Jeanne Marie Draper

Student Solutions Manual

Finite Mathematics

Berresford/Rockett

STUDENT SOLUTIONS MANUAL

TO ACCOMPANY
FINITE MATHEMATICS

Berresford/Rockett

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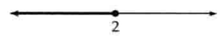
Contents

EXERCISES 1.1

1. $\{x | 0 \le x < 6\}$

3. $\{x | x \le 2\}$



5. **a.** Since $\Delta x = 3$ and $m = 5$, then Δy, the change in y, is

$$\Delta y = 3 \bullet m = 3 \bullet 5 = 15$$

b. Since $\Delta x = -2$ and $m = 5$, then Δy, the change in y, is

$$\Delta y = -2 \bullet m = -2 \bullet 5 = -10$$

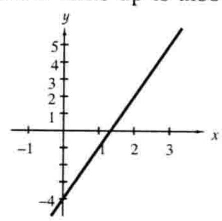
7. For (2, 3) and (4, −1), the slope is $\frac{-1-3}{4-2} = \frac{-4}{2} = -2$

9. For (−4, 0) and (2, 2), the slope is $\frac{2-0}{2-(-4)} = \frac{2}{2+4} = \frac{2}{6} = \frac{1}{3}$

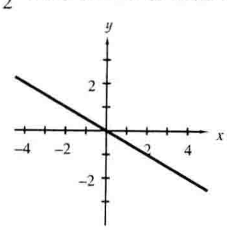
11. For (0, −1) and (4, −1), the slope is $\frac{-1-(-1)}{4-0} = \frac{-1+1}{4} = \frac{0}{4} = 0$

13. For (2, −1) and (2, 5), the slope is $\frac{5-(-1)}{2-2} = \frac{5+1}{0}$ undefined

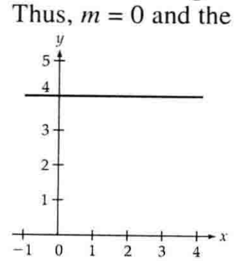
15. Since $y = 3x - 4$ is in slope-intercept form, $m = 3$ and the y-intercept is (0, −4). Using the slope $m = 3$, we see that the point 1 unit over and 3 units up is also on the line



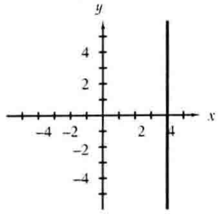
17. Since $y = -\frac{1}{2}x$ is in slope-intercept form, $m = -\frac{1}{2}$ and the y-intercept is (0, 0). Using $m = -\frac{1}{2}$, we see that the point 1 unit over and $\frac{1}{2}$ unit down is also on the line.



19. The equation $y = 4$ is the equation of the horizontal line through the points with y-coordinate 4. Thus, $m = 0$ and the y-intercept is (0, 4).



21. The equation $x = 4$ is the equation of the vertical line through the points with x-coordinate 4. Thus, m is not defined and there is no y-intercept.



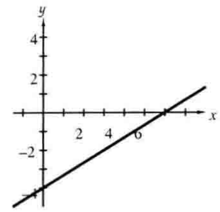
23. First, solve for y:

$$2x - 3y = 12$$

$$-3y = -2x + 12$$

$$y = \frac{2}{3}x - 4$$

Therefore, $m = \frac{2}{3}$ and the y-intercept is (0, –4).

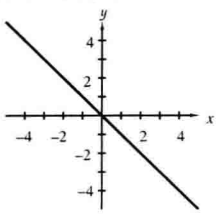


25. First, solve for y:

$$x + y = 0$$

$$y = -x$$

Therefore, $m = -1$ and the y-intercept is (0, 0).



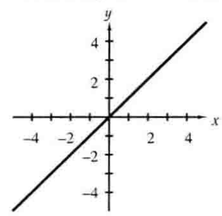
27. First, solve for y:

$$x - y = 0$$

$$-y = -x$$

$$y = x$$

Therefore, $m = 1$ and the y-intercept is (0, 0).

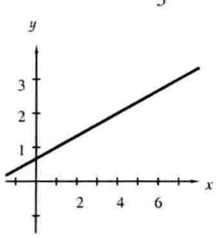


29. First, put the equation in slope-intercept form:

$$y = \frac{x+2}{3}$$

$$y = \frac{1}{3}x + \frac{2}{3}$$

Therefore, $m = \frac{1}{3}$ and the y-intercept is $\left(0, \frac{2}{3}\right)$.



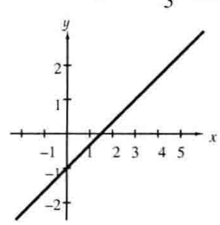
31. First, solve for y:

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

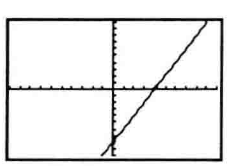
$$-y = -\frac{2}{3}x + 1$$

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

Therefore, $m = \frac{2}{3}$ and the y-intercept is (0, –1).

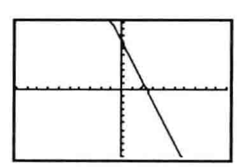


33.



