

Chapter 2 Linear Models, Equations, and Inequalities

Toolbox

1. $3x = 6$

Division property

$$\frac{3x}{3} = \frac{6}{3}$$

$$x = 2$$

2. $x - 7 = 11$

Addition property

$$x - 7 = 11$$

$$x - 7 + 7 = 11 + 7$$

$$x = 18$$

3. $x + 3 = 8$

Subtraction property

$$x + 3 = 8$$

$$x + 3 - 3 = 8 - 3$$

$$x = 5$$

4. $x - 5 = -2$

Addition property

$$x - 5 = -2$$

$$x - 5 + 5 = -2 + 5$$

$$x = 3$$

5. $\frac{x}{3} = 6$

Multiplication property

$$\frac{x}{3} = 6$$

$$\left(\frac{3}{1}\right)\left(\frac{x}{3}\right) = \left(\frac{3}{1}\right)\left(\frac{6}{1}\right)$$

$$x = \frac{18}{1}$$

$$x = 18$$

6. $-5x = 10$

Division property

$$\frac{-5x}{-5} = \frac{10}{-5}$$

$$x = -2$$

7. $2x + 8 = -12$

Subtraction property and division property

$$2x + 8 = -12$$

$$2x + 8 - 8 = -12 - 8$$

$$2x = -20$$

$$x = -10$$

8. $\frac{x}{4} - 3 = 5$

Addition property and multiplication property

$$\frac{x}{4} - 3 = 5$$

$$\frac{x}{4} - 3 + 3 = 5 + 3$$

$$\frac{x}{4} = 8$$

$$\left(\frac{4}{1}\right)\left(\frac{x}{4}\right) = 8\left(\frac{4}{1}\right)$$

$$x = 32$$

9. $4x - 3 = 6 + x$

$$4x - x - 3 = 6 + x - x$$

$$3x - 3 = 6$$

$$3x - 3 + 3 = 6 + 3$$

$$3x = 9$$

$$\frac{3x}{3} = \frac{9}{3}$$

$$x = 3$$

$$10. \quad 3x - 2 = 4 - 7x$$

$$3x + 7x - 2 = 4 - 7x + 7x$$

$$10x - 2 = 4$$

$$10x - 2 + 2 = 4 + 2$$

$$10x = 6$$

$$\frac{10x}{10} = \frac{6}{10}$$

$$x = \frac{6}{10}$$

$$x = \frac{3}{5}$$

$$11. \quad \frac{3x}{4} = 12$$

$$4\left(\frac{3x}{4}\right) = 4(12)$$

$$3x = 48$$

$$\frac{3x}{3} = \frac{48}{3}$$

$$x = 16$$

$$12. \quad \frac{5x}{2} = -10$$

$$2\left(\frac{5x}{2}\right) = 2(-10)$$

$$5x = -20$$

$$\frac{5x}{5} = \frac{-20}{5}$$

$$x = -4$$

$$13. \quad 3(x - 5) = -2x - 5$$

$$3x - 15 = -2x - 5$$

$$3x + 2x - 15 = -2x + 2x - 5$$

$$5x - 15 = -5$$

$$5x - 15 + 15 = -5 + 15$$

$$5x = 10$$

$$\frac{5x}{5} = \frac{10}{5}$$

$$x = 2$$

$$14. \quad -2(3x - 1) = 4x - 8$$

$$-6x + 2 = 4x - 8$$

$$-6x - 4x + 2 = 4x - 4x - 8$$

$$-10x + 2 = -8$$

$$-10x + 2 - 2 = -8 - 2$$

$$-10x = -10$$

$$\frac{-10x}{-10} = \frac{-10}{-10}$$

$$x = 1$$

$$15. \quad 2x - 7 = -4\left(4x - \frac{1}{2}\right)$$

$$2x - 7 = -16x + 2$$

$$2x + 16x - 7 = -16x + 16x + 2$$

$$18x - 7 = 2$$

$$18x - 7 + 7 = 2 + 7$$

$$18x = 9$$

$$\frac{18x}{18} = \frac{9}{18}$$

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

$$16. \quad -2(2x - 6) = 3\left(3x - \frac{1}{3}\right)$$

$$-4x + 12 = 9x - 1$$

$$-4x - 9x + 12 = 9x - 9x - 1$$

$$-13x + 12 = -1$$

$$-13x + 12 - 12 = -1 - 12$$

$$-13x = -13$$

$$\frac{-13x}{-13} = \frac{-13}{-13}$$

$$x = 1$$

$$17. \quad y = 2x \text{ and } x + y = 12$$

$$x + (2x) = 12$$

$$3x = 12$$

$$x = 4$$

18. $y = 4x$ and $x + y = 25$

$x + (4x) = 25$

$5x = 25$

$x = 5$

19. $y = 3x$ and $2x + 4y = 42$

$2x + 4(3x) = 42$

$2x + 12x = 42$

$14x = 42$

$x = 3$

20. $y = 6x$ and $3x + 2y = 75$

$3x + 2(6x) = 75$

$3x + 12x = 75$

$15x = 75$

$x = 5$

21. $3x - 5x = 2x + 7$

$-2x = 2x + 7$

$-4x = 7$

$x = \frac{7}{-4}$

This is a conditional equation.

22. $3(x + 1) = 3x - 7$

$3x + 3 = 3x - 7$

$3 = -7$

This is a contradiction equation.

23. $9x - 2(x - 5) = 3x + 10 + 4x$

$9x - 2x + 10 = 7x + 10$

$7x + 10 = 7x + 10$

This is an identity equation.

24. $\frac{x}{2} - 5 = \frac{x}{4} + 2$

$2x - 20 = x + 8$

$x = 28$

This is a conditional equation.

