4. a.



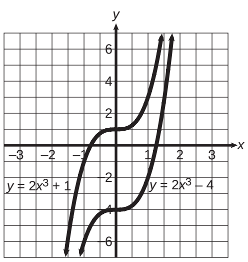
These are the same shape and size; however, $y = 3x^2 + 5$ is shifted up 5 units.

b.



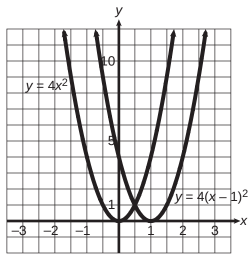
These are the same shape but are reflections of each other in the x-axis.

c.



These are the same shape and size, but $y = 2x^3 - 4$ is shifted vertically 5 units below $y = 2x^3 + 1$.

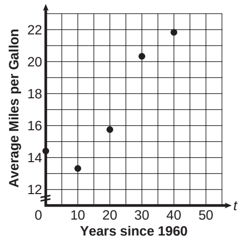
d.



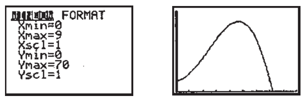
These are the same shape and size, but $y = 4(x - 1)^2$ is shifted horizontally 1 unit to the right of $y = 4x^2$.

5. a. i. (0, 0), ii. (0, 0), (−4, 0), (2, 0), iii. (−2.4, 16.9), (1, −5), **b.** i. (0, 3), ii. (−1, 0), (1.57, 0), iii. (0.79, 4.2).

6. a.



b. $y = 0.00493x^2 + 0.02198x + 13.766$, **c.** 27.2 mpg, **d.** 2015; **7. a.**



$W(t)$ becomes negative after 10 min. **b.** $W(0) = 10$ gal. **c.** 60.8 gal., found by using the CALC menu on the graphing calculator. This is the highest point on the graph. **d.** 7.19 min.

Gateway Review 1. a. up, **b.** $x = 0$, **c.** (0, 2), **d.** (0, 2); **2. a.** down, **b.** $x = 0$, **c.** (0, 0), **d.** (0, 0); **3. a.** down, **b.** $x = 0$, **c.** (0, 4), **d.** (0, 4); **4. a.** up, **b.** $x = \frac{1}{4}$, **c.** $\left(\frac{1}{4}, -\frac{1}{8}\right)$, **d.** (0, 0); **5. a.** up, **b.** $x = -\frac{5}{2}$, **c.** (−2.5, −0.25), **d.** (0, 6); **6. a.** up, **b.** $x = \frac{3}{2}$, **c.** (1.5, 1.75), **d.** (0, 4); **7. a.** up, **b.** $x = 1$, **c.** (1, 0), **d.** (0, 1); **8. a.** down, **b.** $x = 2.5$, **c.** (2.5, 0.25), **d.** (0, −6); **9. a.** (−3, 0), (−1, 0), **b.** D: all real numbers; R: $g(x) \geq -1$, **c.** $x > -2$, **d.** $x < -2$; **10. a.** (−3, 0), (1, 0), **b.** D: all real numbers; R: $f(x) \geq -4$, **c.** $x > -1$, **d.** $x < -1$; **11. a.** (0.382, 0), (2.62, 0), **b.** D: all real numbers; R: $y \geq -1.25$, **c.** $x > 1.5$, **d.** $x < 1.5$; **12. a.** (−3.22, 0), (−0.775, 0), **b.** D: all real numbers; R: $h(x) \geq -3$, **c.** $x > -2$, **d.** $x < -2$; **13. a.** (2, 0), (−2, 0), **b.** D: all real numbers; R: $y(x) \leq 8$, **c.** $x < 0$, **d.** $x > 0$; **14. a.** $\left(\frac{1}{3}, 0\right)$ 2, (1, 0), **b.** D: all real numbers; R: $f(x) \leq \frac{1}{3}$, **c.** $x < \frac{2}{3}$, **d.** $x > \frac{2}{3}$; **15. a.** none, **b.** D: all real numbers; R: $g(x) \geq 5$, **c.** $x > 0$, **d.** $x < 0$; **16.** $x = -2$; **17.** $x = 2, 3$; **18.** $x = -0.51, 6.51$; **19.** $x = -5, 2$; **20.** $x = \pm 1.1$; **21.** $x = -0.26, -4.8$; **22. a.** $9a^2(a^3 - 3)$, **b.** $6x^2(4x - 1)$, **c.** $4x(x - 5)(x + 1)$, **d.** cannot be factored, **e.** $(x - 8)(x + 3)$, **f.** $(t + 5)^2$; **23.** $x = \pm 3$; **24.** $x = \pm 6$; **25.** $x = 3, 4$; **26.** $x = -3, 9$; **27.** $x = 0, -1$; **28.** $a = 1, b = 5, c = 3$; $x = -0.7, -4.3$; **29.** $a = 2, b = -1, c = 3$; $x = 0.25 \pm 1.2i$; **30.** $a = 1, b = 0, c = -81$; $x = \pm 9$;

31. $a = 3, b = 5, c = -12; x = -3, \frac{4}{3}$; **32.** $a = 2, b = -3, c = -5; x = -1, 2.5$; **33.** From the graphing calculator: (0.42, 0), (3.58, 0)

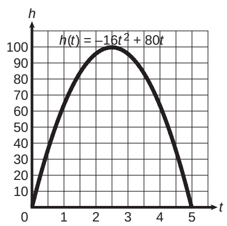
$$x = \frac{-(-8) \pm \sqrt{(-8)^2 - 4(2)(3)}}{2(2)} = \frac{8 \pm \sqrt{40}}{4} = 3.58,$$

0.42; **34. a.** $7i$, **b.** $4i\sqrt{3}$, **c.** $3i$, **d.** $i\sqrt{23}$, **e.** $\frac{\sqrt{5}}{3}i$, **f.** $\frac{\sqrt{17}}{4}i$; **35. a.** $-5 + 17i$, **b.** $5 - 16i$, **c.** $32 + 12i$, **d.** $27 + 6i$; **36.** $d = 1$; two real solutions; **37.** $d = 256$; two real solutions; **38.** $d = 36$; two real solutions; **39.** $d = -20$; two complex solutions;

40. $$x = \frac{-2 \pm \sqrt{2^2 - 4(3)(2)}}{2(3)} = \frac{-2 \pm \sqrt{-20}}{6} = \frac{-2 \pm 2i\sqrt{5}}{2(3)} = \frac{-1 \pm i\sqrt{5}}{3}$$; the graph has no x-intercepts, confirming complex solution;

41. a. $-2 < x < 3$, **b.** $x < -2$ or $x > 3$; **42. a.** $y = 20$, **b.** $y = 32$, **c.** $y = 40$; **43. a.** (2, 0), **b.** D: all real numbers; R: all real numbers, **c.** increasing for all real numbers; **44. a.** $(-1, 0)$, **b.** D: all real numbers; R: all real numbers, **c.** decreasing for all real numbers; **45. a.** $(-1.68, 0)$, $(1.68, 0)$, **b.** D: all real numbers; R: $y \geq -8$, **c.** inc: $x > 0$; dec: $x < 0$; **46. a.** $(0, 0)$, $(-1.26, 0)$, **b.** D: all real numbers; R: $y \geq -1.19$, **c.** inc: $x > -0.8$; dec: $x < -0.8$; **47. a.** none, **b.** D: all real numbers; R: $y \geq 5$, **c.** inc: $x > 0$; dec: $x < 0$;

48. a.



The practical domain is $0 \leq x \leq 5$.