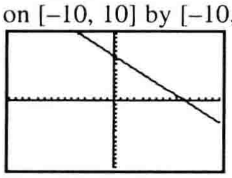
on [–10, 10] by [–10, 10]

35.



on [–10, 10] by [–10, 10]

37.



on [–75, 75] by [–75, 75]

39. $y = -2.25x + 3$

41. $y-(-2)=5[x-(-1)]$
$y+2=5x+5$
$y=5x+3$

43. $y=-4$

45. $x=1.5$

47. First, find the slope.
$m=\frac{-1-3}{7-5}=\frac{-4}{2}=-2$
Then use the point-slope formula with this slope and the point (5, 3).
$y-3=-2(x-5)$
$y-3=-2x+10$
$y=-2x+13$

49. First, find the slope.
$m=\frac{-1-(-1)}{5-1}=\frac{-1+1}{4}=0$
Then use the point-slope formula with this slope and the point (1,–1).
$y-(-1)=0(x-1)$
$y+1=0$
$y=-1$

51. The y-intercept of the line is (0, 1), and $\Delta y=-2$ for $\Delta x=1$. Thus, $m=\frac{\Delta y}{\Delta x}=\frac{-2}{1}=-2$. Now, use the slope-intercept form of the line:
$y=-2x+1$.

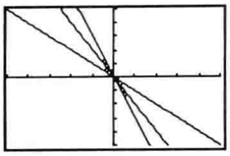
53. The y-intercept is (0, –2), and $\Delta y=3$ for $\Delta x=2$. Thus, $m=\frac{\Delta y}{\Delta x}=\frac{3}{2}$. Now, use the slope-intercept form of the line: $y=\frac{3}{2}x-2$

55. First, consider the line through the points (0, 5) and (5, 0). The slope of this line is $m=\frac{0-5}{5-0}=\frac{-5}{5}=-1$. Since (0, 5) is the y-intercept of this line, use the slope-intercept form of the line: $y=-1\bullet x+5$ or $y=-x+5$.
Now consider the line through the points (5, 0) and (0, –5). The slope of this line is $m=\frac{-5-0}{0-5}=\frac{-5}{-5}=1$. Since (0,–5) is the y-intercept of the line, use the slope-intercept form of the line: $y=1\bullet x-5$ or $y=x-5$
Next, consider the line through the points (0, –5) and (–5, 0). The slope of this line is $m=\frac{0-(-5)}{-5-0}=\frac{5}{-5}=-1$.
Since (0, –5) is the y-intercept, use the slope-intercept form of the line: $y=-1\bullet x-5$ or $y=-x-5$
Finally, consider the line through the points (–5, 0) and (0, 5). The slope of this line is $m=\frac{5-0}{0-(-5)}=\frac{5}{5}=1$.
Since (0, 5) is the y-intercept, use the slope-intercept form of the line: $y=1\bullet x+5$ or $y=x+5$

57. If the point (x_1,y_1) is the y-intercept (0, b), then substituting into the point-slope form of the line gives
$(y-y_1)=m(x-x_1)$
$(y-b)=m(x-0)$
$y-b=mx$
$y=mx+b$

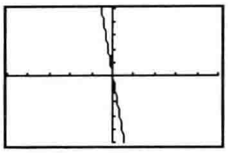
59. To find the x-intercept, substitute $y=0$ into the equation and solve for x:
$y=mx+b$
$0=mx+b$
$-mx=b$
$x=\frac{b}{-m}$
If $m\neq 0$, then a single x-intercept exists. So $a=\frac{b}{-m}$. Thus, the x-intercept is $\left(\frac{b}{-m},0\right)$.

61. **a.**



on [–5, 5] by [–5, 5]

b.



on [–5, 5] by [–5, 5]

63. Low demand: [0, 8); average demand: [8, 20); high demand: [20, 40); critical demand: [40, ∞)

65. **a.** The value of x corresponding to the year 2010 is $x = 2010 - 1900 = 110$. Substituting $x = 110$ into the equation for the regression line gives

$$y = -0.356x + 257.44$$

$$y = -0.356(110) + 257.44 = 218.28 \text{ seconds}$$

Since 3 minutes = 180 seconds, 218.24 = 3 minutes 38.28 seconds. Thus, the world record in the year 2010 will be 3 minutes 38.28 seconds.

b. To find the year when the record will be 3 minutes 30 seconds, first convert 3 minutes 30 seconds to seconds: 3 minutes 30 seconds = 3 minutes • 60 $\frac{\text{sec}}{\text{min}}$ + 30 seconds = 210 seconds.

Now substitute 210 seconds into the equation for the regression line and solve for x.

$$y = -0.356x + 257.44$$

$$210 = -0.356x + 257.44$$

$$0.356x = 257.44 - 210$$

$$x = \frac{47.44}{0.356} \approx 133.26$$

Since x represents the number of years after 1900, the year corresponding to this value of x is 1900 + 133.26 = 2033.26 ≈2033. The world record will be 3 minutes 30 seconds in 2033.

67. **a.** To find the linear equation, first find the slope of the line containing these points.

$$m = \frac{14-6}{3-1} = \frac{8}{2} = 4$$

Next, use the point-slope form with the point (1, 6):

$$y - y_1 = m(x - x_1)$$

$$y - 6 = 4(x - 1)$$

$$y - 6 = 4x - 4$$

$$y = 4x + 2$$

b. To find the profit at the end of 2 years, substitute 2 into the equation $y = 4x + 2$.

