# Solutions to Selected Exercises

## *Chapter 1*

### Section 1.1

1. a. $f(40)=13$

   b. 2 Tons of garbage per week is produced by a city with a population of 5,000.

3. a. In 1995 there are 30 ducks in the lake

   b. In 2000 there are 40 ducks in the late

5. a ,b, d, e  7. a, b  9. a, b, d

11. b  13. b, c, e, f  15. $f(1)=1,\ f(3)=1$

17. $g(2)=4,\ g(-3)=2$  19. $f(3)=53,\ f(2)=1$

| | $f(-2)$ | $f(-1)$ | $f(0)$ | $f(1)$ | $f(2)$ |
|---|---|---|---|---|---|
| 21. | 8 | 6 | 4 | 2 | 0 |
| 23. | 49 | 18 | 3 | 4 | 21 |
| 25. | 4 | -1 | 0 | 1 | -4 |
| 27. | 4 | 4.414 | 4.732 | 5 | 5.236 |
| 29. | -4 | -6 | -6 | -4 | 0 |
| 31. | 5 | DNE | -3 | -1 | -1/3 |
| 33. | 1/4 | 1/2 | 1 | 2 | 4 |

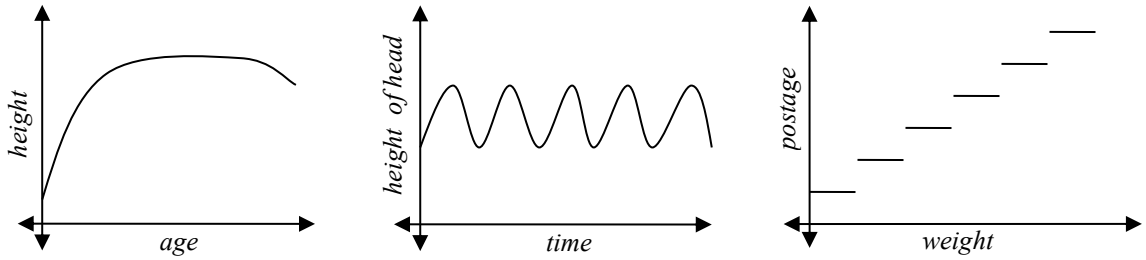
35. a. -6  b.-16  37. a. 5  b. $-\frac{5}{3}$

39. a. iii  b. viii  c. I  d. ii  e. vi  f. iv  g. v  h. vii

41. a. iv  b. ii  c. v  d. I  e. vi  f. iii

43. $(x-3)^2+(y+9)^2=36$

45. (a)  (b)  (c)




47a. $t$  b. $a$  c. $r$  d. L: (c, t) and K: (a, p)

## Section 1.2

1. D: [-5, 3) R: [0,2]

3. D: $2 < t \le 8$ R: $6 \le g(t) < 8$

5. D: [0,4] R: [-3, 0]

7. $[2,\infty)$

9. $(-\infty,3]$

11. $(-\infty,6)\cup(6,\infty)$

13. $(-\infty,-\frac{1}{2})\cup\left(-\frac{1}{2},\infty\right)$

15. $[-4,4)\cup(4,\infty)$

17. $(-\infty,-11)\cup(-11,2)\cup(2,\infty)$

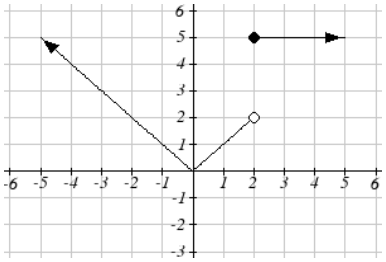
| | $f(-1)$ | $f(0)$ | $f(2)$ | $f(4)$ |
|---|---|---|---|---|
| 19. | -4 | 6 | 20 | 34 |
| 21. | -1 | -2 | 7 | 5 |
| 23. | -5 | 3 | 3 | 16 |

25. $f(x)=\begin{cases} 2 & if \quad -6 \le x \le -1 \\ -2 & if \quad -1 < x \le 2 \\ -4 & if \quad 2 < x \le 4 \end{cases}$

27. $f(x)=\begin{cases} 3 & if \quad x \le 0 \\ x^2 & if \quad x > 0 \end{cases}$

29. $f(x)=\begin{cases} \dfrac{1}{x} & if \quad x < 0 \\ \sqrt{x} & if \quad x \ge 0 \end{cases}$

31.



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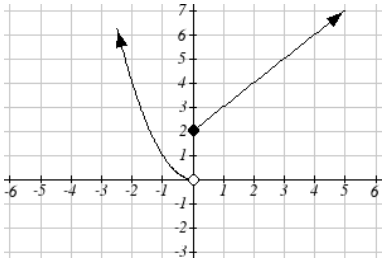

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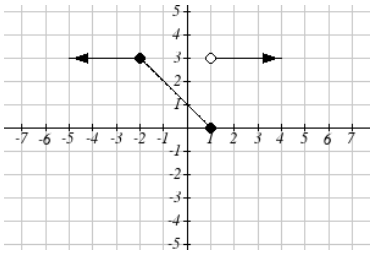


## Section 1.3

1. a) 6 million dollars per year  b) 2 million dollars per year

3. $\frac{4-5}{4-1} = -\frac{1}{3}$  5. 6  7. 27

9. $\frac{596}{27}$  11. $4b+4$  13. 3

15. $-\frac{1}{13h+169}$  17. $9+9h+3h^2$  19. $4x+2h$

21. Increasing: $(-1.5, 2)$. Decreasing: $(-\infty,-1.5)\cup(2,\infty)$

23. Increasing: $(-\infty,1)\cup(3,4)$. Decreasing: $(1,3)\cup(4,\infty)$

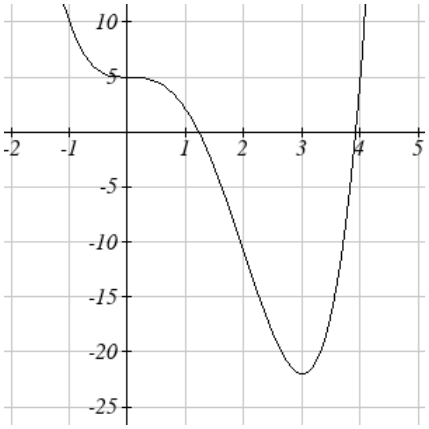
25. Increasing, concave up  27. Decreasing, concave down

29. Decreasing, concave up  31. Increasing, concave down

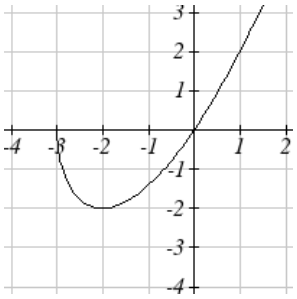
33. Concave up $(-\infty,1)$. Concave down $(1,\infty)$. Inflection point at (1, 2)

35. Concave down $(-\infty,3)\cup(3,\infty)$

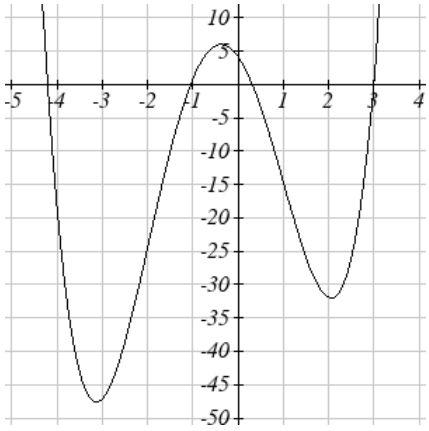
37. Local minimum at (3, -22).
Inflection points at (0,5) and (2, -11).
Increasing on $(3,\infty)$. Decreasing $(-\infty,3)$
Concave up $(-\infty,0)\cup(2,\infty)$. Concave down $(0,2)$