25. $5x + 1 > -5$

$5x > -6$

$x > -\frac{6}{5}$

26. $1 - 3x \geq 7$

$-3x \geq 6$

$x \leq -2$

27. $\frac{x}{4} > -3$

$x > -12$

28. $\frac{x}{6} > -2$

$x > -12$

29. $\frac{x}{4} - 2 > 5x$

$\frac{x}{4} > 5x + 2$

$x > 20x + 8$

$-19x > 8$

$x < -\frac{8}{19}$

$$30. \frac{x}{2} + 3 > 6x$$

$$x + 6 > 12x$$

$$-11x + 6 > 0$$

$$-11x > -6$$

$$x < \frac{6}{11}$$

$$31. -3(x-5) < -4$$

$$-3x + 15 < -4$$

$$-3x < -19$$

$$x > \frac{19}{3}$$

$$32. -\frac{1}{2}(x+4) < 6$$

$$-\frac{1}{2}x - 2 < 6$$

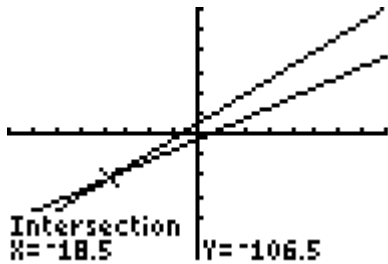
$$-\frac{1}{2}x < 8$$

$$x > -16$$

33. Section 2.1 Skills Check

$$\begin{aligned}
 1. \quad & 5x - 14 = 23 + 7x \\
 & 5x - 7x - 14 = 23 + 7x - 7x \\
 & -2x - 14 = 23 \\
 & -2x - 14 + 14 = 23 + 14 \\
 & -2x = 37 \\
 & \frac{-2x}{-2} = \frac{37}{-2} \\
 & x = -\frac{37}{2} \\
 & x = -18.5
 \end{aligned}$$

Applying the intersections of graphs method, graph $y = 5x - 14$ and $y = 23 + 7x$. Determine the intersection point from the graph:



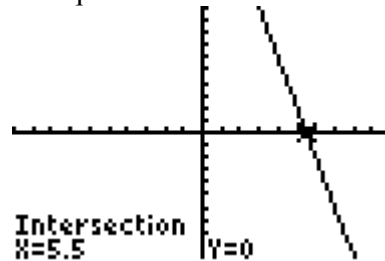
$[-40, 40]$ by $[-300, 300]$

$$\begin{aligned}
 2. \quad & 3x - 2 = 7x - 24 \\
 & 3x - 7x - 2 = 7x - 7x - 24 \\
 & -4x - 2 = -24 \\
 & -4x = -22 \\
 & \frac{-4x}{-4} = \frac{-22}{-4} \\
 & x = \frac{-22}{-4} \\
 & x = \frac{11}{2} = 5.5
 \end{aligned}$$

Applying the x -intercept method, rewrite the equation so that 0 appears on one side of the equal sign.

$$\begin{aligned}
 & 3x - 2 = 7x - 24 \\
 & 3x - 7x - 2 + 24 = 0 \\
 & -4x + 22 = 0
 \end{aligned}$$

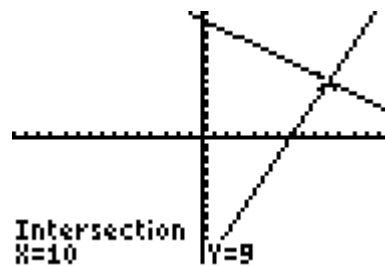
Graph $y = -4x + 22$ and determine the x -intercept. The x -intercept is the solution to the equation.



$[-10, 10]$ by $[-10, 10]$

$$\begin{aligned}
 3. \quad & 3(x - 7) = 19 - x \\
 & 3x - 21 = 19 - x \\
 & 3x + x - 21 = 19 - x + x \\
 & 4x - 21 = 19 \\
 & 4x - 21 + 21 = 19 + 21 \\
 & 4x = 40 \\
 & \frac{4x}{4} = \frac{40}{4} \\
 & x = 10
 \end{aligned}$$

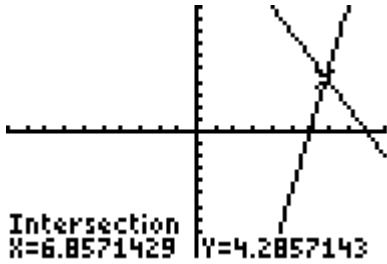
Applying the intersections of graphs method yields:



$[-15, 15]$ by $[-20, 20]$

$$\begin{aligned}
 4. \quad & 5(y - 6) = 18 - 2y \\
 & 5y - 30 = 18 - 2y \\
 & 7y = 48 \\
 & y = \frac{48}{7}
 \end{aligned}$$

Applying the intersections of graphs method yields:



$[-10, 10]$ by $[-10, 10]$

Remember your calculator has solved for the x -value via the graph even though the original equation was written with the variable y .

$$5. \quad x - \frac{5}{6} = 3x + \frac{1}{4}$$

LCD: 12

$$12\left(x - \frac{5}{6}\right) = 12\left(3x + \frac{1}{4}\right)$$

$$12x - 10 = 36x + 3$$

$$12x - 36x - 10 = 36x - 36x + 3$$

$$-24x - 10 = 3$$

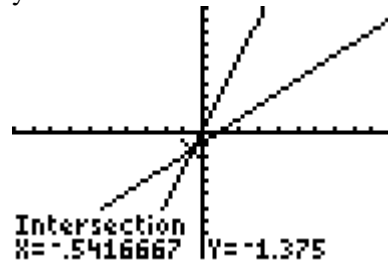
$$-24x - 10 + 10 = 3 + 10$$

$$-24x = 13$$

$$\frac{-24x}{-24} = \frac{13}{-24}$$

$$x = -\frac{13}{24}$$

Applying the intersections of graphs method yields:



$[-10, 10]$ by $[-10, 10]$

$$6. \quad 3x - \frac{1}{3} = 5x + \frac{3}{4}$$

LCD: 12

$$12\left(3x - \frac{1}{3}\right) = 12\left(5x + \frac{3}{4}\right)$$

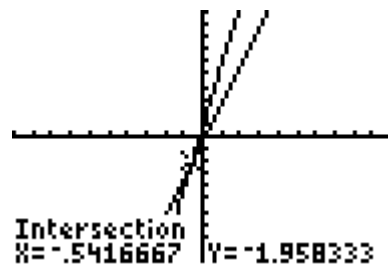
$$36x - 4 = 60x + 9$$

$$-24x - 4 = 9$$

$$-24x = 13$$

$$x = -\frac{13}{24}$$

Applying the intersections of graphs method yields:



$[-10, 10]$ by $[-10, 10]$

$$7. \frac{5(x-3)}{6} - x = 1 - \frac{x}{9}$$

LCD: 18

$$18\left(\frac{5(x-3)}{6} - x\right) = 18\left(1 - \frac{x}{9}\right)$$

$$15(x-3) - 18x = 18 - 2x$$

$$15x - 45 - 18x = 18 - 2x$$

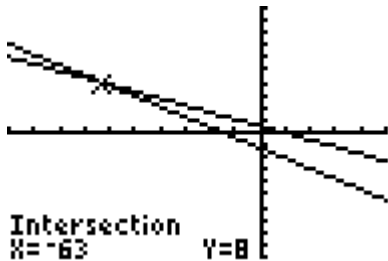
$$-3x - 45 = 18 - 2x$$

$$-1x - 45 = 18$$

$$-1x = 63$$

$$x = -63$$

Applying the intersections of graphs method yields:



[-100, 50] by [-20, 20]

$$8. \frac{4(y-2)}{5} - y = 6 - \frac{y}{3}$$

LCD: 15

$$15\left[\frac{4(y-2)}{5} - y\right] = 15\left[6 - \frac{y}{3}\right]$$

$$3[4(y-2)] - 15y = 90 - 5y$$

$$12(y-2) - 15y = 90 - 5y$$

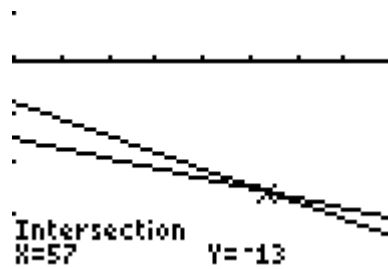
$$12y - 24 - 15y = 90 - 5y$$

$$-3y - 24 = 90 - 5y$$

$$2y = 114$$

$$y = 57$$

Applying the intersections of graphs method yields:



[30, 70] by [-20, 5]

Remember your calculator has solved for the x -value via the graph even though the original equation was written with the variable y .

$$9. 5.92t = 1.78t - 4.14$$

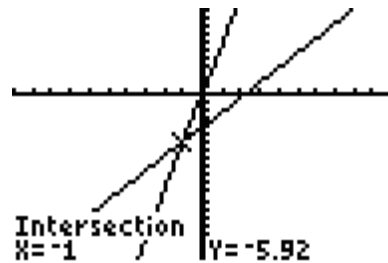
$$5.92t - 1.78t = -4.14$$

$$4.14t = -4.14$$

$$\frac{4.14t}{4.14} = \frac{-4.14}{4.14}$$

$$t = -1$$

Applying the intersections of graphs method yields:



[-10, 10] by [-20, 10]

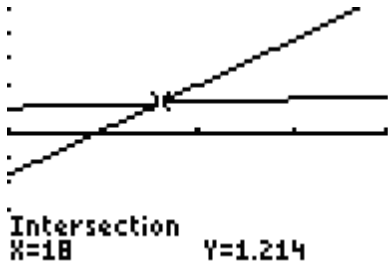
$$10. 0.023x + 0.8 = 0.36x - 5.266$$

$$-0.337x = -6.066$$

$$x = \frac{-6.066}{-0.337}$$

$$x = 18$$

Applying the intersections of graphs method yields:



[10, 30] by [-5, 5]

$$11. \frac{3}{4} + \frac{1}{5}x - \frac{1}{3} = \frac{4}{5}x$$

$$\text{LCD} = 60$$

$$60\left(\frac{3}{4} + \frac{1}{5}x - \frac{1}{3}\right) = 60\left(\frac{4}{5}x\right)$$

$$45 + 12x - 20 = 48x$$

$$-36x = -25$$

$$x = \frac{-25}{-36} = \frac{25}{36}$$

$$12. \frac{2}{3}x - \frac{6}{5} = \frac{1}{2} + \frac{5}{6}x$$

$$\text{LCD} = 30$$

$$30\left(\frac{2}{3}x - \frac{6}{5}\right) = 30\left(\frac{1}{2} + \frac{5}{6}x\right)$$

$$20x - 36 = 15 + 25x$$

$$-5x = 51$$

$$x = \frac{51}{-5} = -\frac{51}{5}$$

13. Answers a), b), and c) are the same. Let $f(x) = 0$ and solve for x .

$$32 + 1.6x = 0$$

$$1.6x = -32$$

$$x = -\frac{32}{1.6}$$

$$x = -20$$

The solution to $f(x) = 0$, the x -intercept of the function, and the zero of the function are all -20 .

14. Answers a), b), and c) are the same. Let $f(x) = 0$ and solve for x .

$$15x - 60 = 0$$

$$15x = 60$$

$$x = 4$$

The solution to $f(x) = 0$, the x -intercept of the function, and the zero of the function are all 4.

15. Answers a), b), and c) are the same. Let $f(x) = 0$ and solve for x .

$$\frac{3}{2}x - 6 = 0$$

$$\text{LCD} : 2$$

$$2\left(\frac{3}{2}x - 6\right) = 2(0)$$

$$3x - 12 = 0$$

$$3x = 12$$

$$x = 4$$

The solution to $f(x) = 0$, the x -intercept of the function, and the zero of the function are all 4.

16. Answers a), b), and c) are the same. Let $f(x) = 0$ and solve for x .

$$\frac{x-5}{4} = 0$$

$$\text{LCD} : 4$$

$$4\left(\frac{x-5}{4}\right) = 4(0)$$

$$x - 5 = 0$$

$$x = 5$$

The solution to $f(x) = 0$, the x -intercept of the function, and the zero of the function are all 5.

17. a. The x -intercept is 2, since an input of 2 creates an output of 0 in the function.

b. The y -intercept is -34 , since the output of -34 corresponds with an input of 0.

c. The solution to $f(x) = 0$ is equal to the x -intercept position for the function. Therefore, the solution to $f(x) = 0$ is 2.

18. a. The x -intercept is -0.5 , since an input of -0.5 creates an output of 0 in the function.

b. The y -intercept is 17, since the output of 17 corresponds with an input of 0.

c. The solution to $f(x) = 0$ is equal to the x -intercept position for the function. Therefore, the solution to $f(x) = 0$ is -0.5 .