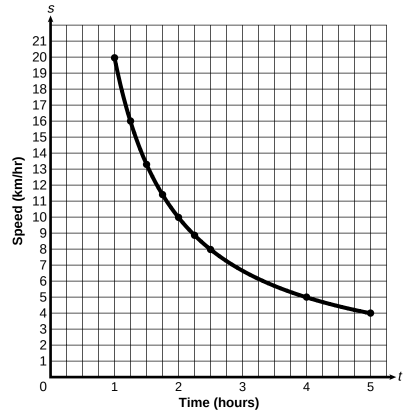
b. (2.5, 100); the ball reaches its highest level, 100 ft., 2.5 sec. after being struck, **c.** (0, 0); the ball is on the ground when the club makes contact with it, **d.** (0, 0), (5, 0); the ball is on the ground when the club makes contact, $t = 0$, and returns to the ground 5 sec. later, **e.** I am assuming that the elevations are the same. **49 a.** $(-5, 6)$, **b.** (0, 0), $(-5, 6)$, $(-10, 0)$, **c.** $y = -0.24x^2 - 2.4x$; **50. a.** vertex: $(2.5, h(2.5))$ or (2.5, 105); the maximum height is 105 ft., **b.** Set $h(t) = 0$; $t = 5.06$ seconds; **51. a.** $s(44) = 122.5$ ft. away, **b.** $v = -51.78$ or 19.78; reject the negative; 19.78 ft./sec. = 13.5 mph.

Chapter 5

Activity 5.1 Exercises: 1. a. The average speed

$$= \frac{20 \text{ km}}{1 \text{ hr } 15 \text{ min}} = \frac{20 \text{ km}}{1.25 \text{ hr}} \approx 16 \text{ km/hr.},$$ **b.** 20, 16, 13.33, 11.43, 10, 8.89, 8, **c.** $s = f(t) = \frac{20}{t}$, **d. i.** the set of all nonzero real numbers, **ii.** (Answers will vary.) $1 \leq t \leq 5$, Because 20 km/hr. (when $t = 1$) is fast for a distance runner and 4 km/hr. (when $t = 5$) is slow for a distance runner, most times will fall between these values.

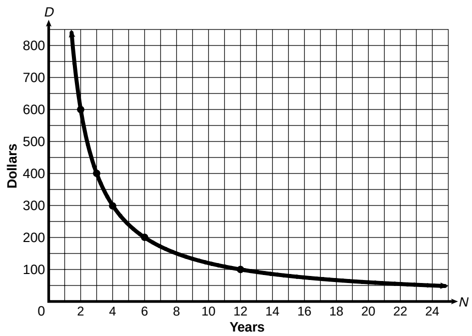
iii.



e. The average speed decreases, approaching 0. **f.** The average speed increases without bound.

3. a. $D = f(N) = \frac{1400-200}{N} = \frac{1200}{N}$, **b.** 1200, 600, 400, 200, 100, 50,

c.



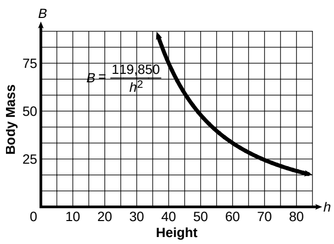
d. Decrease. As N gets larger, D gets smaller.

Activity 5.2 Exercises: 1. a. (Answers will vary.) If a person is 6 ft. = 72 in. tall and weighs 200 lb.,

$$B = \frac{705(200)}{72^2} = 27.2,$$ **b.** $B = \frac{119{,}850}{h^2}$, **c.** $0 < h < 84$

This works unless the person is over 7 ft. tall, **d.** 33.3, 29.3, 25.9, 23.1, 20.7, 18.7,

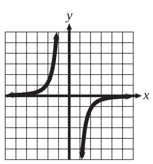
e.



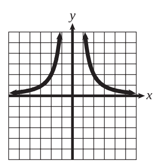
f. Body-mass index B gets smaller and it actually approaches 0. Yes, this makes sense in this case because taller persons with the same weight should be skinnier.

g. $69.2 < h < 79.4$;

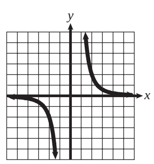
3. a.

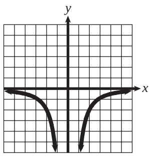


b.



c.

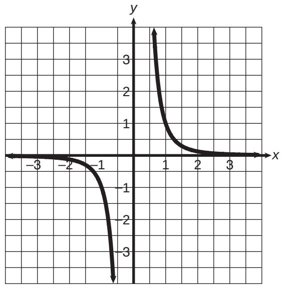


d. 

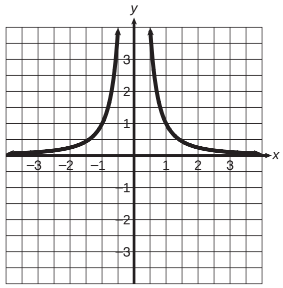
i. graph b, **ii.** graph c, **iii.** graph a, **iv.** graph d;

5. a. all nonzero real numbers,

b.



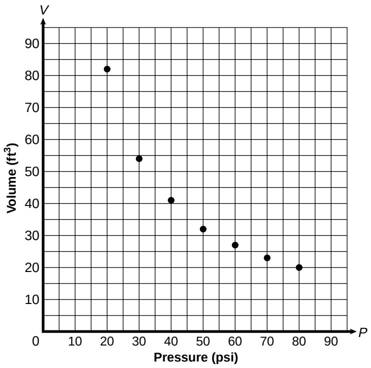
c.



7. a. $y = \frac{2}{x}$; Table: 4, 1, $\frac{1}{3}$, **b.** $y = \frac{8}{x^3}$; Table: 64, 8, $\frac{1}{27}$;

9. $I = \frac{120}{R}$; $I = \frac{120}{15} = 8$ amps;

11. a.

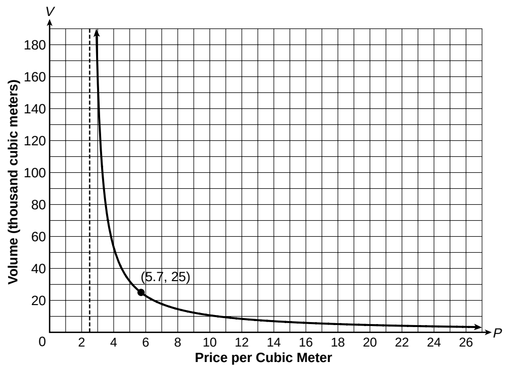


b. No. Using $P = 20$, $V = 82$; $k = 20^2(82) = 32{,}800$. If $V = \frac{32{,}800}{P^2}$, then $P = 30$ would yield $V = \frac{32{,}800}{30^2} = 36.44$ (not very close), **c.** Yes. Using $P = 20$, $V = 82$; $k = 20(82) = 1640$; $V = \frac{1640}{30} = 54.67$; $V = \frac{1640}{40} = 41$, **d.** Answers will vary, ≈25. **e.** $V = \frac{1640}{P}$; $V = \frac{1640}{65} = 25.2$ ft.^{3};

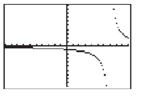
Activity 5.3 Exercises: 1. a.

$$V = \frac{25{,}000 + 55{,}000}{P - 1.5 - 0.40 - 0.60} = \frac{80{,}000}{P - 2.5},$$ **b.** —, 160,000, 32,000, 10,667, 3555.56, **c.** V decreases, **d.** $V(2) = -160{,}000$. A price of \$2 per cubic meter is not practical, **e.** $P > 2.5$,

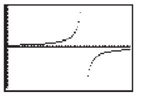
f.