39. Local minimum at (-2, -2)
Decreasing $(-3,-2)$
Increasing $(-2,\infty)$
Concave up $(-3,\infty)$




41. Local minimums at (-3.152, -47.626)
and (2.041, -32.041)
Local maximum at (-0.389, 5.979)
Inflection points at (-2, -24) and (1, -15)
Increasing $(-3.152,-0.389)\cup(2.041,\infty)$
Decreasing $(-\infty,-3.152)\cup(-0.389,2.041)$
Concave up $(-\infty,-2)\cup(1,\infty)$
Concave down $(-2,1)$



## Section 1.4

1. $f(g(0)) = 36$ . $g(f(0)) = -57$

3. $f(g(0)) = 4$ . $g(f(0)) = 4$

5. 4 7. 9 9. 4 11. 7 13. 0 15. 4 17. 3 19. 2

21. $f\left(g\left(x\right)\right) = \frac{x}{7}$ $g\left(f\left(x\right)\right) = 7x - 36$

23. $f\left(g\left(x\right)\right) = x + 3$ $g\left(f\left(x\right)\right) = \sqrt{x^2 + 3}$

25. $f\left(g\left(x\right)\right) = \left|5x + 1\right|$ $g\left(f\left(x\right)\right) = 5\left|x\right| + 1$

27. $f\left(g\left(h\left(x\right)\right)\right) = \left(\sqrt{x} - 6\right)^4 + 6$

29. b 31a. $r\left(V\left(t\right)\right) = \sqrt[3]{\frac{3\left(10 + 20t\right)}{4\pi}}$ b. 4.609in

33. $\left(0, \infty\right)$ 35. $\left(-\infty, \frac{1}{3}\right) \cup \left(\frac{1}{3}, 1\right) \cup \left(1, \infty\right)$ 37. $\left[2,5\right) \cup \left(5, \infty\right)$

39. $g\left(x\right) = x + 2, f\left(x\right) = x^2$ 41. $f\left(x\right) = \frac{3}{x}, g\left(x\right) = x - 5$

43. $f\left(x\right) = 3 + \sqrt{x}, g\left(x\right) = x - 2$ , or $f\left(x\right) = 3 + x, g\left(x\right) = \sqrt{x - 2}$

45a. $f\left(f\left(x\right)\right) = a\left(ax + b\right) + b = \left(a^2\right)x + \left(ab + b\right)$

b. $g(x) = \sqrt{6}x - \frac{8}{\sqrt{6} + 1}$ or $g(x) = -\sqrt{6}x - \frac{8}{1 - \sqrt{6}}$

47a. $C\left(f\left(s\right)\right) = \frac{70\left(\frac{s}{60}\right)^2}{10 + \left(\frac{s}{60}\right)^2}$ b. $C\left(g\left(h\right)\right) = \frac{70\left(60h\right)^2}{10 + \left(60h\right)^2}$

c. $v\left(C\left(m\right)\right) = \frac{5280}{3600}\left(\frac{70m^2}{10 + m^2}\right)$

## Section 1.5

1. Horizontal shift right 49 units

3. Horizontal shift left 3 units

5. Vertical shift up 5 units

7. Vertical shift down 2 units

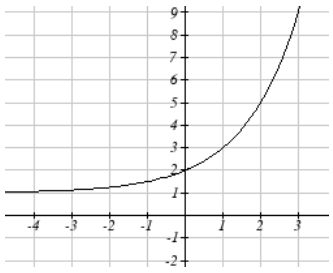
9. Horizontal shift right 2 units, Vertical shift up 3 units

11. $f(x+2)+1=\sqrt{x+2}+1$

13. $f(x-3)-4=\dfrac{1}{x-3}-4$

15. $g(x)=f(x-1), \quad h(x)=f(x)+1$

17.



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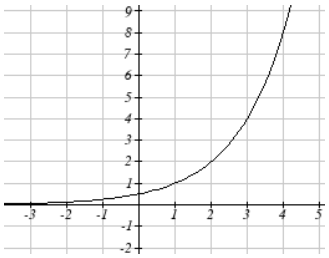

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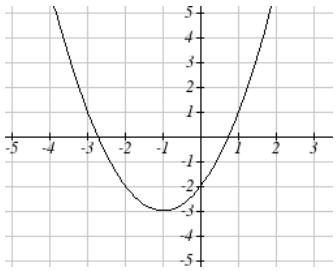

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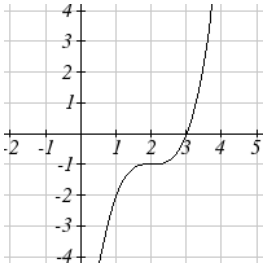
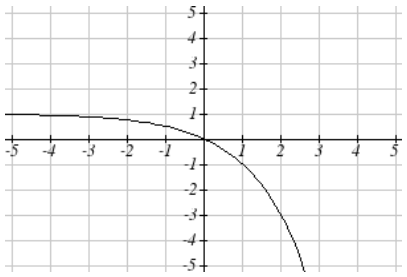


25. $y=|x-3|-2$

27. $y=\sqrt{x+3}-1$

29. $y=-\sqrt{x}$

31.



33a. $-f(-x)=-6^{-x}$

b. $-f(x+2)-3=-6^{x+2}-3$

35. $y=-(x+1)^2+2$

37. $y=\sqrt{-x}+1$

39a. Even b. Neither c. Odd

41. Reflect *f(x)* about the *x*-axis

43. Vertically stretch *y* values by 4

45. Horizontally compress *x* values by 1/5

47. Horizontally stretch *x* values by 3

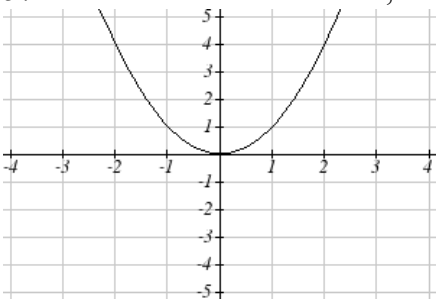
49. Reflect *f(x)* about the *y*-axis and vertically stretch *y* values by 3

51. $f\left(-4x\right)=\left|-4x\right|$

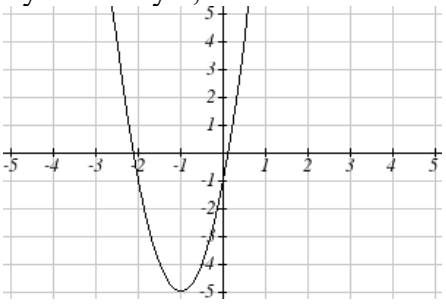
53. $\frac{1}{3}f\left(x+2\right)-3=\frac{1}{3\left(x+2\right)^{2}}-3$

55. $f\left(2\left(x-5\right)\right)+1=\left(2\left(x-5\right)\right)^{2}+1$

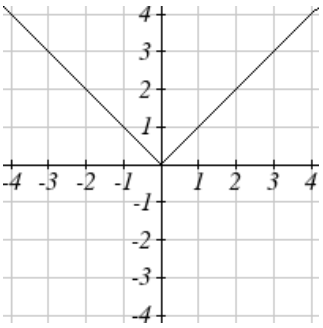
57. Horizontal shift left 1 unit, vertical stretch y values by 4, vertical shift down 5 units