19. The answers to a) and b) are the same. The graph crosses the x -axis at $x = 40$.

20. The answers to a) and b) are the same. The graph crosses the x -axis at $x = 0.8$.

21. Answers a), b), and c) are the same. Let $f(x) = 0$ and solve for x .

$$4x - 100 = 0$$

$$4x = 100$$

$$x = 25$$

The zero of the function, the x -intercept of the graph of the function, and the solution to $f(x) = 0$ are all 25.

22. Answers a), b), and c) are the same. Let $f(x) = 0$ and solve for x .

$$6x - 120 = 0$$

$$6x = 120$$

$$x = 20$$

The zero of the function, the x -intercept of the graph of the function, and the solution to $f(x) = 0$ are all 20.

23. Answers a), b), and c) are the same. Let $f(x) = 0$ and solve for x .

$$330 + 40x = 0$$

$$40x = -330$$

$$x = -8.25$$

The zero of the function, the x -intercept of the graph of the function, and the solution to $f(x) = 0$ are all -8.25 .

24. Answers a), b), and c) are the same. Let $f(x) = 0$ and solve for x .

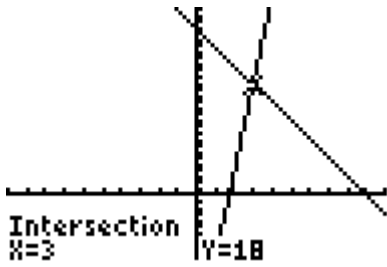
$$250 + 45x = 0$$

$$45x = -250$$

$$x = -\frac{50}{9}$$

The zero of the function, the x -intercept of the graph of the function, and the solution to $f(x) = 0$ are all $-50/9$.

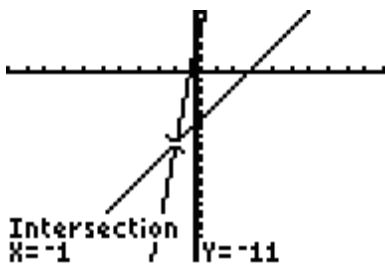
25. Applying the intersections of graphs method yields:



$[-10, 10]$ by $[-10, 30]$

The solution is the x -coordinate of the intersection point or, $x = 3$.

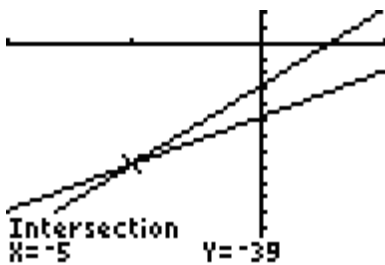
26. Applying the intersections of graphs method yields:



$[-10, 10]$ by $[-30, 10]$

The solution is the x -coordinate of the intersection point or, $x = -1$.

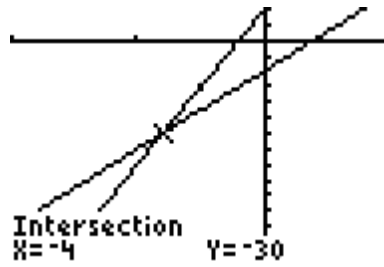
27. Applying the intersections of graphs method yields:



$[-10, 5]$ by $[-70, 10]$

The solution is the x -coordinate of the intersection point or, $s = -5$.

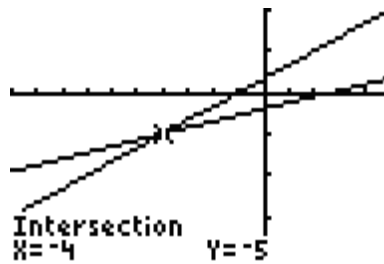
28. Applying the intersections of graphs method yields:



$[-10, 5]$ by $[-70, 10]$

The solution is the x -coordinate of the intersection point or, $x = -4$.

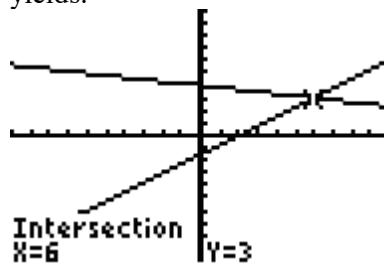
29. Applying the intersections of graphs method yields:



$[-10, 5]$ by $[-20, 10]$

The solution is the x -coordinate of the intersection point or, $t = -4$.

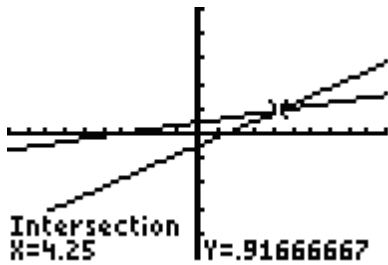
30. Applying the intersections of graphs method yields:



$[-10, 10]$ by $[-10, 10]$

The solution is the x -coordinate of the intersection point or, $x = 6$.

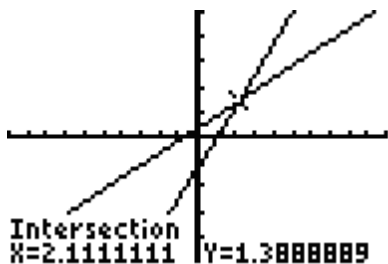
31. Applying the intersections of graphs method yields:



$[-10, 10]$ by $[-5, 5]$

The solution is the x -coordinate of the intersection point, which is $t = 4.25 = \frac{17}{4}$.

32. Applying the intersections of graphs method yields:



$[-10, 10]$ by $[-5, 5]$

The solution is the x -coordinate of the intersection point, which is $x = 2.\bar{1} = \frac{19}{9}$.