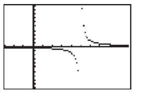
3. a. domain: all real numbers except $x = 7$; vertical asymptote: $x = 7$



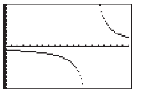
b. domain: all real numbers except $x = 25$; vertical asymptote: $x = 25$



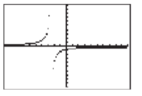
c. domain: all real numbers except $x = 5$; vertical asymptote: $x = 5$



d. domain: all real numbers except $x = 14$; vertical asymptote: $x = 14$



e. domain: all real numbers except $x = -2.5$; vertical asymptote: $x = -2.5$

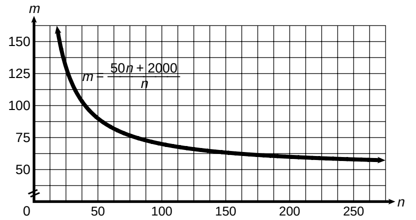


5. a. $x = 5$, **b.** $f(x)$ gets large, approaching infinity. $g(x)$ gets large in magnitude in a negative direction, approaching negative infinity. **c.** $f(x)$ gets large in magnitude in a negative direction, approaching negative infinity. $g(x)$ gets large, approaching infinity.

Activity 5.4 Exercises:

1. a. $500 + 600 + 500 + 400 = \$2000$, **b.** $2000 + 50n$, **c.** $m = \frac{50n + 2000}{n}$, **d.** $m = \frac{50(100) + 2000}{100} = \$70$, **e.** The practical domain is whole numbers from 1 to the size of your class, say 250. **f.** 90, 70, 63.33, 60, 58, **g.** Yes, $m = 50$ is the horizontal asymptote. It makes sense because as the number of attendees increases, the fixed costs attributed to each person get smaller and smaller.

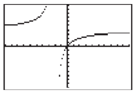
h.



2. a. i. all real numbers except -2,

ii. $x = -2$,

iii.

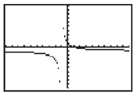


iv. $y = 4$,

b. i. all real numbers except -1,

ii. $x = -1$,

iii.

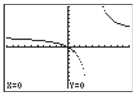


iv. $y = -1$,

c. i. all real numbers except 4,

ii. $x = 4$,

iii.

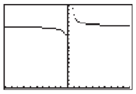


iv. $y = 0$,

d. i. all real numbers except $\frac{1}{2}$,

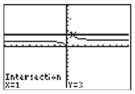
ii. $x = \frac{1}{2}$,

iii.

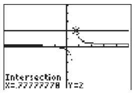


iv. $y = 15$;

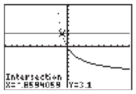
3. a. $x = 1$



b. $x = \frac{7}{9} \approx 0.778$



c. $x = -0.859$



5. a. $15d^2 = 1500$; $d^2 = 100$; $d = \pm 10$ ft., but only 10 makes sense, **b.** $8000 = \frac{1500}{d^2}$; $8000d^2 = 1500$; $d^2 = 0.1875$; $d = 0.433$ ft.;

7. a.

$$R = \frac{250(334) + 12.5(4110) + 1000(26) - 1250(14) + 6.25(530)}{3(530)}$$

$= 92.3$ (rounded to the nearest tenth),

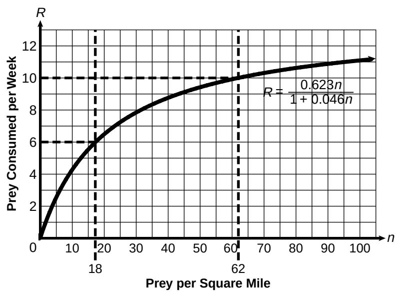
b.

$$R = \frac{250(372) + 12.5(3881) + 1000(20) - 1250(29) + 6.25(607)}{3(607)}$$

$= 70.9$ (rounded to the nearest tenth);

8. a. $R = 7.85$ prey per week, **b.** $61.3 = n$, $n \approx 61$ prey/sq. mi., **c.** $17.3 = n$; putting the two together, $18 \le n \le 62$.

d.



e. The result is negative so discard it. It is not possible for the predator to consume 20 prey/week. Under these conditions, 20 is above the horizontal asymptote.

Activity 5.5 Exercises: 1. a. $5T = 90$, $T = 18$ min., **b.** $t_2T + t_1T = t_1t_2$, $T = \frac{t_1t_2}{t_1 + t_2}$, **c.** $T = \frac{20(15)}{20 + 15} = \frac{300}{35} = 8.57$ min., **d.** $3t_2 = 40$, $t_2 = 13.3$ min., **e.** $14T = 150$, $T = 10.7$ min.; **3.** $t = \frac{72 \pm \sqrt{72^2 - 4(70)}}{2}$, $t \approx 71$ or 1; the only value that makes sense in this situation is $t = 71$ min.; **5.** $21 = 2t$, $t = 10.5$ hr.;

Activity 5.6 Exercises:

1. a. $h = \dfrac{330}{1 - \frac{40}{770}} = 348.08$ Hz; the pitch I hear is higher than the actual pitch, **b.** $h = a \div \frac{770 - s}{770}$; $h = \frac{770a}{770 - s}$;

c. $h = \frac{770(330)}{770 - 40} \approx 348.08$ Hz; the results are the same,

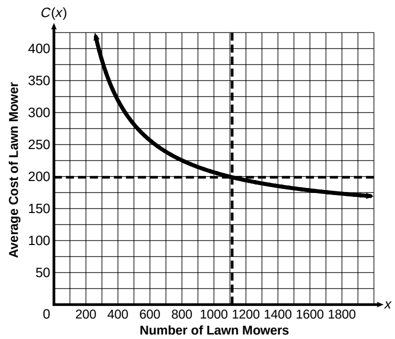
d. $h = \frac{770(330)}{770 - 60} \approx 357.89$ Hz; **3. a.** $= \frac{x - 4}{2x} \cdot \frac{1}{x - 4} = \frac{1}{2x}$,

b. $= \frac{2 - x}{2x} \cdot \frac{4x^2}{(2 - x)(2 + x)} = \frac{2x}{2 + x}$, **c.** $= \frac{3x^2 - 6x}{x^2 - 4x + 3}$,

d. $= \frac{x}{2x + 4}$;

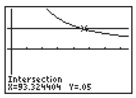
How Can I Practice? 1. The graphs of f and g are reflections of each other about the x-axis (and the y-axis), **2.** They are similar, but the graph of g is closer to the x-axis, and the graph of f is closer to the y-axis, **3. a.** $T =$ time in hours, $s =$ speed in mph, $T = \frac{145}{s}$, **b.** $0 < s < 80$, **c.** all real numbers except 0; **4. a.** domain: all real numbers except $x = -5$; vertical asymptote: $x = -5$, **b.** domain: all real numbers except $x = \frac{13}{2}$; vertical asymptote: $x = \frac{13}{2}$, **c.** domain: all real numbers except $x = \frac{8}{5}$; vertical asymptote: $x = \frac{8}{5}$, **d.** domain: all real numbers except $x = 0.5614$; vertical asymptote: $x = 0.5614$; **5.** $4000^2 \cdot 100 = k = 1.6 \cdot 10^9$; $w = \frac{1.6 \cdot 10^9}{d^2} = \frac{1.6 \cdot 10^9}{(4500)^2} \approx 79.01$ lb.; **6. a.** The practical domain is all positive integers, with some realistic upper limit, depending on the specific situation.

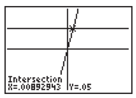
b.



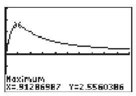
$199x = 132x + 75{,}250$, $x = 1124$ mowers.

7. a. $t = \frac{-(-14) \pm \sqrt{14^2 - 4(0.15)(0.125)}}{2(0.15)} = 93.32$ min. or 0.0089 min. Only 93.32 is practical.

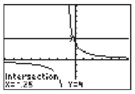




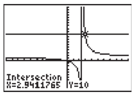
b. The drug will be at its highest concentration 0.913 min. after injection.