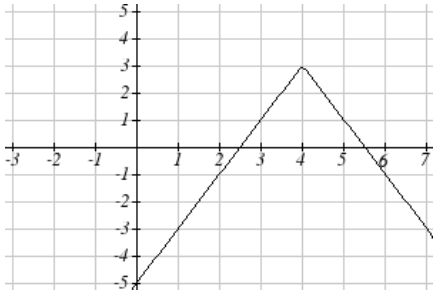

becomes



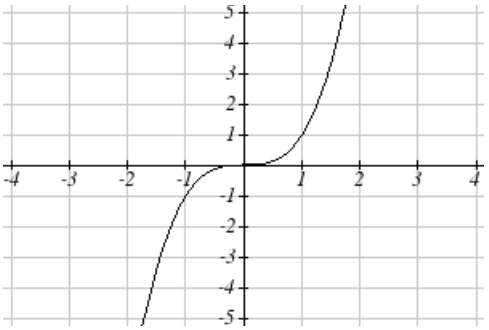

59. Horizontal shift right 4 units, vertical stretch y values by 2, reflect over x axis, vertically shift up 3 units.




becomes



61. Vertically compress y values by ½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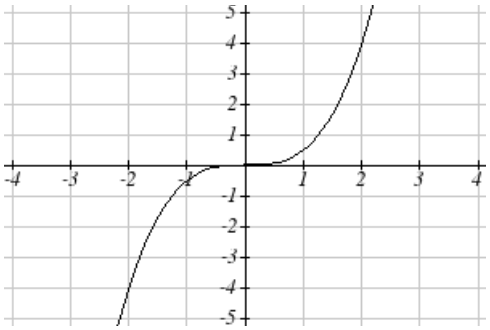
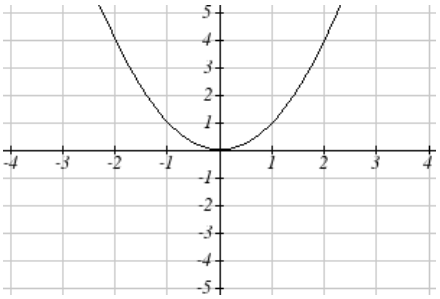


63. Horizontally stretch x values by 3, vertical shift down 3 units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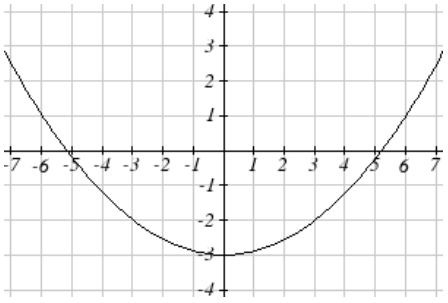
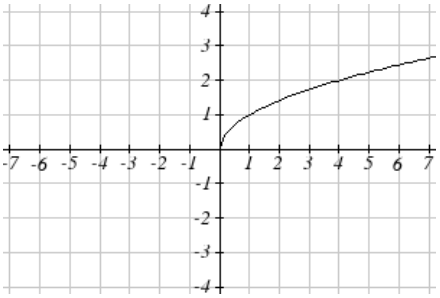


65. Reflected over the y axis, horizontally shift right 4 units $a(x)=\sqrt{-(x-4)}$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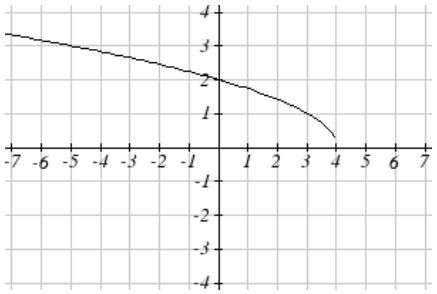


67. This function is increasing on $(-1,\infty)$ and decreasing on $(-\infty,-1)$

69. This function is decreasing on $(-\infty,4)$

71. This function is concave down on $(-3,\infty)$ and concave up on $(-\infty,-3)$

73. This function is concave up everywhere

75. $f(-x)$

77. $3f(x)$

79. $2f(-x)$

81. $2f\left(\frac{1}{2}x\right)$

83. $2f(x)-2$

85. $-f(x+1)+3$

87. $y=-2(x+2)^2+3$ 89. $y=\left(\frac{1}{2}(x-1)\right)^3+2$ 91. $y=\sqrt{2(x+2)}+1$

93. $y=\frac{-1}{(x-2)^2}+3$ 95. $y=-2|x+1|+3$ 97. $y=\sqrt[3]{-\frac{1}{2}(x-2)}+1$

99. $f(x)=\begin{cases}(x+3)^2+1 & \text{if } x\le -2\\ \frac{1}{2}|x-2|+3 & \text{if } x>-2\end{cases}$

101. $f(x)=\begin{cases}1 & \text{if } x<-2\\ -2(x+1)^2+4 & \text{if } -2\le x\le 1\\ \sqrt[3]{x-2}+1 & \text{if } x>1\end{cases}$

103a. *Domain*: $3.5\le x\le 6$ d. *Range*: $-9\le y\le 7$

## Section 1.6

1. 6 3. -4 5. ½

7a. 3 b. 2 c. 2 d. 3

9a. 0 b. 7 c. 1 d. 3

11.

| $x$ | 1 | 4 | 7 | 12 | 16 |
|---|---|---|---|---|---|
| $f^{-1}(x)$ | 3 | 6 | 9 | 13 | 14 |

13. $f^{-1}(x)=x-3$ 15. $f^{-1}(x)=-x+2$ 17. $f^{-1}(x)=\frac{x-7}{11}$

19. Restricted domain $x\ge -7, f^{-1}(x)=\sqrt{x}-7$

21. Restricted domain $x\ge 0$, $f^{-1}(x)=\sqrt{x+5}$

23a. $f(g(x))=\left(\sqrt[3]{x+5}\right)^3-5=x$ b. $g(f(x))=\sqrt[3]{x^3-5+5}=x$

c. This means that they are inverse functions (of each other)

# *Chapter 2*

## Section 2.1

1. $P(t) = 1700t + 45000$ 3. $D(t) = 10 + 2t$ 5. $M(n) = 40 - 2n$

7. Increasing 9. Decreasing 11. Decreasing

13. Increasing 15. Decreasing 17. 3

19. $-\frac{1}{3}$ 21. $\frac{4}{5}$ 23. $\frac{2}{3}$

25. -0.05 mph (or 0.05 miles per hour toward her home)

27. Population is decreasing by 400 people per year

29. Monthly charge in dollars has an initial base charge of $24, and increases by $0.10 for each minute talked

31. Terry started at an elevation of 3,000 ft and is descending by 70ft per second.

33. $y = \frac{3}{5}x - 1$ 35. $y = 3x - 2$ 37. $y = -\frac{1}{3}x + \frac{11}{3}$

39. $y = -1.5x - 3$ 41. $y = \frac{2}{3}x + 1$ 43. $y = -2x + 3$

45. $P(n) = -0.004n + 34$

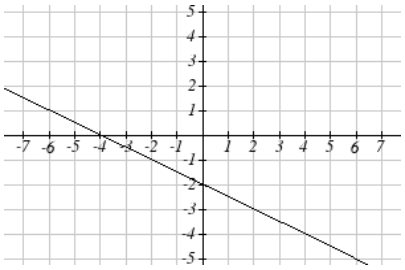
47. The 1st ,3rd & 4th tables are linear: respectively

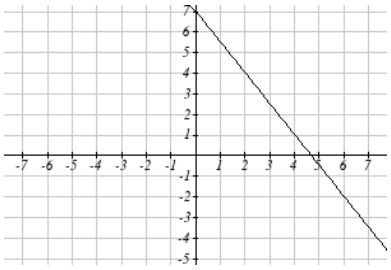
1. $g(x) = -3x + 5$ 3. $f(x) = 5x - 5$ 4. $k(x) = 3x - 2$