$y = 4(2) + 2 = \$10$ million

c. The profit at the end of 5 years is $y = 4(5) + 2 = \$22$ million.

69. **a.** First, find the slope of the line containing the points.

$$m = \frac{212-32}{100-0} = \frac{180}{100} = \frac{9}{5}$$

Next, use the point-slope form with the point (0, 32):

$$y - y_1 = m(x - x_1)$$

$$y - 32 = \frac{9}{5}(x - 0)$$

$$y = \frac{9}{5}x + 32$$

b. Substitute 20 into the equation.

$$y = \frac{9}{5}x + 32$$

$$y = \frac{9}{5}(20) + 32 = 36 + 32 = 68°\text{F}$$

71. **a.** Price = \$50,000; useful lifetime = 20 years; scrap value = \$6000

$$V = 50{,}000 - \left(\frac{50{,}000-6000}{20}\right)t \quad 0 \le t \le 2$$

$$= 50{,}000 - 2200t \quad 0 \le t \le 20$$

b.

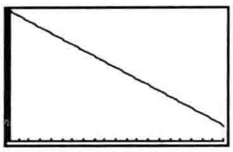
Substitute $t = 5$ into the equation.

$$V = 50{,}000 - 2200t$$

$$= 50{,}000 - 2200(5)$$

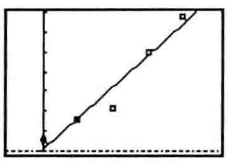
$$= 50{,}000 - 11{,}000 = \$39{,}000$$

c.



on [0, 20] by [0, 50,000]

75. **a-b.**



on [−10, 50] by [65, 72]

$y_1 = 0.158x + 65.06$

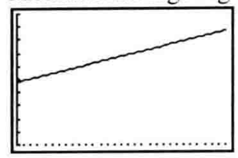
c. The value $x = 2025 - 1950 = 75$ corresponds to the year 2025. Substitute 75 into the equation.

$$y = 0.158x + 65.06$$

$$y = 0.158(75) + 65.06$$

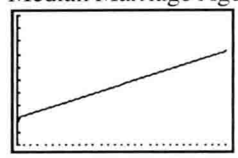
$$\approx 76.9 \text{ years}$$

73. **a.** Median Marriage Age for Men



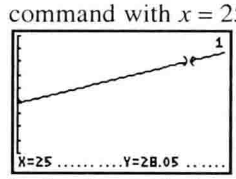
on [0, 30] by [20, 30]

Median Marriage Age for Women

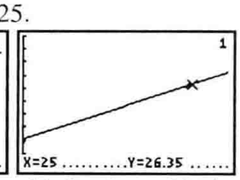


on [0, 30] by [20, 30]

b. The x-value corresponding to the year 2005 is $x = 2005 - 1980 = 25$. The following screens are a result of the EVALUATE command with $x = 25$.



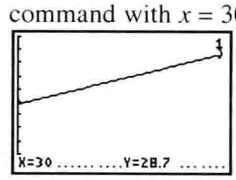
Median Age at Marriage for Men in 2005



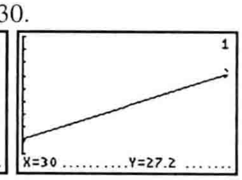
Median Age at Marriage for Women in 2005.

So, the median marriage age for men in 2005 will be 28.05 years and for women it will be 26.35 years.

c. The x-value corresponding to the year 2005 is $x = 2010 - 1980 = 30$. The following screens are a result of the EVALUATE command with $x = 30$.



Median Age at Marriage for Men in 2010



Median Age at Marriage for Women in 2010.

So, the median marriage age for men in 2010 will be 28.7 years and for women it will be 27.2 years.

EXERCISES 1.2

1. $\left(2^2 \cdot 2\right)^2 = \left(2^2 \cdot 2^1\right)^2 = \left(2^3\right)^2 = 2^6 = 64$

3. $2^{-4} = \frac{1}{2^4} = \frac{1}{16}$

5. $\left(\frac{1}{2}\right)^{-3} = \left(2^{-1}\right)^{-3} = 2^3 = 8$

7. $\left(\frac{5}{8}\right)^{-1} = \frac{8}{5}$

9. $4^{-2}\cdot 2^{-1}=\left(2^2\right)^{-2}\cdot 2^{-1}$
$=2^{-4}\cdot 2^{-1}=2^{-5}=\frac{1}{2^5}=\frac{1}{32}$

11. $\left(\frac{3}{2}\right)^{-3}=\left(\frac{2}{3}\right)^3=\frac{2^3}{3^3}=\frac{8}{27}$

13. $\left(\frac{1}{3}\right)^{-2}-\left(\frac{1}{2}\right)^{-3}=\left(\frac{3}{1}\right)^2-\left(\frac{2}{1}\right)^3=\frac{3^2}{1^2}-\frac{2^3}{1^3}$
$=9-8=1$

15. $\left[\left(\frac{2}{3}\right)^{-2}\right]^{-1}=\left[\left(\frac{3}{2}\right)^2\right]^{-1}=\left(\frac{3^2}{2^2}\right)^{-1}=\left(\frac{9}{4}\right)^{-1}=\frac{4}{9}$