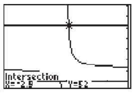
8. a. $x = -0.25$



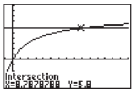
b. $x = \frac{50}{17} \approx 2.94$



c. $x = \frac{-116}{40} = -2.9$

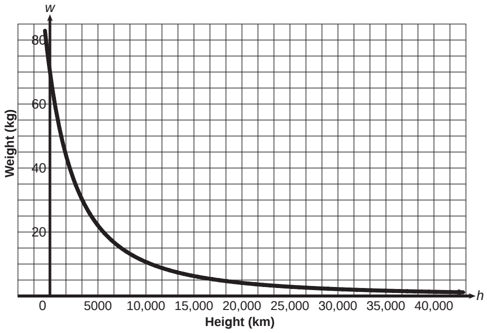


d.
$$x = \frac{5.8}{2.4 - (0.3)\,5.8} = \frac{290}{33} \approx 8.788$$



9. a. (Answers will vary.) 200-lb. man ≈ 90.9 kg; $W = \frac{90.9}{\left(1 + \frac{15}{6400}\right)^2} = 90.475$ kg **b.** $W = \frac{70}{\left(1 + \frac{h}{6400}\right)^2}$, **c.** 70, 69.78, 67.86, 52.36, 45.94, 40.64, 10.66, 4.11, **d.** The weight decreases. **e.** 1.3317 kg, **f.** (Answers will vary at the upper end.) The domain is $0 \le h \le 40{,}000$.

g.

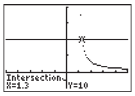


h. $h = 2650.9668$ km

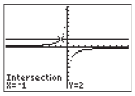
10. a. $R_3 = 12$ ohms, **b.** $R = \frac{R_1R_2R_3}{R_1R_2 + R_2R_3 + R_1R_3}$,

c. $R = \frac{4(6)(12)}{4(6) + 4(12) + 6(12)} = \frac{288}{24 + 48 + 72} = \frac{288}{144} = 2$ ohms.;

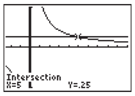
11. a. $x = 1.3$



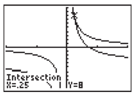
b. $x = -1$



c. $x = 5$



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



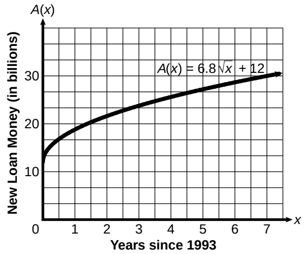
12. a. $s = \frac{2(15.3)}{\frac{15.3}{45} + \frac{15.3}{40}} = \frac{30.6}{0.34 + 0.3825} = 42.4$ mph,

b. $s = \frac{2dr_1r_2}{d(r_1 + r_2)} = \frac{2r_1r_2}{r_1 + r_2}$ **c.** $s = \frac{2(45)(40)}{(40 + 45)} = 42.4$ mph; the results are the same. **13. a.** $= \frac{4x + 2}{x - 3}$,

b. $= \frac{(x + 5)(x - 5)}{(x + 5)} = x - 5$, **c.** $= \frac{1}{x + 2} \cdot \frac{x + 2}{x + 3} = \frac{1}{x + 3}$;

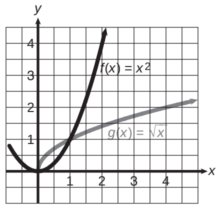
Activity 5.7 Exercises: 1. a. 5.48, **b.** 2.45, **c.** 169, **d.** 27; **3. a.** (0, 12); in 1993, there was \$12 billion in new student loans, **b.** Table: 12, 18.8, 21.6, 23.8, 25.6, 27.2, 28.7, 30. The equation matches very well, with the possible exception of 1994, when it is off by \$0.8 billion.

c.



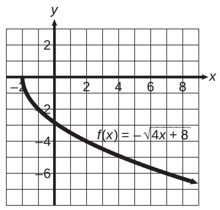
d. In 2005, $x = 12$, so $A(12) = 6.8\sqrt{12} + 12 = \$35.6$ billion in new student loan money.

5. a.

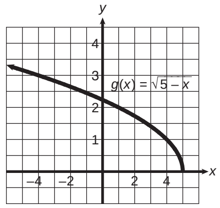


b. No, the graph of f is below the graph of g for $0 < x < 1$. **c.** Yes, the graph of f is above the graph of g for $x > 1$.

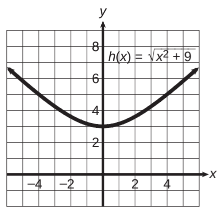
7. a. i. The domain is all real numbers such that $4x + 8 \ge 0$ or $x \ge -2$, **ii.** The x-intercept is $(-2, 0)$, and the y-intercept is $(0, -\sqrt{8})$, **iii.**



b. i. The domain is all real numbers such that $5 - x \ge 0$ or $x \le 5$, **ii.** The x-intercept is (5, 0). The y-intercept is $(0, \sqrt{5})$, **iii.**



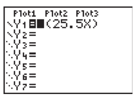
c. i. The domain is all real numbers such that $x^2 + 9 \ge 0$ or all real numbers, **ii.** There is no x-intercept. The y-intercept is (0, 3), **iii.**

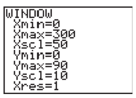


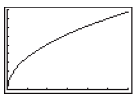
9. $d = \sqrt{12^2 + 24^2 + 17^2} = \sqrt{1009} \approx 31.8$ in. It will not fit. **10. a.** $s = \sqrt{30(0.85)l} = \sqrt{25.5l}$,

b. $s = \sqrt{25.5(90)} = 47.9$ mph, **c.** 0 ft. $\le l \le 300$ ft. is possible,

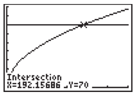
d.





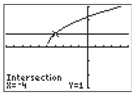


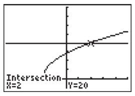
e. The length of the skid marks is approximately 192 feet.



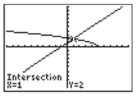
Activity 5.8 Exercises: 1. a. $x = 4$, **b.** $\sqrt{x + 1} = -4$; this can't happen; a positive radical can't equal -4. There is no solution. Equation b has no solution. The left side of equation b will always be greater than 1, so no solution is possible. **c.** $x = -2$, but $x = 1$ does not check.

3. a. $x = -4$ checks. **b.** $x = 2$ checks.





c. $x = 1$; $x = -4$ does not check.



5. $L = 32\left(\frac{1.95}{2\pi}\right)^2$, $L = 3.08$ ft.;

7. a. $V = \sqrt{\frac{1000(10)}{3}} = 57.7$ mph,

b. $P = \frac{14700}{1000} = 14.7$ lb./ft.^{2};

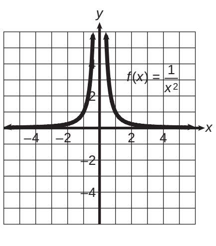
9. a. $A = \sqrt{\frac{70 \cdot 200}{3131}} = 2.11$ sq.m, **b.** $w = \frac{3131A^2}{h}$;

Activity 5.9 Exercises: 1. a. 4, **b.** 2, **c.** -3, **d.** 5, **e.** $\frac{1}{6}$, **f.** not real, **g.** 10, **h.** not real; **3.** The difference is $\sqrt[3]{1450} - \sqrt[3]{1280} = 0.46$ in.; **5. a.** all real numbers, **b.** $x \geq 3$, **c.** all real numbers, **d.** $x \leq 2$; **7. a.** $x = 64$, **b.** $x = 81$; **9. a.** $r = \sqrt[3]{\frac{3 \cdot 40}{4\pi}} = 2.12$ cm, **b.** $V = \frac{4\pi(3.5)^3}{3} = 179.6$ ft.^{3}, **c.** $V = \frac{4\pi r^3}{3}$;

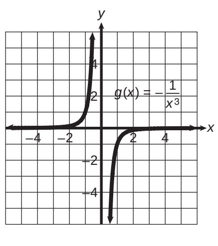
How Can I Practice? 1. a. $x = 98$, **b.** $x = 41$, **c.** $x = 12$, **d.** $x = \pm\sqrt{61}$, **e.** no solution, **f.** $x = 10$, **g.** $x = 10.5$, **h.** $x \approx 0.95$; **2. a.** $x \leq 6$, **b.** all real numbers; **c.** $x \geq 2$ or $x \leq -2$; **3.** Length is approximately 7.71 in. **4.** $r = \sqrt[3]{\frac{3V}{4\pi}}$, $V = 620$, $r = 5.29$ cm.; **5.** $v = 100$, $100 = \sqrt{64d}$, $d = 156.25$ ft.; **6.** $x = 6.5$ in. The dimensions of the bottom of the box are 6.5 in. $\times$ 6.5 in. **7.** The graphs are reflections about the line $x = 2$.