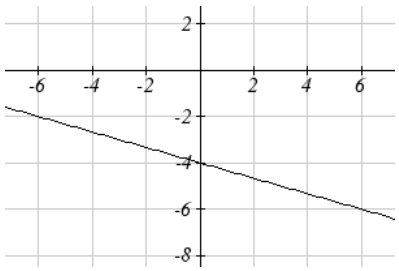
49a. $C = \frac{5}{9}F - \frac{160}{9}$ b. $F = \frac{9}{5}C + 32$ c. $-9.4°F$

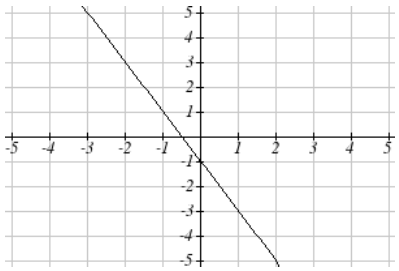
## Section 2.2

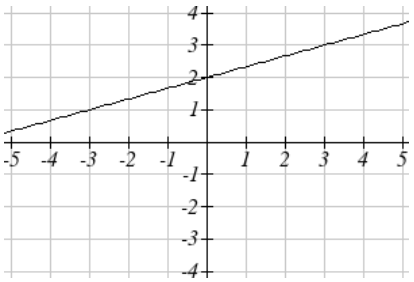
1. E 3. D 5. B

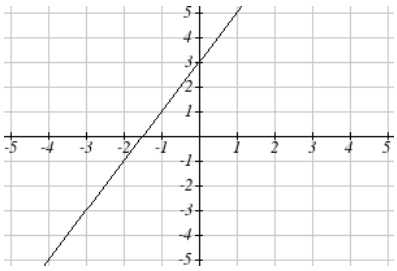
7. 

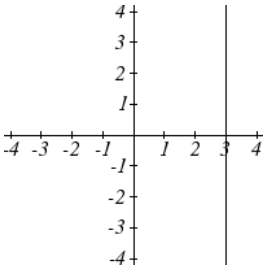
9. 

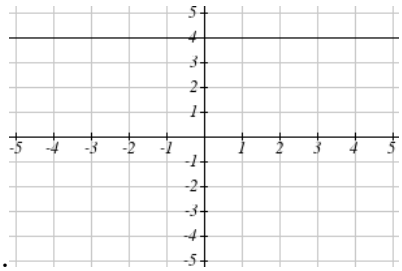
11. 

13. 

15. 

17. 

19. 

21. 

23. a. $g(x)=\frac{3}{4}(x+2)-4$ b. ¾ c. -5/2

25. $y=3$

27. $x=-3$

| | Vertical Intercept | Horizontal Intercept |
|---|---|---|
| 29. | (0,2) | (2,0) |
| 31. | (0,-5) | (5/3, 0) |
| 33. | (0,4) | (-10,0) |

35. Line 1: $m=-10$ Line 2: $m=-10$ Parallel

37. Line 1: $m=-2$ Line 2: $m=1$ Neither

39. Line 1: $m=-\frac{2}{3}$ Line 2: $m=\frac{3}{2}$ Perpendicular

41. $y=-5x-2$ 43. $y=\frac{1}{2}t+1$ 45. (-1,1)

47. (1.2, 10) 49. Plan B saves money if the miles are $>111\frac{1}{9}$

51. $f(x)=\begin{cases}2x+3 & \text{if } -3\le x<-1\\ x-1 & \text{if } -1\le x\le 2\\ -2 & \text{if } 2<x\le 5\end{cases}$

## Section 2.3

1a. 696 people  b. 4 years  c. 174 people per year
d. 305 people  e. $P(t)=305+174t$  f. 2219 people.

3a. $C(x)=0.15x+10$

b. The flat monthly fee is \$10 and there is an additional \$0.15 fee for each additional minute used

c. \$113.05

5a. $P(t)=190t+4170$  b. 6640 moose

7a. $R(t)=16-2.1t$  b. 5.5 billion cubic feet  c. During the year 2017

9. More than 133 minutes  11. More than $\$42,857.14$ worth of jewelry

13. 20.012 square units  15. 6 square units

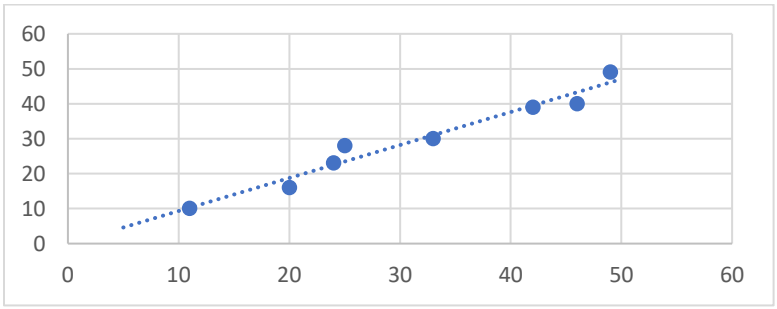
17. $A=-\dfrac{b^2}{2m}$

19a. Hawaii  b. \$80,640  c. During the year 1933

21. 26.225 miles

## Section 2.4

1.




3. $y=1.971x-3.519,\ r=0.967$  5. $y=-0.901x+26.04,\ r=-0.968$

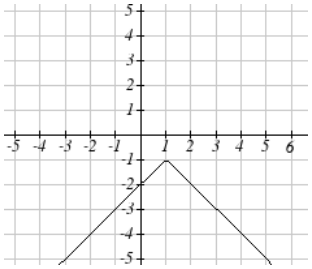
7. $17.483\approx 17$ *situps*  9. D  11. A

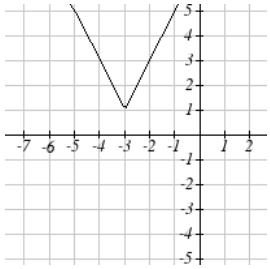
13. Yes, trend appears linear because $r$ =0.994 and will exceed 35% near the end of the year 2019.

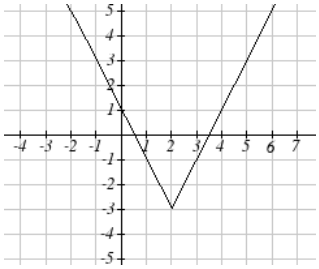
## Section 2.5

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

3. $y = -3|x-3|+3$

5. 

7. 

9. 

11. $x = -\frac{9}{5}$ *or* $x = \frac{13}{5}$

13. $x = \frac{1}{2}$ *or* $x = \frac{15}{2}$

15. $x = -\frac{5}{3}$ *or* $x = -\frac{1}{3}$

| | Horizontal Intercepts | Vertical Intercept |
|---|---|---|
| 17. | (-6, 0 ) and (4, 0) | (0, -8) |
| 19. | none | (0, -7) |

21. $-11 < x < 1$ or $(-11,1)$

23. $x \geq 5$ , $x \leq -1$ or $(-\infty,-1] \cup [5,\infty)$

25. $-\frac{13}{3} < x < -\frac{5}{3}$ or $(-\frac{13}{3},-\frac{5}{3})$

# *Chapter 3*

## Section 3.1

1. As $x \to \infty,\ f(x) \to \infty$ As $x \to -\infty,\ f(x) \to \infty$
3. As $x \to \infty,\ f(x) \to \infty$ As $x \to -\infty,\ f(x) \to -\infty$
5. As $x \to \infty,\ f(x) \to -\infty$ As $x \to -\infty,\ f(x) \to -\infty$
7. As $x \to \infty,\ f(x) \to -\infty$ As $x \to -\infty,\ f(x) \to \infty$
9. 7th Degree, Leading coefficient 4
11. 2nd Degree, Leading coefficient -1
13. 4th Degree, Leading coefficient -2
15. 3rd Degree, Leading coefficient 6
17. As $x \to \infty,\ f(x) \to -\infty$ As $x \to -\infty,\ f(x) \to -\infty$
19. As $x \to \infty,\ f(x) \to \infty$ As $x \to -\infty,\ f(x) \to \infty$
21. intercepts: 5, turning points: 4 23. 3
25. 5 27. 3 29. 5
31. Horizontal Intercepts (1,0), (-2, 0), (3, 0) Vertical Intercept (0, 12)
33. Horizontal Intercepts (1/3, 0) (-1/2, 0) Vertical Intercept (0, 2)