17. $25^{1/2}=\sqrt{25}=5$

19. $25^{3/2}=\left(\sqrt{25}\right)^3=5^3=125$

21. $16^{3/4}=\left(\sqrt[4]{16}\right)^3=2^3=8$

23. $(-8)^{2/3}=\left(\sqrt[3]{-8}\right)^2=(-2)^2=4$

25. $(-8)^{5/3}=\left(\sqrt[3]{-8}\right)^5=(-2)^5=-32$

27. $\left(\frac{25}{36}\right)^{3/2}=\left(\sqrt{\frac{25}{36}}\right)^3=\left(\frac{5}{6}\right)^3=\frac{5^3}{6^3}=\frac{125}{216}$

29. $\left(\frac{27}{125}\right)^{2/3}=\left(\sqrt[3]{\frac{27}{125}}\right)^2=\left(\frac{3}{5}\right)^2=\frac{3^2}{5^2}=\frac{9}{25}$

31. $\left(\frac{1}{32}\right)^{2/5}=\left(\sqrt[5]{\frac{1}{32}}\right)^2=\left(\frac{1}{2}\right)^2=\frac{1}{4}$

33. $4^{-1/2}=\frac{1}{4^{1/2}}=\frac{1}{\sqrt{4}}=\frac{1}{2}$

35. $4^{-3/2}=\frac{1}{4^{3/2}}=\frac{1}{\left(\sqrt{4}\right)^3}=\frac{1}{2^3}=\frac{1}{8}$

37. $8^{-2/3}=\frac{1}{8^{2/3}}=\frac{1}{\left(\sqrt[3]{8}\right)^2}=\frac{1}{2^2}=\frac{1}{4}$

39. $(-8)^{-1/3}=\frac{1}{(-8)^{1/3}}=\frac{1}{\sqrt[3]{-8}}=\frac{1}{-2}=-\frac{1}{2}$

41. $(-8)^{-2/3}=\frac{1}{(-8)^{2/3}}=\frac{1}{\left(\sqrt[3]{(-8)^2}\right)}=\frac{1}{\sqrt[3]{64}}=\frac{1}{4}$

43. $\left(\frac{25}{16}\right)^{-1/2}=\left(\frac{16}{25}\right)^{1/2}=\left(\sqrt{\frac{16}{25}}\right)=\frac{4}{5}$

45. $\left(\frac{25}{16}\right)^{-3/2}=\left(\frac{16}{25}\right)^{3/2}=\left(\sqrt{\frac{16}{25}}\right)^3=\left(\frac{4}{5}\right)^3=\frac{4^3}{5^3}=\frac{64}{125}$

47. $\left(-\frac{1}{27}\right)^{-5/3}=(-27)^{5/3}=\left(\sqrt[3]{-27}\right)^5=(-3)^5=-243$

49. $7^{0.39}\approx 2.14$

51. $8^{2.7}\approx 274.37$

53. $(-8)^{7/3}=-128$

55. $\left[\left(\frac{5}{2}\right)^{-1}\right]^{-2}=6.25$

57. $\left[(4)^{-1}\right]^{0.5}=0.5$

59. $\left(0.4^{-7}\right)^{-1/7}=0.4$

61. $\left[(0.1)^{0.1}\right]^{0.1}\approx 0.977$

63. $\left(1-\frac{1}{100}\right)^{-1000}\approx 2.720$

65. $\left(x^3\cdot x^2\right)^2=\left(x^5\right)^2=x^{10}$

67. $\left[z^2\left(z\cdot z^2\right)^2 z\right]^3=\left[z^2\left(z^3\right)^2 z\right]^3=\left(z^2\cdot z^6\cdot z\right)^3$
$=\left(z^9\right)^3=z^{27}$

69. $\left[\left(x^2\right)^2\right]^2=\left(x^4\right)^2=x^8$

71. $\frac{\left(ww^2\right)^3}{w^3 w}=\frac{w^3 w^6}{w^3 w}=w^5$

73. $\frac{\left(5xy^4\right)^2}{25x^3y^3}=\frac{25x^2y^8}{25x^3y^3}=\frac{y^5}{x}$

75. $\frac{\left(9xy^3z\right)^2}{3(xyz)^2}=\frac{81x^2y^6z^2}{3x^2y^2z^2}=27y^4$

77. $\frac{\left(2u^2vw^3\right)^2}{4\left(uw^2\right)^2}=\frac{4u^4v^2w^6}{4u^2w^4}=u^2v^2w^2$

79. Average body thickness
$=0.4(\text{hip-to-shoulder length})^{3/2}$
$=0.4(16)^{3/2}$
$=0.4\left(\sqrt{16}\right)^3=0.4(64)$
$=25.6$ ft

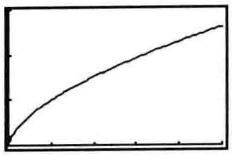
79.

81. $C' = x^{0.6}C$

$= 4^{0.6}C \approx 2.3C$

To quadruple the capacity costs about 2.3 times a much.

83.



on [0, 5] by [0, 3]

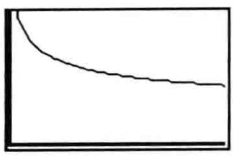
Capacity can be multiplied by about 3.2

85. $(\text{Heart rate}) = 250(\text{weight})^{-1/4}$

$= 250(16)^{-1/4}$

$= 125$ beats per minute

87.



on [0, 200] by [0, 150]

Heart rate decreases more slowly as body weight increases.