Gateway Review 1. a. $d = \frac{1200}{w}$, **b.** 40, 34.286, 30, 24, 20, **c.** As width increases, the depth decreases. **d.** The depth is 12 feet, not enough room for most theater sets. **e.** No. Division by 0 is undefined. **f.** (Answers may vary.) $30 \leq w \leq 60$, **g.** a rational function, **h.** all real numbers except 0, **i.** $w = 0$, **j.** $d = 0$; as w increases, d approaches 0.

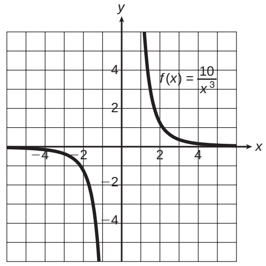
2. a.

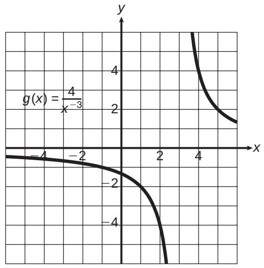


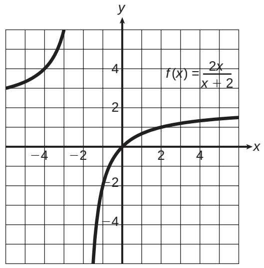
b.



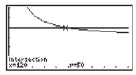
c. The graphs have the same horizontal and vertical asymptotes. $f(x) = \frac{1}{x^2}$ is symmetrical with respect to the y-axis. $f(x) = -\frac{1}{x^3}$ is symmetrical with respect to (0, 0) in quadrants II and IV. f is always positive. g is both positive and negative. **3. a.** $y = \frac{k}{x}$; $12 = \frac{k}{10}$; $k = 120$; $y = \frac{120}{30} = 4$, **b.** $l = \frac{k}{d^2}$; $32 = \frac{k}{16}$; $k = 512$; $l = \frac{512}{100} = 5.12$ dB, **c.** $h = \frac{k}{r^2}$; $8 = \frac{k}{4}$; $32 = k$; $h = \frac{32}{25} = 1.28$ in.; **4. a.** H: $y = 0$; V: $x = 0$; no y-intercept, no x-intercept, **b.** H: $y = 0$, V: $x = 3$, $\left(0, -\frac{4}{3}\right)$; no x-intercept, **c.** H: $y = 2$; V: $x = -2$, (0, 0), (0, 0)



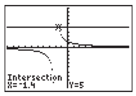




5. a. $f(n) = 45n + 600$, **b.** $f(100) = \$5100$, **c.** $A(n) = \frac{45n + 600}{n}$, **d.** $A(100) = \frac{45(100) + 600}{100}$ $A(100) = \$51$, **e.** 57, 51, 49, 48, 47.40, **f.** $50 = \frac{45n + 600}{n}$; $50n = 45n + 600$; $5n = 600$; $n = 120$ people,

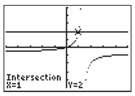


g. $0 < n <$ seating capacity of restaurant, **h.** The vertical asymptote is $n = 0$. Zero people cannot attend the event. There would not be an event. **i.** The horizontal asymptote is $A(n) = 45$. As the number of people attending increases, the average cost approaches \$45. **6. a.** $\frac{4}{x - 2} = 6$; $4 = 6x - 12$; $16 = 6x$; $x = \frac{8}{3}$, **b.** The solution is the x-coordinate of the x-intercept.



7. a. $x = -\frac{7}{5} = -1.4$

b. $x = 1$



8. $\frac{1}{20} + \frac{1}{15} = \frac{1}{x}$ $60x\left(\frac{1}{20} + \frac{1}{15}\right) = 60x\left(\frac{1}{x}\right)$ $3x + 4x = 60$ $7x = 60$ $x = 8.57$ min.; **9.** $x = 67.5$, $2x = 135$ min., or $2\frac{1}{4}$ hr.; **10. a.** $x = 10.2$, **b.** $x = 33$; **11. a.** $S = \frac{C}{1 - r}$

$S(1 - r) = C\ S - Sr = C\ S - C = Sr\ r = \frac{S - C}{S}$,

b. $bc - 4ab = -3ac\ b(c - 4a) = -3ac\ b = \frac{-3ac}{c - 4a}$;

12. a. $\frac{b + 2a}{2b + a}$, **b.** $\frac{x + 2}{x - 2}$;

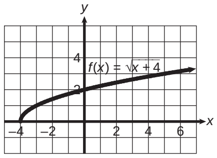
13. a. $f = \dfrac{1}{\frac{1}{4} + \frac{1}{3}} = \dfrac{1}{\frac{3}{12} + \frac{4}{12}} = 1 \div \frac{7}{12} = \frac{12}{7} = 1.71$ m,

b. $f = \dfrac{1}{\frac{1}{p} + \frac{1}{q}} = \dfrac{1}{\frac{q}{pq} + \frac{p}{pq}} = \dfrac{1}{\frac{p + q}{pq}} = \dfrac{pq}{p + q}$,

c. $f = \frac{4(3)}{4 + 3} = \frac{12}{7} = 1.71$ m; the values are the same.

14. a. $x \geq -4$,

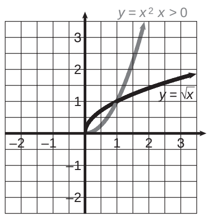
b.



c. The output is increasing. **d.** $y \geq 0$, **e.** The x-intercept is $(-4, 0)$. The y-intercept is $(0, 2)$. **f.** g has the same shape but is shifted 8 units to the right. **g.** The graphs are reflected through the x-axis.

15. a.

b.



The graphs are reflections in $y = x$.

e.

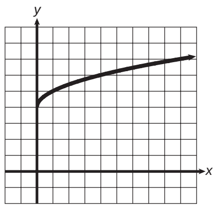
$(f^{-1}(f(x)) = f^{-1}(\sqrt{x}) = (\sqrt{x})^2 = x$;

$y = \sqrt{x}$; $x = \sqrt{y}$; $y = x^2$; $f^{-1}(x) = x^2$; $x \geq 0$, **d.**

16. a. i. $x \geq 0, y \geq 4$,

ii. (0, 4) only,

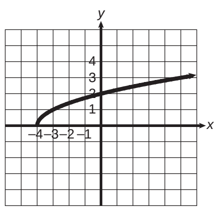
iii.



b. i. $x \geq -4, y \geq 0$,

ii. $(0, 2)$ and $(-4, 0)$,

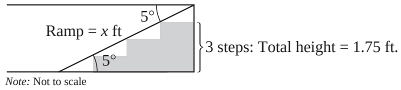
iii.