## Section 3.2

1. $f(x)=(x-2)^2-3$ 3. $f(x)=-2(x-2)^2+7$ 5. $f(x)=\frac{1}{2}(x-3)^2-1$

| | Vertex | Vertical Intercept | Horizontal Intercepts |
|---|---|---|---|
| 7. | $(-2.5,-0.5)$ | (0,12) | (-2, 0) (-3, 0) |
| 9. | $(2.5,-8.5)$ | (0,4) | (0.438, 0) (4.562,0) |
| 11. | $(0.75,1.25)$ | (0,-1) | (0.191, 0) (1.309, 0) |

13. $f(x)=(x-6)^2-4$ 15. $f(x)=2(x+2)^2-18$ 17. $b$ = 32 and $c$ = -39

19. $f(x)=-\frac{2}{3}(x+3)(x-1)$ 21. $f(x)=\frac{3}{5}(x-2)(x-5)$

23. $f(x)=-\frac{1}{4}(x-4)^2$ 25. $f(x)=-\frac{1}{9}(x+3)^2+2$

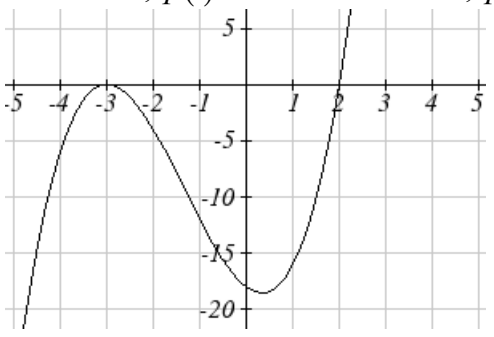
27a. 234m b. 2909.561 ft c. 47.735 seconds
29a. 3 ft b. 111 ft c. 72.497 ft
31. 24.91 in by 24.91 in
33. $125\,ft$ by $83\frac{1}{3}\,ft$
35. 24.6344 cm
37. $10.70

## Section 3.3

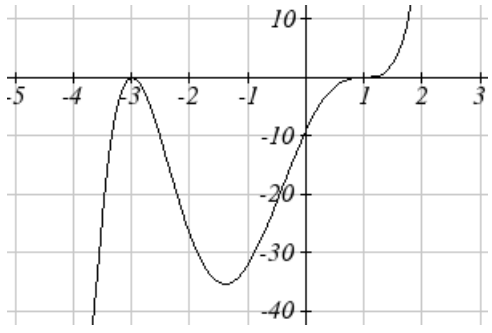
| *C(t)* | *C*, intercepts | *t*, intercepts |
|---|---|---|
| 1. | (0,48) | (4,0), (-1,0), (6,0) |
| 3. | (0,0) | (0,0), (2,0), (-1,0) |
| 5. | (0,0) | (0,0), (1,0), (3,0) |

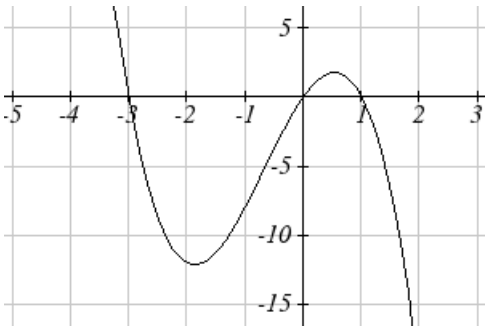
7. (-1.646, 0) (3.646, 0) (5,0)
9. As $t\to\infty$, $h(t)\to\infty$ $t\to-\infty$, $h(t)\to-\infty$
11. As $t\to\infty$, $p(t)\to-\infty$ $t\to-\infty$, $p(t)\to-\infty$

13.




15.



17. 


19. $(3,\infty)$

21. $(-\infty,-2)\cup(1,3)$

23. $[3.5,6]$

25. $(-\infty,1]\cup[4,\infty)$

27. $[-2,-2]\cup[3,\infty)$

29. $(-\infty,-4)\cup(-4,2)\cup(2,\infty)$

31. $y=-\frac{2}{3}(x+2)(x-1)(x-3)$

33. $y=\frac{1}{3}(x-1)^2(x-3)^2(x+3)$

35. $y=-15(x-1)^2(x-3)^3$

37. $y=\frac{1}{2}(x+2)(x-1)(x-3)$

39. $y=-(x+1)^2(x-2)$

41. $y=-\frac{1}{24}(x+3)(x+2)(x-2)(x-4)$

43. $y=\frac{1}{24}(x+4)(x+2)(x-3)^2$

45. $y=\frac{1}{12}(x+2)^2(x-3)^2$

47. $y=\frac{1}{6}(x+3)(x+2)(x-1)^3$

49. $y=-\frac{1}{16}(x+3)(x+1)(x-2)^2(x-4)$

51. Base 2.58, Height 3.336

## Section 3.4

1. $4x^2+3x-1=(x-3)(4x+15)+44$

3. $5x^4-3x^3+2x^2-1=(x^2+4)(5x^2-3x-18)+(12x+71)$

5. $9x^3+5=(2x-3)\left(\frac{9}{2}x^2+\frac{27}{4}x+\frac{81}{8}\right)+\frac{283}{8}$

7. $(3x^2-2x+1)=(x-1)(3x+1)+2$

9. $(3-4x-2x^2)=(x+1)(-2x-2)+5$

11. $(x^3+8)=(x+2)(x^2-2x+4)+0$

13. $(18x^2-15x-25)=\left(x-\frac{5}{3}\right)(18x+15)+0$

15. $(2x^3+x^2+2x+1)=\left(x+\frac{1}{2}\right)(2x^2+2)+0$

17. $(2x^3-3x+1)=\left(x-\frac{1}{2}\right)\left(2x^2+x-\frac{5}{2}\right)-\frac{1}{4}$

19. $(x^4-6x^2+9)=(x-\sqrt{3})(x^3+\sqrt{3}x^2-3x-3\sqrt{3})+0$

21. $x^3 - 6x^2 + 11x - 6 = (x-1)(x-2)(x-3)$

23. $3x^3 + 4x^2 - x - 2 = 3\left(x - \frac{2}{3}\right)(x+1)^2$

25. $x^3 + 2x^2 - 3x - 6 = (x+2)(x+\sqrt{3})(x-\sqrt{3})$

27. $4x^4 - 28x^3 + 61x^2 - 42x + 9 = 4\left(x - \frac{1}{2}\right)^2 (x-3)^2$

## Section 3.5

1. All of the real zeros lie in the interval $[-7,7]$

- Possible rational zeros are $\pm 1,\ \pm 2,\ \pm 3$

3. All of the real zeros lie in the interval $[-13,13]$

- Possible rational zeros are $\pm 1,\ \pm 2,\ \pm 3,\ \pm 4,\ \pm 6,\ \pm 12$

5. All of the real zeros lie in the interval $[-8,8]$

- Possible rational zeros are $\pm 1,\ \pm 7$

7. All of the real zeros lie in the interval $[-3,3]$

- Possible rational zeros are $\pm\frac{1}{17},\ \pm\frac{2}{17},\ \pm\frac{5}{17},\ \pm\frac{10}{17},\ \pm 1,\ \pm 2,\ \pm 5,\ \pm 10$