33. a. $A = P(1 + rt)$

$$A = P + Prt$$

$$A - P = P - P + Prt$$

$$A - P = Prt$$

$$\frac{A - P}{Pr} = \frac{Prt}{Pr}$$

$$\frac{A - P}{Pr} = t \text{ or } t = \frac{A - P}{Pr}$$

- b. $A = P(1 + rt)$

$$\frac{A}{1 + rt} = \frac{P(1 + rt)}{1 + rt}$$

$$\frac{A}{1 + rt} = P \text{ or } P = \frac{A}{1 + rt}$$

34. $V = \frac{1}{3}\pi r^2 h$

LCD: 3

$$3(V) = 3\left(\frac{1}{3}\pi r^2 h\right)$$

$$3V = \pi r^2 h$$

$$\frac{3V}{\pi r^2} = \frac{\pi r^2 h}{\pi r^2}$$

$$\frac{3V}{\pi r^2} = h \text{ or } h = \frac{3V}{\pi r^2}$$

35. $5F - 9C = 160$

$$5F - 9C + 9C = 160 + 9C$$

$$5F = 160 + 9C$$

$$\frac{5F}{5} = \frac{160 + 9C}{5}$$

$$F = \frac{9}{5}C + \frac{160}{5}$$

$$F = \frac{9}{5}C + 32$$

$$36. 4(a - 2x) = 5x + \frac{c}{3}$$

LCD: 3

$$3(4(a - 2x)) = 3\left(5x + \frac{c}{3}\right)$$

$$12(a - 2x) = 15x + c$$

$$12a - 24x = 15x + c$$

$$12a - 24x - 15x = 15x - 15x + c$$

$$12a - 39x = c$$

$$12a - 12a - 39x = c - 12a$$

$$-39x = c - 12a$$

$$x = \frac{c - 12a}{-39} \text{ or}$$

$$x = \left(\frac{-1}{-1}\right)\left(\frac{c - 12a}{-39}\right) = \frac{12a - c}{39}$$

$$37. \frac{P}{2} + A = 5m - 2n$$

LCD: 2

$$2\left(\frac{P}{2} + A\right) = 2(5m - 2n)$$

$$P + 2A = 10m - 4n$$

$$P + 2A - 10m = 10m - 4n - 10m$$

$$\frac{P + 2A - 10m}{-4} = \frac{-4n}{-4}$$

$$\frac{P + 2A - 10m}{-4} = n$$

$$n = \frac{P}{-4} + \frac{2A}{-4} - \frac{10m}{-4}$$

$$n = \frac{5m}{2} - \frac{P}{4} - \frac{A}{2}$$

$$38. y - y_1 = m(x - x_1)$$

$$y - y_1 = mx - mx_1$$

$$y - y_1 + mx_1 = mx - mx_1 + mx_1$$

$$\frac{y - y_1 + mx_1}{m} = \frac{mx}{m}$$

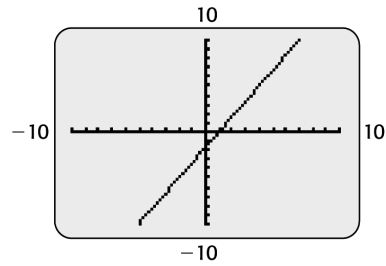
$$x = \frac{y - y_1 + mx_1}{m}$$

$$39. 5x - 3y = 5$$

$$-3y = -5x + 5$$

$$y = \frac{-5x + 5}{-3}$$

$$y = \frac{5}{3}x - \frac{5}{3}$$



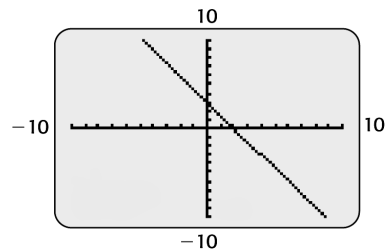
$[-10, 10]$ by $[-10, 10]$

$$40. 3x + 2y = 6$$

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

$$y = \frac{-3x + 6}{2}$$

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



$[-10, 10]$ by $[-10, 10]$

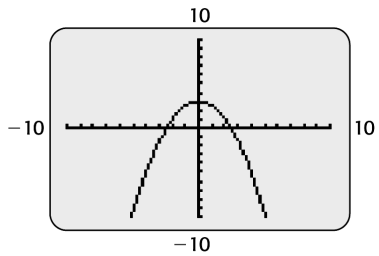
$$41. x^2 + 2y = 6$$

$$2y = 6 - x^2$$

$$y = \frac{6 - x^2}{2}$$

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

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



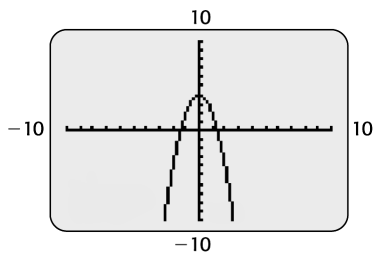
$[-10, 10]$ by $[-10, 10]$

42. $4x^2 + 2y = 8$

$$2y = -4x^2 + 8$$

$$y = \frac{-4x^2 + 8}{2}$$

$$y = -2x^2 + 4$$



$[-10, 10]$ by $[-10, 10]$

Section 2.1 Exercises

43. Let $y = 690,000$ and solve for x .

$$690,000 = 828,000 - 2300x$$

$$-138,000 = -2300x$$

$$x = \frac{-138,000}{-2300}$$

$$x = 60$$

After 60 months or 5 years the value of the building will be \$690,000.

44. Let $C = 20$ and solve for F .

$$5F - 9C = 160$$

$$5F - 9(20) = 160$$

$$5F - 180 = 160$$

$$5F = 340$$

$$F = \frac{340}{5} = 68$$

68° Fahrenheit equals 20° Celsius.

45. $S = P(1 + rt)$

$$9000 = P(1 + (0.10)(5))$$

$$9000 = P(1 + 0.50)$$

$$9000 = 1.5P$$

$$P = \frac{9000}{1.5} = 6000$$

\$6000 must be invested as the principal.

$$\begin{aligned}
 46. \quad I &= t - 0.55(1-h)(t-58) \\
 79 &= 80 - 0.55(1-h)(80-58) \\
 79 &= 80 - 0.55(1-h)(22) \\
 79 &= 80 - 12.1(1-h) \\
 79 &= 80 - 12.1 + 12.1h \\
 79 &= 67.9 + 12.1h \\
 12.1h &= 11.1 \\
 h &= \frac{11.1}{12.1} = \\
 h &= 0.9173553719 \approx 0.92
 \end{aligned}$$

A relative humidity of 92% gives an index of 79.

$$\begin{aligned}
 47. \quad M &= 0.959W - 1.226 \\
 50.56 &= 0.959W - 1.226 \\
 0.959W &= 51.786 \\
 W &= \frac{51.786}{0.959} = 54
 \end{aligned}$$

The median annual salary for whites is approximately \$54,000.

$$\begin{aligned}
 48. \quad \text{Let } B(t) &= 14.44, \text{ and calculate } t. \\
 14.44 &= 3.303t - 6591.56 \\
 14.44 + 6591.56 &= 3.303t \\
 6606 &= 3.303t \\
 t &= \frac{6606}{3.303} \\
 t &= 2000
 \end{aligned}$$

The model predicts that in 2000 there were 14.44 million accounts.