17. a. $x = 6$, **b.** $x = 6$, **c.** $x = \frac{23}{5} = 4.6$, **d.** $x = -1$
-1 does not check. There is
no solution. **e.** $x = 27$;
18. a. all real numbers, **b.** $x \geq 6$, **c.** $x \geq -1$;
19. $36 = 1.5h$, $h = 24$ ft; **20.** $d = 153.76$ ft.;

Chapter 6

Activity 6.1 Exercises: 1. a. 0.6000, **b.** 0.8000, **c.** 0.8000, **d.** 0.6000, **e.** 0.7500, **f.** 1.3333; **3. a.** Given $\tan B = \frac{7}{4}$, the side opposite angle B is 7; the side adjacent to angle B is 4. Using the Pythagorean theorem, I determine that the hypotenuse is $\sqrt{65}$. **b.** $\sin B = \frac{7}{\sqrt{65}} = 0.8682$, **c.** $\cos B = \frac{4}{\sqrt{65}} = 0.4961$; **5. a.** the sine function, **b.** $\sin B = \frac{y}{c}$; **7. a.** $x = 9.1$, **b.** $x = 85.6$, **c.** $x = 61.4$;
8. a.



b. $3 \cdot 7 = 21$ in. The increase in height from one end of the ramp to the top of the stairs is $\frac{21}{12} = 1.75$ ft. **c.** $x = 20.1$ ft. The ramp needs to be at least 20.1 feet long. Therefore, the donated ramp will not be long enough to meet the code. Alternative approach: $15 \sin 5 = 1.3$ ft. The three steps must measure at most 1.3 ft. high for the 15-foot ramp to satisfy the code. Each solution suggests ways to think about modifications to either the ramp or the steps (or both) that could be used to meet the code.

Activity 6.2 Exercises: 1. a. $s + w = 0.68$ mi. **b.** These calculations confirm the result in part a.

3. a.

90 − x	sin x	cos (90 − x)
83	0.1219	0.1219
73	0.2924	0.2924
66	0.4067	0.4067
57	0.5446	0.5446
42	0.7431	0.7431
23	0.9205	0.9205
13	0.9744	0.9744

;

b. The table in part a illustrates the property that cofunctions of complementary angles are equal.

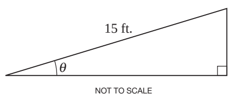
Activity 6.3 Exercises: 1. a. $\theta = 30°$, **b.** $\theta = 64.62°$, **c.** $\theta = 67.04°$, **d.** $\theta = 63.82°$, **e.** $\theta = 66.80°$, **f.** $\theta = 64.62°$, **g.** $\theta = 22.28°$, **h.** $\theta = 20.76°$;

2.

V	θ	E	N
32	65°	13.5	29.0
23.3	59.0°	12	20
4.1	54°	2.4	3.3
26	43.8°	18.8	18
4.5	45°	3.2	3.2

; **3.** $\theta = \tan^{-1}\left(\frac{30}{50}\right) \approx 31°$ My friend should look up at an angle of approximately 31°.

4. a.

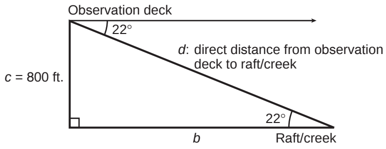


b. Because grade is rise over run, $\tan\theta = 0.1$. $\theta = \tan^{-1}(0.1) = 5.7°$ The ramp makes an angle of 5.7° with the horizontal. **c.** $y = 15 \sin(5.7) \approx 1.5$ ft. The elevation changes 1.5 feet from one end of the ramp to the other.

Activity 6.4 Exercises: 1. a. The side adjacent to the 57° angle is 4.2 feet. The hypotenuse is 7.8 feet. The other acute

angle is 33°. **b.** The hypotenuse is 19.0. The angle adjacent to side 18 is 18.4°. The other acute angle is 71.6°.
c. The other leg is 7.9 inches. The angle adjacent to side 9 inches is 41.4°. The other angle is 48.6°.

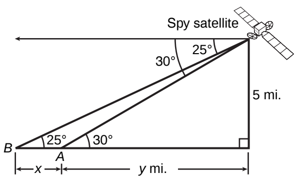
3. a.



b. The direct distance, d, from the observation deck to the raft is approximately $\frac{800}{\sin(22°)} = 2135$ feet. If you could walk straight down the cliff and straight across at the base of the cliff to the creek, the distance would be approximately $b + c = 2780$ feet, where $b = \frac{800}{\tan 22}$.

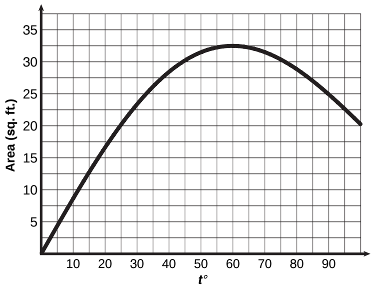
Project Activity 6.5 Exercises: 1. a. The slope is $\frac{5}{100}$ or $\frac{1}{20}$ or 0.05. **b.** $A = \tan^{-1}(0.05) = 2.86°$. The highway makes an angle of 2.86° with the horizontal. This angle is called the angle of elevation. **c.** 1 mile is equivalent to 5280 feet. If x represents the number of feet above sea level after walking 1 mile, then $x = 5280 \cdot \sin(2.86°) =$ approximately 264 feet. I would be 264 feet above sea level after 1 mile.

3. Using the following diagram: The two equations are (a) $\tan 25° = \frac{5}{x + y}$ and (b) $\tan 30° = \frac{5}{y}$. Solving equation (b), $y = 8.7$ miles. Then equation (a) becomes $\tan 25° = \frac{5}{x + 8.7}$. Solve this equation for x. $(x + 8.7)\tan 25° = 5$, $x \tan 25° = 5 - 8.7 \tan 25°$, $x = \frac{(5 - 8.7 \tan 25°)}{\tan 25°}$, $x \approx 2.0$ mi. The runway is approximately 2 miles long.



6. a. Let A represent the area of the trapezoidal cross section. The height of the cross section is h, and the two bases are 5 and $5 + 2x$, respectively. The area is then determined by the formula $A = \frac{1}{2}h(10 + 2x)$, which, after simplifying, is $A = h(5 + x)$ or $A = 5h + hx$.
b. $h = 5\sin t$, $x = 5\cos t$, $A = 5(\sin t)(5 + 5\cos t)$ or $A = 25\sin t(1 + \cos t)$ or, $A = 25\sin t + 25\sin t(\cos t)$,

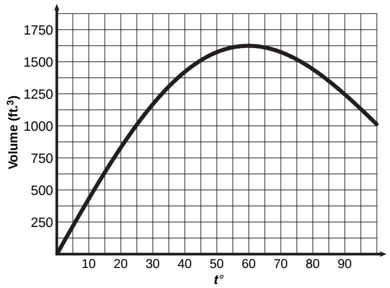
c.



d. The graph in part c indicates that the area of the trapezoidal cross section (output) is the greatest when the angle t is 60°.

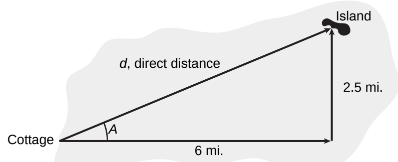
e. The area is approximately 32.5 square feet as read from the graph in part c. **f.** Let V represent the volume. Then, $V = 50 \cdot A$, where A is the cross-section area. In terms of t, the volume is $V = 1250\sin t(1 + \cos t)$.

g.



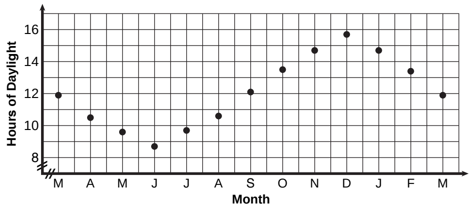
h. The graph indicates the greatest value for the volume between 0° and 90° is approximately 1625 cubic feet when the angle t is 60°.
i. The angle is the same, namely 60° in this scenario.