9. All of the real zeros lie in the interval $\left[-\frac{14}{3}, \frac{14}{3}\right]$

- Possible rational zeros are $\pm\frac{1}{3},\ \pm\frac{2}{3},\ \pm\frac{5}{3},\ \pm\frac{10}{3},\ \pm 1,\ \pm 2,\ \pm 5,\ \pm 10$

11. $x = -2,\ x = 1,\ x = 3$ (each has mult. 1)

13. $x = -2$ (mult. 2), $x = 1$ (mult. 1), $x = 3$ (mult. 1)

15. $x = 7$ (mult. 1)

17. $x = \frac{5}{17},\ x = \pm\sqrt{2}$ (each has mult. 1)

19. $x = -2,\ x = \frac{3 \pm \sqrt{69}}{6}$ (each has mult. 1)

21. $x = 0,\ x = \frac{5 \pm \sqrt{61}}{18}$ (each has mult. 1)

23. $x = \pm\sqrt{3}$ (each has mult. 1)

25. $x = \pm\sqrt{5}$ (each has mult. 1)

27. $x = \sqrt[3]{-2} = -\sqrt[3]{2},\ x = \sqrt[3]{5}$ (each has mult. 1)

29. $x = 2,\ x = \pm\sqrt{2}$ (each has mult. 1)

31. $x = -4$ (mult. 3), $x = 6$ (mult. 2)

## Section 3.6

1. $3i$
3. $-12$
5. $1+\sqrt{3}i$
7. $8-i$
9. $-11+4i$
11. $-12+8i$
13. $30-10i$
15. $11+10i$
17. $20$
19. $\frac{3}{2}+2i$
21. $\frac{3}{2}+\frac{5}{2}i$
23. $-\frac{1}{25}-\frac{18}{25}i$
25. $f(x)=x^2-4x+13=(x-(2+3i))(x-(2-3i))$. Zeros: $x=2\pm 3i$
27. $f(x)=3x^2+2x+10=3\left(x-\left(-\frac{1}{3}+\frac{\sqrt{29}}{3}i\right)\right)\left(x-\left(-\frac{1}{3}-\frac{\sqrt{29}}{3}i\right)\right)$. Zeros: $x=-\frac{1}{3}\pm\frac{\sqrt{29}}{3}i$
29. $f(x)=x^3+6x^2+6x+5=(x+5)(x^2+x+1)=(x+5)\left(x-\left(-\frac{1}{2}+\frac{\sqrt{3}}{2}i\right)\right)\left(x-\left(-\frac{1}{2}-\frac{\sqrt{3}}{2}i\right)\right)$

    Zeros: $x=-5, x=-\frac{1}{2}\pm\frac{\sqrt{3}}{2}i$
31. $f(x)=x^3+3x^2+4x+12=(x+3)\left(x^2+4\right)=(x+3)(x+2i)(x-2i)$. Zeros: $x=-3,\pm 2i$
33. $f(x)=x^3+7x^2+9x-2=(x+2)\left(x-\left(-\frac{5}{2}+\frac{\sqrt{29}}{2}\right)\right)\left(x-\left(-\frac{5}{2}-\frac{\sqrt{29}}{2}\right)\right)$

    Zeros: $x=-2, x=-\frac{5}{2}\pm\frac{\sqrt{29}}{2}$
35. $f(x)=4x^4-4x^3+13x^2-12x+3=\left(x-\frac{1}{2}\right)^2\left(4x^2+12\right)=4\left(x-\frac{1}{2}\right)^2(x+i\sqrt{3})(x-i\sqrt{3})$

    Zeros: $x=\frac{1}{2}, x=\pm\sqrt{3}i$
37. $f(x)=x^4+x^3+7x^2+9x-18=(x+2)(x-1)\left(x^2+9\right)=(x+2)(x-1)(x+3i)(x-3i)$

    Zeros: $x=-2,1,\pm 3i$
39. $f(x)=-3x^4-8x^3-12x^2-12x-5=(x+1)^2\left(-3x^2-2x-5\right)=-3(x+1)^2\left(x-\left(-\frac{1}{3}+\frac{\sqrt{14}}{3}i\right)\right)\left(x-\left(-\frac{1}{3}-\frac{\sqrt{14}}{3}i\right)\right)$

    Zeros: $x=-1, x=-\frac{1}{3}\pm\frac{\sqrt{14}}{3}i$
41. $f(x)=x^4+9x^2+20=\left(x^2+4\right)\left(x^2+5\right)=(x-2i)(x+2i)\left(x-i\sqrt{5}\right)\left(x+i\sqrt{5}\right)$

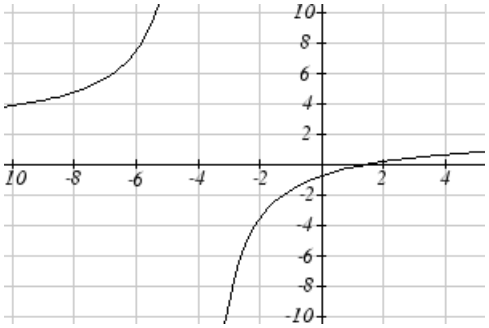
    Zeros: $x=\pm 2i,\pm i\sqrt{5}$

## Section 3.7

1. D 3. A

| | Vertical Asymptotes | Horizontal Asymptote | Vertical $y$-Intercept | Horizontal $x$-intercept |
|---|---|---|---|---|
| 5. | $x=-4$ | $y=2$ | (0,-3/4) | (3/2, 0) |
| 7. | $x=2$ | $y=0$ | (0,1) | DNE |
| 9. | $x=-4, 1\frac{1}{3}$ | $y=1$ | (0, 5/16) | (-1/3, 0), (5,0) |
| 11. | $x=-1$, hole at $x=1$ | $y=1$ | (0,3) | (-3, 0) |
| 13. | $x=4$ | none<br>y=2x (oblique) | (0, ¼) | (-1, 0), (1/2, 0) |
| 15. | $x=0,\ 4$ | $y=0$ | DNE | (-2, 0), (2/3, 0) |
| 17. | $x=-2,\ 4$ | $y=1$ | (0, -15/16) | (1, 0), (-3, 0), (5, 0) |

5.



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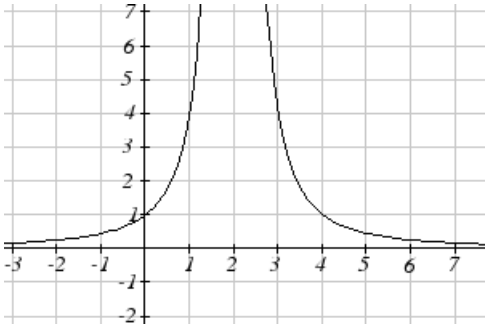

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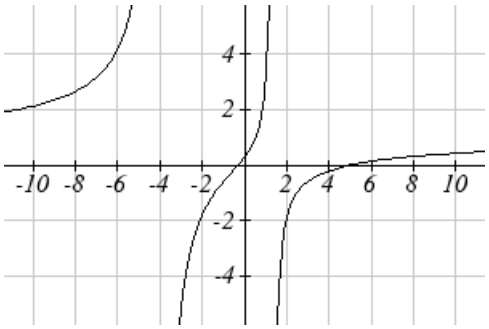

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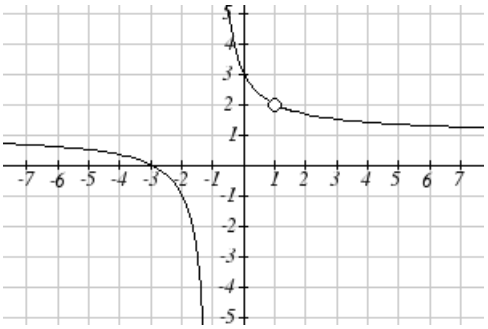