49. Recall that $5F - 9C = 160$. Let $F = C$, and solve for C .

$$\begin{aligned}
 5C - 9C &= 160 \\
 -4C &= 160 \\
 C &= \frac{160}{-4} \\
 C &= -40
 \end{aligned}$$

Therefore, $F = C$ when the temperature is -40° .

50. Let $y = 80$, and solve for x .

$$\begin{aligned}
 80 &= 1.78x - 3.998 \\
 1.78x &= 83.998 \\
 x &= \frac{83.998}{1.78} \approx 47.19
 \end{aligned}$$

Based on the model, the level will have reached 80% in approximately 1998 (rounded to the next year).

51. Let $y = 259.4$, and solve for x .

$$\begin{aligned}
 259.4 &= 0.155x + 255.37 \\
 259.4 - 255.37 &= 0.155x \\
 4.03 &= 0.155x \\
 x &= \frac{4.03}{0.155} \\
 x &= 26
 \end{aligned}$$

An x -value of 26 corresponds to the year 1996. The average reading score would be 259.4 in 1996.

52. Let $B(t) = 46.94$, and calculate t .

$$\begin{aligned}
 46.94 &= 17.69 + 2.25t \\
 2.25t &= 29.25 \\
 t &= \frac{29.25}{2.25} = 13
 \end{aligned}$$

In 1993 the per capita tax burden was \$4694.

- 53. a.** Let $P(x) = \$8000$, and calculate x .

$$8000 = 20x - 4000$$

$$20x = 12000$$

$$x = \frac{12000}{20} = 600$$

Based on the model, producing and selling 600 units will result in a profit of \$8000.

- b.** $20x - 4000 \geq 0$

$$20x \geq 4000$$

$$x \geq \frac{4000}{20} = 200$$

Based on the model, producing and selling 200 units will avoid a loss.

- 54.** $y = -0.0762x + 8.5284$

$$6.09 = -0.0762x + 8.5284$$

$$-0.0762x = -2.4384$$

$$x = \frac{-2.4384}{-0.0762} = 32$$

When x is 32, the year is 1982.

The model predicts the marriage rate was 6.09% in 1982.

- 55.** Note that p is in thousands. A population of 303,780,000 corresponds to a p -value of 303,780. Let $p = 303,780$ and solve for x .

$$303,780 = 2490x + 179,280$$

$$303,780 - 179,280 = 2490x$$

$$124,500 = 2490x$$

$$x = \frac{124,500}{2490}$$

$$x = 50$$

An x -value of 50 corresponds to the year 2010. Based on the model, in 2010 the population is estimated to be 303,780,000.

- 56.** Let $P(x) = 44\%$, and solve for x .

$$44 = 26.5x - 62$$

$$44 + 62 = 26.5x$$

$$106 = 26.5x$$

$$x = \frac{106}{26.5} = 4$$

An x -value of 4 corresponds to the year 1999. Based on the model, forty-four percent of firms recruited on the Internet in 1999.

- 57.** When the number of inmates is 1,787,000, then $y = 1,787$. Let $y = 1,787$, and calculate x .

$$1,787 = 76x + 115$$

$$1,787 - 115 = 76x$$

$$1672 = 76x$$

$$x = \frac{1672}{76} = 22$$

An x -value of 22 corresponds to the year 2012. The number of inmates is estimated to be 1,787,000 in 2012.

- 58.** Let $p = 7\%$, and solve for x .

$$30(7) - 19x = 1$$

$$210 - 19x = 1$$

$$-19x = -209$$

$$x = \frac{-209}{-19} = 11$$

When x is 11, the year is 2001. During 2001 the percentage using marijuana daily was 7%.

- 59. a.** Let $p = 49.16\%$, and solve for x .

$$\begin{aligned} 49.16 &= 63.20 - 0.26x \\ 49.16 - 63.20 &= -0.26x \\ -14.04 &= -0.26x \\ x &= \frac{-14.04}{-0.26} \\ x &= 54 \end{aligned}$$

An x -value of 54 corresponds to the year 2004. The model predicts that in 2004 the percent voting in a presidential election is 49.16%

- b.** Year 2000 corresponds with an x -value of 50. Let $x = 50$, and solve for p .

$$\begin{aligned} p &= 63.20 - 0.26(50) \\ p &= 63.20 - 13 \\ p &= 50.2 \end{aligned}$$

Based on the model the percentage of people voting in the 2000 election was approximately 50.2%. The prediction is different from what actually happened, in part due to changing conditions that cause models to not always yield accurate predictions.

- 60.** Let $I(x) = 10.951$, and solve for x .

$$\begin{aligned} 10,951 &= 386.17x + 524.32 \\ 10,951 - 524.32 &= 386.17x \\ 10,426.68 &= 386.17x \\ x &= \frac{10,426.68}{386.17} \\ x &\approx 27 \end{aligned}$$

An x -value of 27 corresponds to the year 2007. Based on the model, U.S. personal income reached \$10,951 billion in 2007.

- 61.** Let $y = 6000$, and solve for x .

$$\begin{aligned} 6000 &= 277.318x - 1424.766 \\ 277.318x &= 7424.766 \\ x &= \frac{7424.766}{277.318} \approx 26.77 \end{aligned}$$

An x -value of 27 corresponds to the year 1997. Cigarette advertising exceeded \$6 billion in 1997.

- 62.** If the number of customers is 292,980,000, then the value of $S(x)$ is 292.98. Let $S(x) = 292.98$, and solve for x .

$$\begin{aligned} 292.98 &= 18.13x + 21.03 \\ 292.98 - 21.03 &= 18.13x \\ 271.95 &= 18.13x \\ x &= \frac{271.95}{18.13} = 15 \end{aligned}$$

An x -value of 15 corresponds to the year 2010. The model indicates that there will be 292.98 million subscribers in 2010.