89. $(\text{Time to build the 50th Boeing 707})$

$= 150\left(50^{-0.322}\right)$

≈ 42.6 thousand man - hours

It took approximately 42,600 man-hours to build the 50th Boeing 707.

91. **a.** Increase in ground motion $= 10^{B-A}$

$= 10^{8.3-6.8}$

$= 10^{1.5} \approx 32$

The 1906 San Francisco earthquake was about 32 times as powerful than the 1994 Northridge, California, earthquake.

b. Increase in ground motion $= 10^{B-A}$

$= 10^{8.1-7.2}$

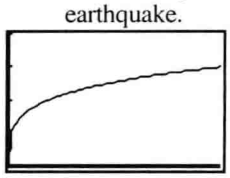
$= 10^{0.9} \approx 8$

The 1933 Miyagi earthquake was about 8 times as powerful as the Kobe (Japan) earthquake.

93. $S = \frac{60}{11}x^{0.5}$

$= \frac{60}{11}(3281)^{0.5} \approx 312$ mph

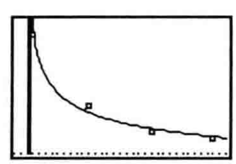
95.



on [0,100] by[0,4]

$x \approx 18.2$. Therefore, the land area must be increased by a factor of more than 18 to double the number of species.

97. **a.**



on [–2, 32] by [1,000, 3,500]

b. $y_1 = 3261x^{-0.267}$

c. For $x = 50$,

$y_1 = 3261x^{-0.267}$

$= 3261(50)^{-0.267} \approx 1147$ man - hours

It will take approximately 1147 man-hours to build the fiftieth supercomputer.

EXERCISES 1.3

1. Yes **3.** No **5.** No **7.** No

9. Domain = $\{x \mid x \le 0 \text{ or } x \ge 1\}$
Range = $\{y \mid y \ge -1\}$

11. **a.** $f(x) = \sqrt{x-1}$
$f(10) = \sqrt{10-1} = \sqrt{9} = 3$

b. Domain = $\{x \mid x \ge 1\}$ since $f(x) = \sqrt{x-1}$ is defined for all values of $x \ge 1$.

c. Range = $\{y \mid y \ge 0\}$

13. **a.** $h(z) = \frac{1}{z+4}$
$h(-5) = \frac{1}{-5+4} = -1$

b. Domain $=\{z \mid z \ne -4\}$ since $h(z) = \frac{1}{z+4}$ is defined for all values of z except $z = -4$.

c. Range = $\{y \mid y \ne 0\}$

15. **a.** $h(x) = x^{1/4}$
$h(81) = 81^{1/4} = \sqrt[4]{81} = 3$

b. Domain = $\{x \mid x \ge 0\}$ since $h(x) = x^{1/4}$ is defined for nonnegative values of x.

c. Range = $\{y \mid y \ge 0\}$

17. **a.** $f(x) = x^{2/3}$
$f(-8) = (-8)^{2/3} = \sqrt[3]{(-8)^2} = \sqrt[3]{64} = 4$

b. Domain = $\Re$

c. Range = $\{y \mid y \ge 0\}$

19. **a.** $f(x) = \sqrt{4-x^2}$
$f(0) = \sqrt{4-0^2} = 2$

b. $f(x) = \sqrt{4-x^2}$ is defined for values of x such that $4 - x^2 \ge 0$. Thus,
$4 - x^2 \ge 0$
$-x^2 \ge -4$
$x^2 \le 4$
$-2 \le x \le 2$
Domain = $\{x \mid -2 \le x \le 2\}$

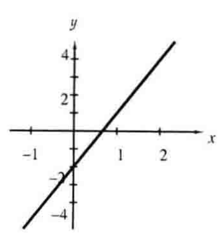
c. Range = $\{y \mid 0 \le y \le 2\}$

21. **a.** $f(x) = \sqrt{-x}$
$f(-25) = \sqrt{-(-25)} = 5$

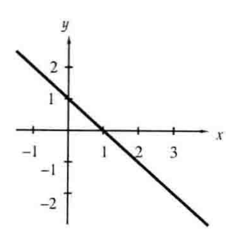
b. Domain = $\{x \mid x \le 0\}$ since $f(x) = \sqrt{-x}$ is defined only for values of $x \le 0$.

c. Range = $\{y \mid y \ge 0\}$

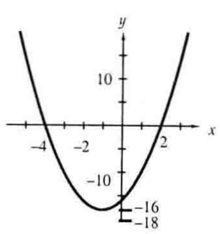
23.



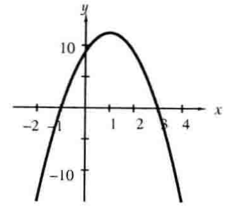
25.



27.



29.



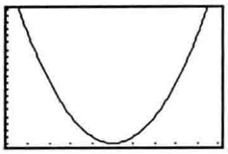
31. **a.** $x = \frac{-b}{2a} = \frac{-(-40)}{2(1)} = \frac{40}{2} = 20$

To find the y-coordinate, evaluate f at $x = 20$.