How Can I Practice? 1. a. $\frac{8}{15}$, **b.** $\frac{15}{8}$, **c.** $\frac{15}{17}$, **d.** $\frac{8}{17}$, **e.** $\frac{8}{17}$, **f.** $\frac{15}{17}$; **2. a.** 0.731, **b.** 0.574, **c.** 0.601, **d.** 5.671; **3.** $\cos A = \frac{12}{13}$ and $\tan A = \frac{5}{12}$; **4.** $\sin B = \frac{7}{\sqrt{65}}$ and $\cos B = \frac{4}{\sqrt{65}}$;
5. a. $\theta = 48.6°$, **b.** $\theta = 23.5°$, **c.** $\theta = 74.1°$, **d.** $\theta = 16.6°$, **e.** $\theta = 44.2°$, **f.** $\theta = 13.7°$;
6. $\overline{BC} = 4.8$ cm, $\overline{AC} = 3.6$ cm, $\angle B = 37°$, $\angle C = 90°$;
7. $A = \arctan\left(\frac{10}{15}\right) = 33.7°$; therefore, I should buy the 35° trusses. **8. a.** $\theta = 20.6$, **b.** $D = \sqrt{16^2 + 6^2} = 17.1$ ft.
9. a.



The direct distance, d, from the cottage to the island is $d = \sqrt{2.5^2 + 6^2} = 6.5$ miles.
b. $A = \arctan\left(\frac{2.5}{6}\right) = 22.6°$; I should direct my boat 22.6° north of east to get from the cottage to the island in the shortest distance.

Activity 6.6 Exercises: 1. a. (0.31, 0.95), **b.** (0.64, −0.77), **c.** (0, −1), **d.** (−0.36, 0.93), **e.** (−0.85, −0.53), **f.** (0.26, 0.97), **g.** (0.34, −0.94); **2. a.** $\frac{72}{360} \cdot 2\pi = 1.26$, **b.** $\frac{310}{360} \cdot 2\pi = 5.41$, **c.** $\frac{270}{360} \cdot 2\pi = 4.71$, **d.** $\frac{111}{360} \cdot 2\pi = 1.94$, **e.** $\frac{212}{360} \cdot 2\pi = 3.70$, **f.** $\frac{435}{360} \cdot 2\pi = 7.59$, **g.** $\frac{-70}{360} \cdot 2\pi = -1.22$; distance is 1.22;
4. a. The graph looks like the cosine function reflected in the x-axis. **b.** The motion indicates cosine values for points $P(x, y)$ starting at $(-1, 0)$.
5. a.



b. Yes, the number of hours of daylight is cyclical. The graph looks like a shifted and stretched sine graph.
c. The graph has the same wave-like shape. **d.** South. The number of hours of daylight is greater from October to February, winter in the Northern Hemisphere.

Activity 6.7 Exercises: 1. a. $45 \cdot \frac{\pi}{180} = \frac{\pi}{4} = 0.785$ radians, **b.** $140 \cdot \frac{\pi}{180} = \frac{7\pi}{9} = 2.443$ radians, **c.** $330 \cdot \frac{\pi}{180} = \frac{11\pi}{6} = 5.760$ radians, **d.** $-36 \cdot \frac{\pi}{180} = \frac{-\pi}{5} = -0.628$ radians;

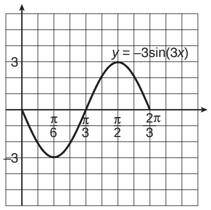
3.

0°	30°	45°	60°	90°	135°	180°	210°	270°	360°
0	$\pi/6$	$\pi/4$	$\pi/3$	$\pi/2$	$3\pi/4$	π	$7\pi/6$	$3\pi/2$	2π

;

5. a. $y = 2\cos x$ is $y = \cos x$ stretched vertically by a factor of 2. $y = \cos(2x)$ is $y = \cos x$ compressed horizontally by a factor of 2. **b.** $y = \cos\left(\frac{1}{3}x\right)$ is $y = \cos x$ stretched horizontally by a factor of 3. $y = \cos(3x)$ is $y = \cos x$ compressed horizontally by a factor of 3.

7.

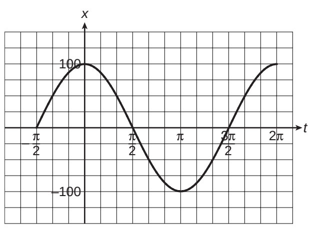


max: 3,
min: −3,
period: $\frac{2\pi}{3}$;

9. a. The bill is highest for December and January. The amount of the bill is approximately \$600. **b.** The bill is lowest for June and July. The amount of the bill is approximately \$250. **c.** The largest value is \$650. **d.** The period is 6 billing periods or 12 months. **e.** The graph will be stretched vertically by a factor of 1.05. This will not affect the period of the function. **f.** The amount of the bills for the summer months would increase. The graph would flatten out as the monthly charges become more equal.

Activity 6.8 Exercises:

1.

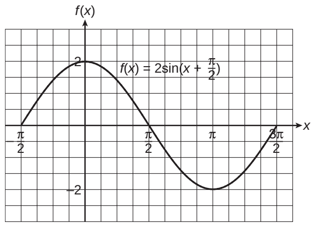


3. a. The maximum value is 100. **b.** The minimum value is −100. **5.** $x = 150\cos\theta$
$y = 150\sin\theta$;

8. a. $y = -15\sin(2x)$, **b.** $y = 1.3\cos(0.7x)$; **10. a.** Graph is iii, **b.** Graph is iv, **c.** Graph is i, **d.** Graph is ii;

Activity 6.9 Exercises: 1. a. amplitude: 0.7, period: π, displacement: $\frac{-\frac{\pi}{2}}{2} = -\frac{\pi}{4}$, **b.** amplitude: π, period: 2π, displacement: $\frac{-(-1)}{1} = 1$, **c.** amplitude: 2.5, period: 5π, displacement: $\frac{-\frac{\pi}{3}}{0.4} = -\frac{5\pi}{6}$, **d.** amplitude: 15, period: 1, displacement: $\frac{-(-0.3)}{2\pi} = \frac{3}{20\pi} = 0.0477$;

3.

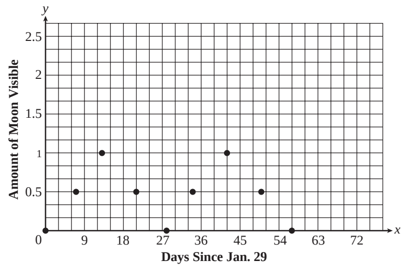


5. a. Graph is iii. **b.** Graph is iv. **c.** Graph is i, **d.** Graph is ii.

Activity 6.10 Exercises: 1. a.

DATE	Jan 29	Feb 5	Feb 13	Feb 21	Feb 28	Mar 6	Mar 14	Mar 22	Mar 29
x; days since Jan 29	0	7	13	21	28	34	42	50	57
y; the amount of Moon visible	0	0.5	1	0.5	0	0.5	1	0.5	0

b.



c. Yes. It does show repeated and periodic behavior. **d.** $y = 0.500\sin(0.222x - 1.509) + 0.521$, **e.** $y(95) = 0.85$, or about 85% of the side of the Moon facing the earth will be visible 95 days after Jan. 29th.

Activity 6.11 Exercises 1. a. D to C = 1.1224; E to C = 1.2599; F to C = 1.3348; G to C = 1.4983; A to C = 1.6818; B to C = 1.8877; **3. a.** $r = 2^{(1/12)} \approx 1.059463$, **b.**

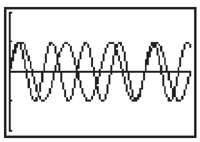
C	C#	D	D#	E	F	F#	G	G#	A	A#	B	C
261.6	277.2	293.6	311.1	329.6	349.2	370.0	392.0	415.3	440.0	466.1	493.8	523.2

c. $\frac{415.3}{311.1} = 1.33494 \approx 1.33... = \frac{4}{3}$, so the notes should be consonant.

d. D# :
$\frac{344}{311.1} = 1.106\,\text{m} \Rightarrow b = \frac{2\pi}{1.106} \approx 5.68 \Rightarrow y = \sin(5.68x)$

E# :
$\frac{344}{415.3} = 0.828\,\text{m} \Rightarrow b = \frac{2\pi}{0.828} \approx 7.59 \Rightarrow y = \sin(7.59x)$

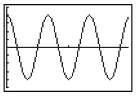
Appears consonant:



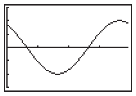
How Can I Practice? 1. a. (0.81, 0.59), **b.** (−0.87, −0.5), **c.** (0, −1), **d.** (0.73, −0.68), **e.** (−0.81, −0.59), **f.** (0, 1); **2. a.** 0.63 units, **b.** 3.67 units, **c.** 1.57 units clockwise, **d.** 5.53 units, **e.** 2.51 units clockwise, **f.** 7.85 units; **3. a.** $18 \cdot \frac{\pi}{180} = \frac{\pi}{10}$, **b.** $18 \cdot \frac{\pi}{180} = \frac{\pi}{10}$, **c.** $390 \cdot \frac{\pi}{180} = \frac{13\pi}{6}$, **d.** $-72 \cdot \frac{\pi}{180} = \frac{-2\pi}{5}$; **4. a.** $\frac{5\pi}{6} \cdot \frac{180}{\pi} = 150°$,

b. $1.7\pi \cdot \frac{180}{\pi} = 306°$, **c.** $-3\pi \cdot \frac{180}{\pi} = -540°$,
d. $0.9\pi \cdot \frac{180}{\pi} = 162°$;

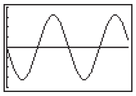
5. amplitude: 4
period: $\frac{2\pi}{3}$
displacement: 0



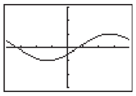
6. amplitude: 2
period: $\frac{2\pi}{1} = 2\pi$
displacement: 1



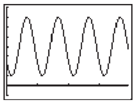
7. amplitude: 3.2
period: $\frac{2\pi}{2} = \pi$
displacement: 0



8. amplitude: 1
period: $\frac{2\pi}{\frac{1}{2}} = 4\pi$
displacement: -2



9. amplitude: 3
period: $\frac{2\pi}{4} = \frac{\pi}{2}$
displacement: $\frac{-(-1)}{4} = \frac{1}{4}$



10. a. because of the repetitive nature of the height of the water as a function of time,
b. amplitude $= \frac{80 - 0}{2} = 40$,
c. The period is approximately 12 hours, because high tide occurs twice a day. **d.** Let x represent the number of hours since midnight. $y = a\sin(bx + c) + d$, $a = 40$, the amplitude, period : $\frac{2\pi}{b} = 12$, $b = \frac{\pi}{6}$, displacement :$3 = \frac{-c}{b} = \frac{-c}{\frac{\pi}{6}}$, $-c = 3 \cdot \left(\frac{\pi}{6}\right)$, $c = \frac{-\pi}{2}$, vertical shift :$d = 40$, $y = 40\sin\left(\frac{\pi}{6}x - \frac{\pi}{2}\right) + 40$. Other equations are possible; depends on the choice of displacement.

Gateway Review 1. a. $N = 7\sin(63°) = 6.24$ mi, **b.** $E = 7\cos(63°) = 3.18$ mi; **2. a.** side $c = 13$, angle $A = 67.4°$, angle $B = 22.6°$, **b.** side $a = 6.93$, side $b = 4$, angle $A = 60°$, **c.** side $b = 3$, side $c = 4.24$, angle $B = 45°$, **d.** side $a = 8.66$, side $c = 10$, angle $B = 30°$; **3. a.** $\cos\theta = \frac{8}{10}$, $\tan\theta = \frac{6}{8}$, **b.** $\sin\theta = \frac{1}{2}$, $\tan\theta = \frac{1}{\sqrt{3}}$, $\theta = 30°$, **c.** $c^2 = 5^2 + 8^2 = 89$, $c = \sqrt{89}$, $\sin\theta = \frac{8}{\sqrt{89}}$, $\cos\theta = \frac{5}{\sqrt{89}}$; **4.** No; there is a difference, but it is so small that it is difficult to see. For me:
$\theta = \tan^{-1}\left(\frac{1408}{100}\right) = 85.9375°$.
For my nephew: $\theta = \tan^{-1}\left(\frac{1411}{100}\right) = 85.9461°$.

5.

$$\tan 57° = \frac{a}{30}$$
$$30\tan 57° = a$$
$$a = 46.2$$
$$\cos 57° = \frac{30}{c}$$
$$c = \frac{30}{\cos 57°}$$
$$c = 55.1$$

$$\tan 13° = \frac{b}{46.2}$$
$$b = 46.2\tan 13°$$
$$b = 10.7$$
$$\cos 13° = \frac{46.2}{h}$$
$$h = \frac{46.2}{\cos 13°}$$
$$h = 47.4$$

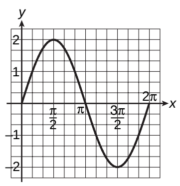
6. So, $(2x)^2 = x^2 + (200 + x)^2$ $x = \frac{400 \pm \sqrt{480,000}}{4}$.

The negative does not make sense, thus $x = \frac{400 + 400\sqrt{3}}{4}$.
$x = 100 + 100\sqrt{3}$; $h = 300 + 100\sqrt{3}$

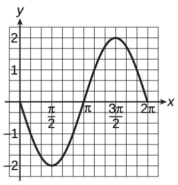
7.

$\sin\theta$	$\cos\theta$	$\tan\theta$
$\frac{\sqrt{3}}{2}$	$-\frac{1}{2}$	$-\sqrt{3}$
$\frac{1}{\sqrt{2}}$	$-\frac{1}{\sqrt{2}}$	-1
$\frac{1}{2}$	$\frac{\sqrt{3}}{2}$	$\frac{1}{\sqrt{3}}$
0	-1	0
$-\frac{1}{2}$	$-\frac{\sqrt{3}}{2}$	$\frac{1}{\sqrt{3}}$
$-\frac{1}{\sqrt{2}}$	$-\frac{1}{\sqrt{2}}$	1
$-\frac{\sqrt{3}}{2}$	$-\frac{1}{2}$	$\sqrt{3}$
-1	0	undef.
$-\frac{\sqrt{3}}{2}$	$\frac{1}{2}$	$-\sqrt{3}$
$-\frac{1}{\sqrt{2}}$	$\frac{1}{\sqrt{2}}$	-1
$-\frac{1}{2}$	$\frac{\sqrt{3}}{2}$	$-\frac{1}{\sqrt{3}}$
0	1	0

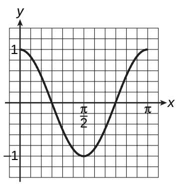
8. a. amplitude: 2
period: 2π



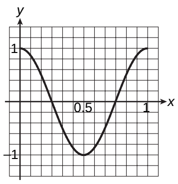
b. amplitude: 2
period: 2π



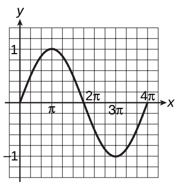
c. amplitude: 1
period: π



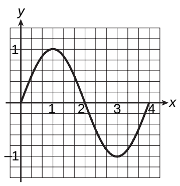
d. amplitude: 1
period: 1



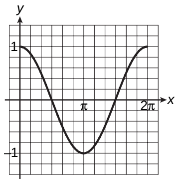
e. amplitude: 1
period: 4π



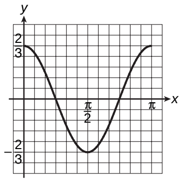
f. amplitude: 1
period: 4



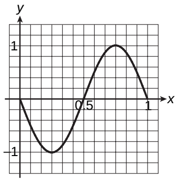
g. amplitude: 1
period: 2π



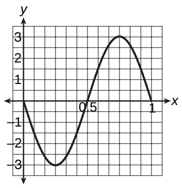
h. amplitude: $\frac{2}{3}$
period: π



i. amplitude: 1
period: 1



j. amplitude: 3
period: 1



9. **a.** Graph is vi. **b.** Graph is ii. **c.** Graph is iv. **d.** Graph is v. **e.** Graph is vii. **f.** Graph is viii.