- 63.** Let x represent the score on the fifth exam.

$$\begin{aligned} 90 &= \frac{92 + 86 + 79 + 96 + x}{5} \\ \text{LCD: } 5 & \\ 5(90) &= 5\left(\frac{92 + 86 + 79 + 96 + x}{5}\right) \\ 450 &= 353 + x \\ x &= 97 \end{aligned}$$

The student must score 97 on the fifth exam to earn a 90 in the course.

- 64.** Since the final exam score must be higher than 79 to earn a 90 average, the 79 will be dropped from computation. Therefore, if the final exam scores is x , the student's average

$$\text{is } \frac{2x + 86 + 96}{4}.$$

To determine the final exam score that produces a 90 average, let

$$\frac{2x + 86 + 96}{4} = 90.$$

LCD: 4

$$4\left(\frac{2x + 86 + 96}{4}\right) = 4(90)$$

$$2x + 86 + 96 = 360$$

$$2x + 182 = 360$$

$$2x = 178$$

$$x = \frac{178}{2} = 89$$

The student must score at least an 89 on the final exam.

- 65.** Let x = the company's 1999 revenue in billions of dollars.

$$0.94x = 74$$

$$x = \frac{74}{0.94}$$

$$x \approx 78.723$$

The company's 1999 revenue was approximately \$78.723 billion.

- 66.** Let x = the company's 1999 revenue in billions of dollars.

$$4.79x = 36$$

$$x = \frac{36}{4.79}$$

$$x \approx 7.52$$

The company's 1999 revenue was approximately \$7.52 billion.

- 67.** Commission Reduction

$$= (20\%)(50,000)$$

$$= 10,000$$

New Commission

$$= 50,000 - 10,000$$

$$= 40,000$$

To return to a \$50,000 commission, the commission must be increased \$10,000. The percentage increase is now based on the \$40,000 commission.

Let x represent the percent increase from the second year.

$$40,000x = 10,000$$

$$x = 0.25 = 25\%$$

- 68.** Salary Reduction

$$= (5\%)(100,000)$$

$$= 5000$$

New Salary

$$= 100,000 - 5000$$

$$= 95,000$$

To return increase to a \$104,500 salary, the new \$95,000 must be increased \$9,500. The percentage increase is now based on the \$95,000 salary.

Let x represent the percent raise from the reduced salary.

$$95,000x = 9500$$

$$x = \frac{9500}{95,000} = 0.10 = 10\%$$

69. Total cost = Original price + Sales tax

Let x = original price.

$$29,998 = x + 6\%x$$

$$29,998 = x + 0.06x$$

$$29,998 = 1.06x$$

$$x = \frac{29,998}{1.06} = 28,300$$

$$\text{Sales tax} = 29,998 - 28,300 = \$1698$$

70. Let x = total in population.

$$\frac{x}{50} = \frac{50}{20}$$

$$1000\left(\frac{x}{50}\right) = 1000\left(\frac{50}{20}\right)$$

$$20x = 2500$$

$$x = \frac{2500}{20} = 125$$

The estimated population is 125 sharks.

71. $A = P + Prt$

$$A - P = P - P + Prt$$

$$A - P = Prt$$

$$\frac{A - P}{Pr} = \frac{Prt}{Pr}$$

$$\frac{A - P}{Pr} = t \text{ or } t = \frac{A - P}{Pr}$$

72. $A = P(1 + rt)$

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

73. $A = P(1 + rt)$

$$A = P + Prt$$

$$A - P = P - P + Prt$$

$$A - P = Prt$$

$$\frac{A - P}{Pt} = \frac{Prt}{Pt}$$

$$\frac{A - P}{Pt} = r$$

$$\frac{3200 - 2000}{2000(6)} = r$$

$$\frac{1200}{12000} = \frac{1}{10} = r$$

$$r = .1 = 10\%$$

74. $A = P(1 + rt)$

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

$$\frac{5888}{1 + .07(12)} = P$$

$$P = \$3200$$

75. $\frac{I_1}{r_1} = \frac{I_2}{r_2}$

$$\frac{920}{.12} = \frac{x}{.08}$$

$$x = \frac{920(.08)}{.12} = \$613.33$$

76. $\frac{I_1}{t_1} = \frac{I_2}{t_2}$

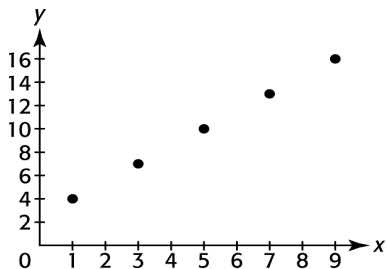
$$\frac{4903.65}{5} = \frac{7845.84}{x}$$

$$x = \frac{7845.84(5)}{4903.65} = 8 \text{ years}$$

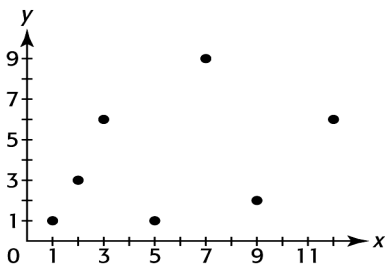
Section 2.2 Skills Check

- No. The data points do not lie approximately in a straight line.
- Yes. The data points lie approximately in a straight line.
- Can be modeled approximately since not all points lie exactly on a line.
- Can be modeled exactly since all points line up with a straight edge.

5.

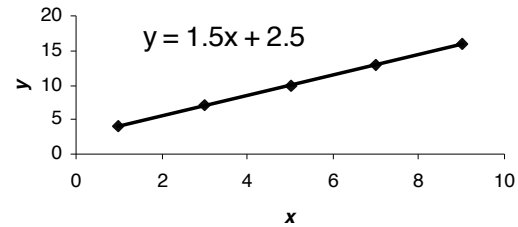


6.