$f(20) = (20)^2 - 40(20) + 500 = 100$

The vertex is (20, 100).

b.



on [15, 25] by [100, 120]

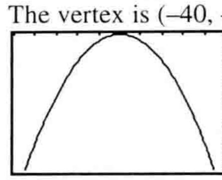
33. **a.** $x = \frac{-b}{2a} = \frac{-(-80)}{2(-1)} = \frac{80}{-2} = -40$

To find the y-coordinate, evaluate f at $x = -40$.

$f(-40) = -(-40)^2 - 80(-40) - 1800 = -200$

The vertex is (–40, –200).

b.



on [–45, –35] by [–220, –200]

35.

$$x^2 - 6x - 7 = 0$$
$$(x-7)(x+1) = 0$$

Equals 0 at $x = 7$; Equals 0 at $x = -1$

$x = 7, \quad x = -1$

37.

$$x^2 + 2x = 15$$
$$x^2 + 2x - 15 = 0$$
$$(x+5)(x-3) = 0$$

Equals 0 at $x = -5$; Equals 0 at $x = 3$

$x = -5, \quad x = 3$

39.

$$2x^2 + 40 = 18x$$
$$2x^2 - 18x + 40 = 0$$
$$x^2 - 9x + 20 = 0$$
$$(x-4)(x-5) = 0$$

Equals 0 at $x = 4$; Equals 0 at $x = 5$

$x = 4, \quad x = 5$

41.

$$5x^2 - 50x = 0$$
$$x^2 - 10x = 0$$
$$x(x-10) = 0$$

Equals 0 at $x = 10$

$x = 0, \quad x = 10$

43.

$$2x^2 - 50 = 0$$
$$x^2 - 25 = 0$$
$$(x-5)(x+5) = 0$$

Equals 0 at $x = 5$; Equals 0 at $x = -5$

$x = 5, \quad x = -5$

45.

$$4x^2 + 24x + 40 = 4$$
$$4x^2 + 24x + 36 = 0$$
$$x^2 + 6x + 9 = 0$$
$$(x+3)^2 = 0$$
$$x = -3$$

47.

$$-4x^2 + 12x = 8$$
$$-4x^2 + 12x - 8 = 0$$
$$x^2 - 3x + 2 = 0$$
$$(x-2)(x-1) = 0$$

Equals 0 at $x = 2$; Equals 0 at $x = 1$

$x = 2, \quad x = 1$

49.

$$2x^2 - 12x + 20 = 0$$
$$x^2 - 6x + 10 = 0$$

Use the quadratic formula with $a = 1$, $b = -6$, and $c = 10$.

$$x = \frac{-(-6) \pm \sqrt{(-6)^2 - 4(1)(10)}}{2(1)} = \frac{6 \pm \sqrt{36-40}}{2} = \frac{6 \pm \sqrt{-4}}{2} \quad \text{Undefined}$$

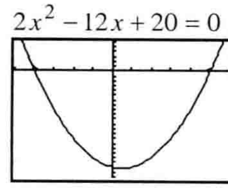
$2x^2 - 12x + 20 = 0$ has no real solutions.

51.

$$3x^2 + 12 = 0$$
$$x^2 + 4 = 0$$
$$x^2 = -4$$
$$x = \pm\sqrt{-4} \quad \text{Undefined}$$

$3x^2 + 12 = 0$ has no real solutions.

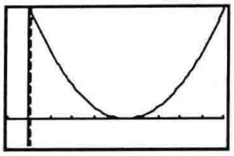
53.



on [–5, 6] by [–22, 6]

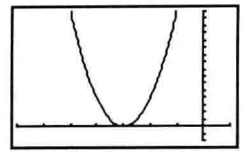
$x = -4$, $x = 5$

55.



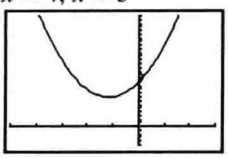
on [−1, 9] by [−10, 40]
$x = 4, x = 5$

57.



on [−7, 1] by [−2, 16]
$x = -3$

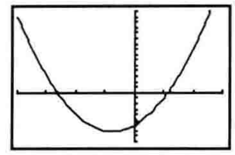
59.



on [−5, 3] by [−5, 30]

No real solutions

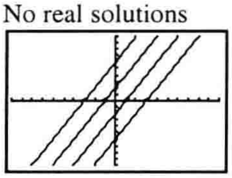
61.



on [−4, 3] by [−9, 15]

$x = -2.64, x = 1.14$

63.



on [−10, 10] by [−10, 10]

a. Their slopes are all 2, but they have different y-intercepts.

b. The line 2 units below the line of the equation $y = 2x - 6$ must have y-intercept −8. Thus, the equation of this line is $y = 2x - 8$.