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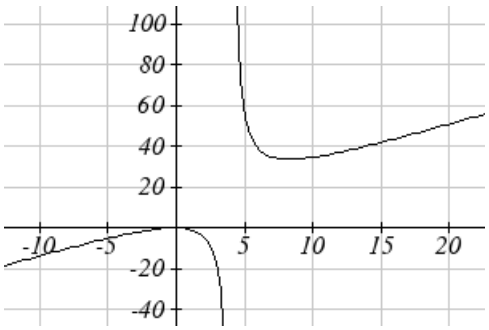

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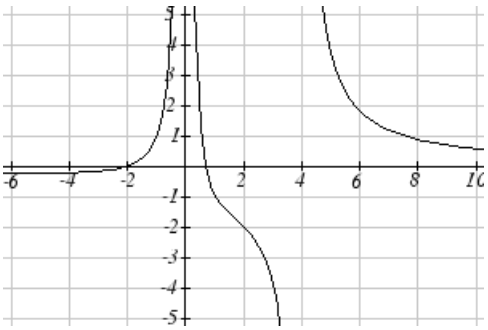
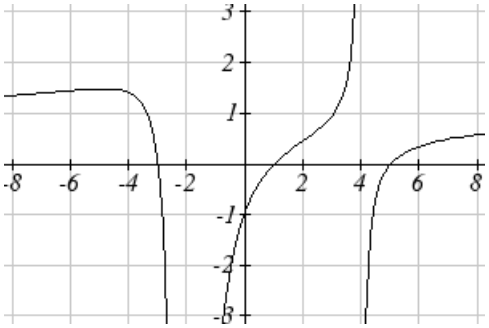


17. 

19. $y=\dfrac{50(x-2)(x+1)}{(x+5)(x-5)}$

21. $y=\dfrac{7(x-4)(x+6)}{(x+4)(x+5)}$

23. $y=\dfrac{1(x-2)^2}{2(x+1)}$

25. $y=\dfrac{4(x-3)}{(x+3)(x-4)}$

27. $y=\dfrac{27(x-2)}{(x+3)(x-3)^2}$

29. $y=\dfrac{1(x+3)(x-2)}{3(x-1)}$

31. $y=\dfrac{-6(x-1)^2}{(x+3)(x-2)^2}$

33. $y=-\dfrac{2(x)(x-3)}{(x+3)(x-4)}$

35. $y=\dfrac{2(x-1)^3}{(x+1)(x-2)^2}$

37. $y=\dfrac{(x-4)(x-2)}{(x-4)(x+1)}$

39. $y=3x-2$

41. $y=\dfrac{1}{2}x+1$

43. $y=-2x+1$

45. a. $C(n)=\dfrac{4}{20+n}$ b. $C(10)\approx 13.33\%$ c. 80 mL d. as $n\to\infty, C\to 0$

## Section 3.8

1. Domain $(4,\infty)$ Inverse $f^{-1}(x)=\sqrt{x}+4$

3. Domain $(-\infty,0)$ Inverse $f^{-1}(x)=-\sqrt{12-x}$

5. Domain $(-\infty,\infty)$ Inverse $f^{-1}(x)=\sqrt[3]{\dfrac{x-1}{3}}$

7. $f^{-1}(x)=\dfrac{(x-9)^2}{4}+1$

9. $f^{-1}(x)=\left(\dfrac{x-9}{2}\right)^3$

11. $f^{-1}(x)=\dfrac{2-8x}{x}$

13. $f^{-1}(x)=\dfrac{3-7x}{x-1}$

15. $f^{-1}(x)=\dfrac{5x-4}{3+4x}$

17. 65.574 mph

19. 34.073 mph

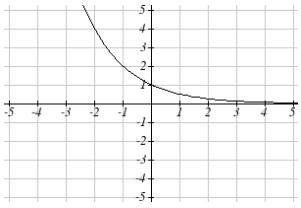
21. 14.142 feet

# *Chapter 4*

## Section 4.1

1. Linear
3. Exponential
5. Neither
7. $P(t)=11{,}000(1.085)^t$
9. 47622 Fox
11. \$17561.70
13. $y=6(5)^x$
15. $y=2000(0.1)^x$
17. $y=3(2)^x$
19. $y=\left(\frac{1}{6}\right)^{-\frac{3}{5}}\left(\frac{1}{6}\right)^{\frac{x}{5}}=2.93(0.699)^x$
21. $y=\frac{1}{8}(2)^x$
23. $34.32\,mg$
25. 1.39%; \$155,368.09
27. \$4,813.55
29. Annual $\approx$ \$7353.84
Quarterly $\approx$ \$7,469.63
Monthly $\approx$ \$7,496.71
Continuously $\approx$ \$7,510.44
31. 3.03%
33. 7.4 years
35a. $w(t)=(1.113)(1.046)^t$
b. \$1.11
c. Below what the model predicts $\approx$ \$5.70

## Section 4.2

1. B
3. A
5. E
7. D
9. C
11.

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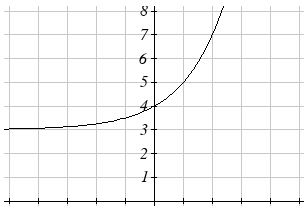
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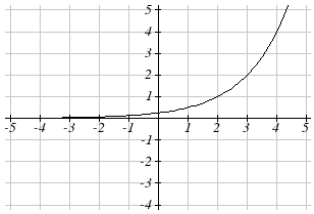

17. $y=4^x+4$
19. $y=4^{x+2}$
21. $y=-4^x$
23. As $x\to\infty$ $f(x)\to-\infty$. As $x\to-\infty$ $f(x)\to-1$
25. As $x\to\infty$ $f(x)\to-2$ As $x\to-\infty$ $f(x)\to\infty$
27. As $x\to\infty$ $f(x)\to 2$ As $x\to-\infty$ $f(x)\to\infty$
29. $y=-2^{x+2}+1=-4(2)^x+1$
31. $y=-2(2)^{-x}+3$
33. $y=-2(3)^x+7$
35. $y=2\left(\frac{1}{2}\right)^x-4$

## Section 4.3

1. $4^m=q$
3. $a^c=b$
5. $10^t=v$
7. $e^n=w$
9. $\log_4(y)=x$
11. $\log_c(k)=d$
13. $\log(b)=a$
15. $\ln(h)=k$
17. 9
19. 1/8
21. 1000
23. $e^2$
25. 2
27. -3
29. ½

31. 4
33. -3
35. -2
37. -1.398
39. 2.708
41. $\frac{\log(14)}{\log(5)} \approx 1.6397$
43. $\frac{\log\left(\frac{1}{15}\right)}{\log(7)} \approx -1.392$
45. $\frac{\ln(17)}{5} \approx 0.567$
47. $\frac{\frac{\log(38)}{\log(3)}+5}{4} \approx 2.078$
49. $\frac{\log(5)}{\log(1.03)} \approx 54.449$
51. $\frac{\log\left(\frac{8}{3}\right)}{3\log(1.04)} \approx 8.335$
53. $\frac{\ln\left(\frac{1}{5}\right)}{-0.12} \approx 13.412$
55. $\frac{\log\left(\frac{5}{8}\right)}{\log\left(\frac{1}{2}\right)} \approx 0.678$
57. $f(t) = 300e^{-0.0943t}$
59. $f(t) = 10e^{0.03922t}$
61. $f(t) = 150(1.0618)^t$
63. $f(t) = 50(0.98807)^t$
65. During the year 2013
67. During the year 2074
69. $\approx 34$ *hours*
71. 13.532 years