65. Let x = the number of board feet of wood. Then
$C(x) = 4x + 20$

67. Let x = the number of hours of overtime. Then
$P(x) = 15x + 500$

69. **a.**
$$p(d) = 0.45d + 15$$
$$p(6) = 0.45(6) + 15 = 17.7 \text{ pounds per square inch}$$

b.
$$p(d) = 0.45d + 15$$
$$p(35{,}000) = 0.45(35{,}000) + 15 = 15{,}765 \text{ pounds per square inch}$$

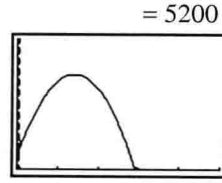
71.
$$D(v) = 0.055v^2 + 1.1v$$
$$D(40) = 0.055(40)^2 + 1.1(40) = 132 \text{ ft}$$

73. **a.**
$$N(t) = 200 + 50t^2$$
$$N(2) = 200 + 50(2)^2 = 400 \text{ cells}$$

b.
$$N(t) = 200 + 50t^2$$
$$N(10) = 200 + 50(10)^2 = 5200 \text{ cells}$$

75.
$$v(x) = \frac{60}{11}\sqrt{x}$$
$$v(1454) = \frac{60}{11}\sqrt{1454} \approx 208 \text{ mph}$$

77.



on [0, 5] by [0, 50]
The object hits the ground in about 2.92 seconds

79. **a.** To find the break-even points, set $C(x)$ equal to $R(x)$ and solve the resulting equation.

$$C(x) = R(x)$$

$$180x + 16000 = -2x^2 + 660x$$

$$2x^2 - 480x + 16000 = 0$$

Use the quadratic formula with $a = 2$, $b = -480$ and $c = 16000$.

$$x = \frac{480 \pm \sqrt{(-480)^2 - 4(2)(16000)}}{2(2)}$$

$$x = \frac{240 \pm 160}{2} = \frac{400}{2} \text{ or } \frac{80}{2} = 200 \text{ or } 40$$

The company will break even when it makes either 40 devices or 200 devices.

b. To find the number of devices that maximizes profit, first find the profit function, $P(x) = R(x) - C(x)$.

$$P(x) = \left(-2x^2 + 660x\right) - (180x + 16000)$$

$$= -2x^2 + 480x - 16000$$

Since this is a parabola that opens downward the maximum profit is found at the vertex.

$$x = \frac{-480}{2(-2)} = \frac{-480}{-4} = 120$$

Thus, profit is maximized when 120 devices are produced per week. The maximum profit is found by evaluating $P(120)$.

$$P(120) = -2(120)^2 + 480(120) - 16000$$

$$= \$12,800$$

Therefore, the maximum profit is $12,800.

81. **a.** To find the break-even points, set $C(x)$ equal to $R(x)$ and solve the resulting equation.

$$C(x) = R(x)$$

$$100x + 3200 = -2x^2 + 300x$$

$$2x^2 - 200x + 3200 = 0$$

Use the quadratic formula with $a = 2$, $b = -200$ and $c = 3200$.

$$x = \frac{200 \pm \sqrt{(-200)^2 - 4(2)(3200)}}{2(2)}$$

$$x = \frac{100 \pm 60}{2} = \frac{160}{2} \text{ or } \frac{40}{2} = 80 \text{ or } 20$$

The store will break even when it sells either 80 exercise machines or 20 exercise machines.

b. To find the number of exercise machines that maximizes profit, first find the profit function, $P(x) = R(x) - C(x)$.

$$P(x) = \left(-2x^2 + 300x\right) - (100x + 3200)$$

$$= -2x^2 + 200x - 3200$$

Since this is a parabola that opens downward the maximum profit is found at the vertex.

$$x = \frac{-200}{2(-2)} = \frac{-200}{-4} = 50$$

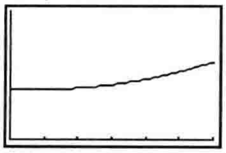
Thus, profit is maximized when 50 exercise machines are sold per day. The maximum profit is found by evaluating $P(50)$.

$$P(50) = -2(50)^2 + 200(50) - 3200$$

$$= \$1800$$

Therefore, the maximum profit is $1800.

83. **a.**



on [10, 16] by [0, 100]

b. Using EVALUATE, $y = 39.764$ when $x = 12$.
So, the probability that a smoker who is a high school graduate will quit is 39.8%.

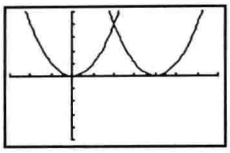
c. Using EVALUATE, $y = 60.436$ when $x = 16$.
So, the probability that a smoker who is a high school graduate will quit is 60.4%.

85. $(w + a)(v + b) = c$

$$v + b = \frac{c}{w+a}$$

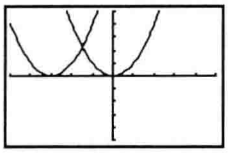
$$v = \frac{c}{w+a} - b = \frac{c - bw - ba}{w+a}$$

87. **a.**



on [–3, 7] by [–5, 5]
The new parabola is shifted 4 units to the right, and its vertex is (4, 0).

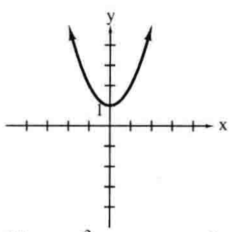
b.



on [–5, 5] by [–5, 5]
The new parabola is shifted 3 units to the left, and its vertex is (–3,0)

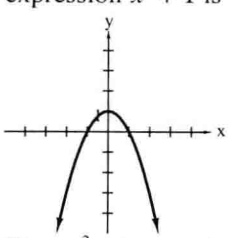
c. The parabola $y=(x-a)^2$ is the parabola $y=x^2$ shifted a units to the right if $a>0$, and its vertex is $(a, 0)$. If the sign is a plus instead of a minus, the parabola is shifted $|a|$ units to the left.

91. **a.**



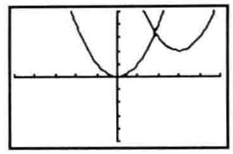
Since x^2 can never be negative the smallest it can be is 0. So the smallest value of the expression x^2+1 is 1.

b.



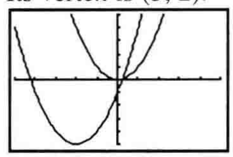
Since x^2 can never be negative, $-x^2$ can never be positive. The largest this expression can be is 0. So the largest value of the expression $-x^2+1$ is 1.

89. **a.**



on [–5, 5] by [–5, 5]
The new parabola is the parabola $y=x^2$ shifted 3 units to the right and 2 units up. Its vertex is (3, 2).

b.



on [–5, 5] by [–5, 5]
The new parabola is the parabola $y=x^2$ shifted 2 units to the left and 5 units down. Its vertex is (–2, –5).

c. The parabola $y=(x-a)^2+b$ is the parabola $y=x^2$ shifted a units to the right if $a>0$ and b units up if $b>0$ or b units down if $b<0$, and its vertex is (a, b). If $a<0$, the parabola is shifted $|a|$ units to the left and either b units up or b units down.

93. **a.** To verify the two expressions are equal, "multiply out" the left side and collect like terms.

$$(x+3)^2+1=x^2+6x+9+1$$
$$=x^2+6x+10$$

b. To verify the two expressions are equal, "multiply out" the left side and collect like terms.

95. **a.** If $a > 0$, the expression $a\left(x+\frac{b}{2a}\right)^2$ can never be negative. So, the smallest possible value of $f(x)$ will occur when the expression $x+\frac{b}{2a}$ is zero. That is,

$$x+\frac{b}{2a}=0$$
$$x=-\frac{b}{2a}$$

b. If $a < 0$, the expression $a\left(x+\frac{b}{2a}\right)^2$ can never be positive. So, the largest possible value of $f(x)$ will occur when the expression $x+\frac{b}{2a}$ is zero. That is,

$$x+\frac{b}{2a}=0$$
$$x=-\frac{b}{2a}$$

EXERCISES 1.4

1. Domain = $\{x \mid x < -4 \text{ or } x > 0\}$
Range = $\{y \mid y < -2 \text{ or } y > 0\}$

b.
c.

3. **a.** $f(x)=\frac{1}{x+4}$

$f(-3)=\frac{1}{-3+4}=1$

b. Domain = $\{x \mid x \neq -4\}$
c. Range = $\{y \mid y \neq 0\}$

5. **a.** $f(x)=\frac{x^2}{x-1}$

$f(-1)=\frac{(-1)^2}{-1-1}=-\frac{1}{2}$

b. Domain = $\{x \mid x \neq 1\}$
c. Range = $\{y \mid y \leq 0 \text{ or } y \geq 4\}$

7. **a.** $f(x)=\frac{12}{x(x+4)}$

$f(2)=\frac{12}{2(2+4)}=1$

b. Domain = $\{x \mid x \neq 0, x \neq -4\}$
c. Range = $\{y \mid y \leq -3 \text{ or } y > 0\}$

9. **a.** $g(x)=|x+2|$

$g(-5)=|(-5)+2|=|-3|=3$

b. Domain = $\Re$
c. Range = $\{y \mid y \geq 0\}$

11.
$$x^5+2x^4-3x^3=0$$
$$x^3\left(x^2+2x-3\right)=0$$
$$x^3(x+3)(x-1)=0$$
Equals 0 at $x=0$; Equals 0 at $x=-3$; Equals 0 at $x=1$

$x=0, x=-3,$ and $x=1$

13.
$$5x^3-20x=0$$
$$5x\left(x^2-4\right)=0$$
$$5x(x-2)(x+2)=0$$
Equals 0 at $x=0$; Equals 0 at $x=2$; Equals 0 at $x=-2$

$x=0, x=2,$ and $x=-2$

15.
$$2x^3+18x=12x^2$$
$$2x^3-12x^2+18x=0$$
$$2x\left(x^2-6x+9\right)=0$$
$$2x(x-3)^2=0$$
Equals 0 at $x=0$; Equals 0 at $x=3$

$x=0$ and $x=3$

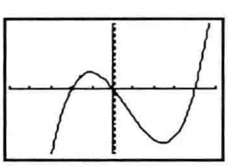
17.
$$6x^5=30x^4$$
$$6x^5-30x^4=0$$
$$6x^4(x-5)=0$$
Equals 0 at $x=0$; Equals 0 at $x=5$

$x=0$ and $x=5$

19.
$$3x^{5/2}-6x^{3/2}=9x^{1/2}$$
$$3x^{5/2}-6x^{3/2}-9x^{1/2}=0$$
$$3x^{1/2}\left(x^2-2x-3\right)=0$$
$$3x^{1/2}(x-3)(x+1)=0$$
Equals 0 at $x=0$; Equals 0 at $x=3$; Equals 0 at $x=-1$

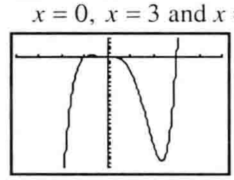
$x=0,\ x=3$ and $x=-1$

21.



on [–5, 5] by [–20, 20]
$x=-2, x=0,$ and $x=4$

23.



on [–4, 5] by [–30, 5]
$x=-1, x=0,$ and $x=3$