## Section 4.4

1. $\log_3(4)$
3. $\log_3(7)$
5. $\log_3(5)$
7. $\log_7(2)$
9. $\log\left(6x^9\right)$
11. $\ln\left(2x^7\right)$
13. $\log\left(x^2(x+1)^3\right)$
15. $\log\left(\frac{xz^3}{\sqrt{y}}\right)$
17. $15\log(x)+13\log(y)-19\log(z)$
19. $-2\ln(a)+4\ln(b)-5\ln(c)$
21. $\frac{3}{2}\log(x)-2\log(y)$
23. $\ln(y)+\frac{1}{2}(\ln(y)-\ln(1-y))$
25. $\frac{8}{3}\log(x)+\frac{14}{3}\log(y)$
27. $x \approx -0.717$
29. $x \approx -6.395$
31. $t \approx 17.329$
33. $x = \frac{2}{7}$
35. $x \approx 0.123$
37. $x \approx 4.642$
39. $x \approx 30.158$
41. $x \approx -2.889$.
43. $x \approx 6.873$ or $x \approx -0.873$
45. $x = \frac{12}{11} \approx 1.091$
47. $x = 10$

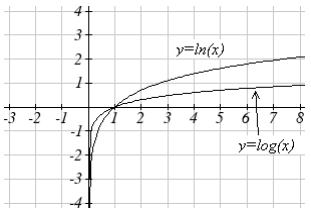
## Section 4.5

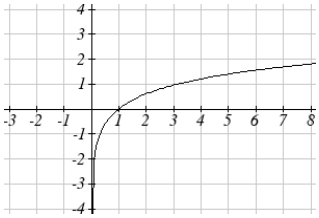
1. Domain: $: x > 5$ V. A. @ $x = 5$

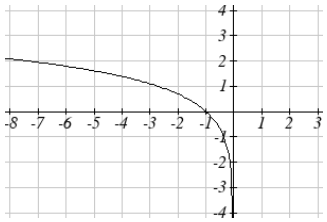
3. Domain: $x < 3$ V.A. @ $x = 3$

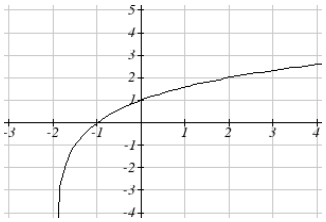
5. Domain: $x > -\frac{1}{3}$ V.A. @ $x = -\frac{1}{3}$

7. Domain: $x < 0$ V.A. @ $x = 0$

9. 


11. 

13. 

15. 

17. $y = \frac{1}{\log(2)} \log(-(x-1))$

19. $y = -\frac{3}{\log(3)} \log(x+4)$

21. $y = \frac{3}{\log(4)} \log(x+2)$

23. $y = -\frac{2}{\log(5)} \log(-(x-5))$

## Section 4.6

1. $f(t) = 13(0.9195)^t$. 2 mg will remain after 22.3098 minutes

3. $f(t) = 200(0.999564)^t$. $f(1000) = 129.3311$ mg

5. $r$ = -0.06448. Initial mass: 9.9018 mg. After 3 days: 0.01648 mg

7. $f(t) = 250(0.9909)^t$. Half-life = 75.8653 minutes

9. $f(t) = a(0.999879)^t$. 60% (0.60$a$) would remain after 4222.813 years

11. $P(t) = 1500(1.02337)^t$ ($t$ in minutes). After 2 hours = 24000.

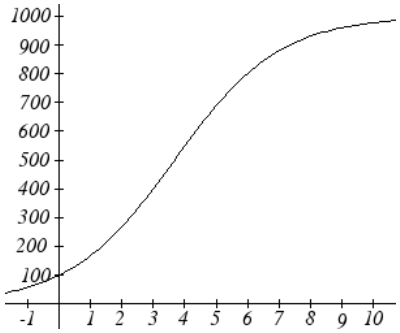
After 100 minutes = 15119

13. a) 610.5143 (about 611) b) 25.6427 minutes c) 10431.21 d) 106.9642 minutes

15. 23.1914 years

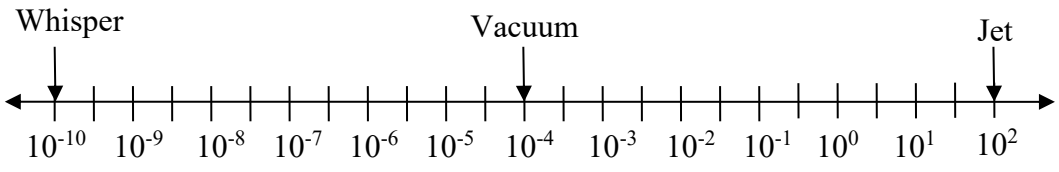
17. 53.319 hours

19. $T(t) = 90(0.99166)^t + 75$. a) 134.212 deg b) 112.743 minutes

21. a) 

b) 100 c) 269.487 d) 7.324 years

23. $\log(x) = -0.5$. $x = 0.3162$ 25. $\log(x) = 1.5$. $x = 31.623$

27. 


29. 63095.7 times more intense 31. MMS magnitude 5.817

33. a) about 1640671 b) 1.4 hours c) No, because $(2.042727)^{0.693147} \approx e^{0.495105}$

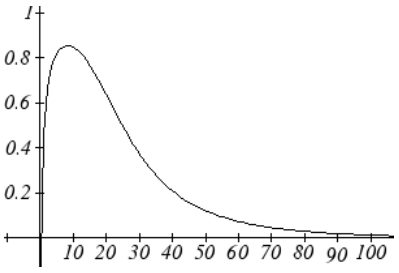
d) Anja's data predicts a continuous growth rate of 0.4116, which is much smaller than the rate 0.495105 you calculated. Our model would overestimate the number of cells.

35. a) The curve that increases rapidly at first is *M(p)*

b) $H(100) = 0.9775$

c) Myoglobin: $M(20) = 0.9524$. Hemoglobin: $H(20) = 0.3242$

d) At 20 torrs: 0.6282. At 40 torrs: 0.2060. At 60 torrs: 0.0714



Efficiency seems to be maximized at about 8 torr

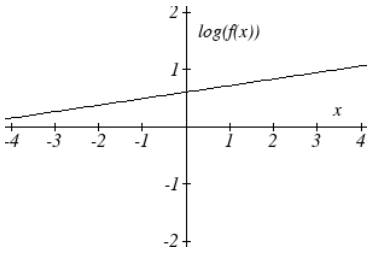
37. a) $C(t) = 1.03526^t$, or $C(t) = e^{0.03466t}$

b) Volume of one cell: $\frac{4}{3}\pi\left(50\times10^{-4}\right)^3 \approx 5.236\times10^{-7}$ cm$^3$, so will need about $1.9099\times10^6$ cells for a volume of 1cm$^3$. $C(t) = 1.9099\times10^6$ after 417.3 hours

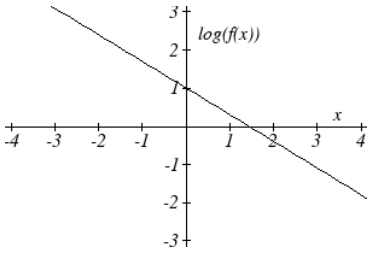
39. 31.699 days

## Section 4.7

1. $\log(f(x)) = \log(1.3)x + \log(4)$




3. $\log(f(x)) = \log(0.2)x + 1$

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5. $y = e^{\frac{1}{2}x-1} = e^{-1}e^{\frac{1}{2}x} \approx 0.368(1.6487)^x$

7. $y = 10^{-x-2} = 10^{-2}10^{-1x} = 0.01(0.1)^x$

9. $y = 776.682(1.426)^x$

11. $y = 731.92(0.738)^x$

13. Expenditures are approximately $205

15. $y = 7.599(1.016)^x$ $r = 0.83064$, $y = 0.1493x + 7.4893$, $r = 0.81713$. Using the better function, we predict electricity will be 11.157 cents per kwh