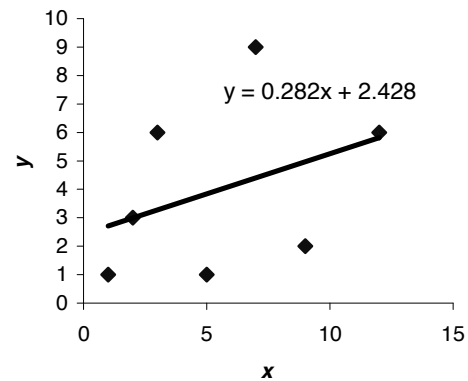


- Exactly. The first differences of the outputs are constantly three.
- No. The first differences are not constant. Also, a line will not connect perfectly the points on the scatter plot.

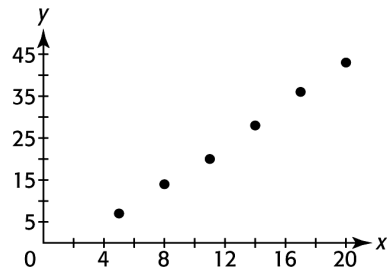
9. Using a spreadsheet program yields



10. Using a spreadsheet program yields

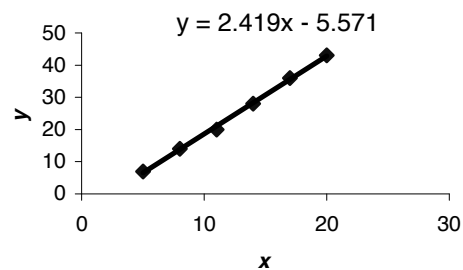


11.

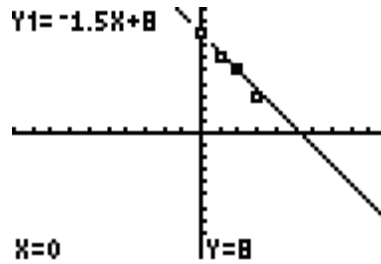
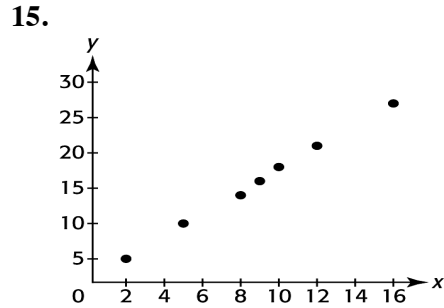
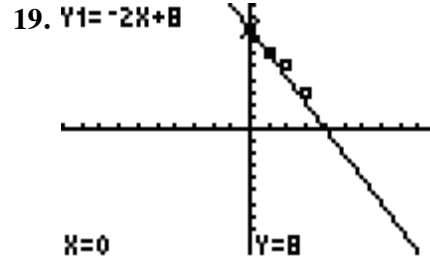


12. Yes. The points appear to lie approximately along a line.

13. Using a spreadsheet program yields

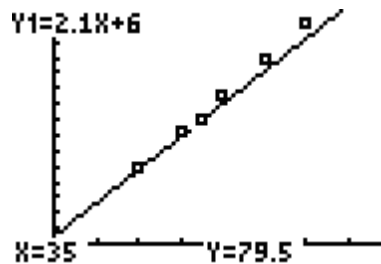
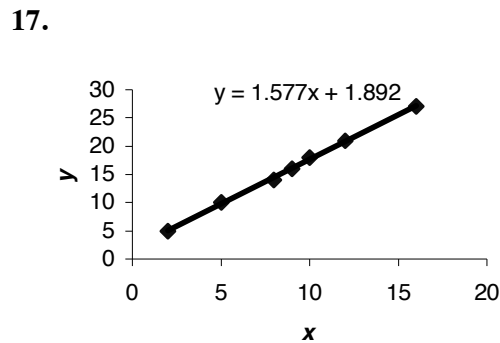


14. $f(3) = 2.419(3) - 5.5714$
 $= 7.257 - 5.5714$
 $= 1.6856 \approx 1.7$
 $f(5) = 2.419(5) - 5.5714$
 $= 12.095 - 5.5714$
 $= 6.5236 \approx 6.5$



The second equation, $y = -1.5x + 8$, is a better fit to the data points.

16. Yes. The points appear to lie approximately along a line.



18. $f(3) = 1.577(3) + 1.892$
 $= 4.731 + 1.892$
 $= 6.623 \approx 6.6$
 $f(5) = 1.577(5) + 1.892$
 $= 7.885 + 1.892$
 $= 9.777 \approx 9.8$

The first equation, $y = 2.3x + 4$, is a better fit to the data points.

- 21. a.** Exactly linear. The first differences are constant.
- b.** Nonlinear. The first differences increase continuously.
- c.** Approximately linear. The first differences vary, but don't grow continuously.
- 22.** The difference between inputs is not constant. The inputs are not equally spaced.

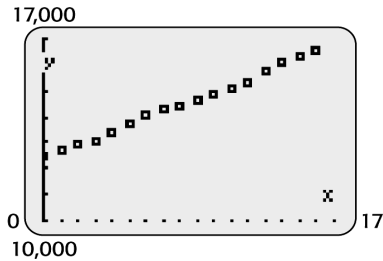
Section 2.2 Exercises

- 23. a.** Discrete. The ratio is calculated each year, and the years are one unit apart, in increments of 10 years.
- b.** No. A line would not fit the points on the scatter plot.
- c.** Yes. Beginning in 2010, a line would fit the points on the scatter plot well.
- 24. a.** Discrete. There are gaps between the years.
- b.** Continuous. Gaps between the years no longer exist.
- c.** No. A line would not fit the points on the scatter plot. A non-linear function is best.
- 25. a.** Yes. There is a one unit gap between the years and a constant 60 unit gap in future values.
- b.** $S = f(t) = 60t + 1000$, where 60 is the constant rate of change and (0, 1000) is the y-intercept.
- c.** For $t = 7$, $S(7) = 60(7) + 1000 = 1420$. Thus the future value of this investment at the end of the 7th year is \$1420. This is an extrapolation since the result is beyond the original table values.
- d.** Discretely, since the payments occur only at the end of the years.
- 26.** No. The first differences are not constant.
- 27. a.** Yes, the first differences are constant for uniform inputs.
- b.** $T = 0.15x - 782.50$

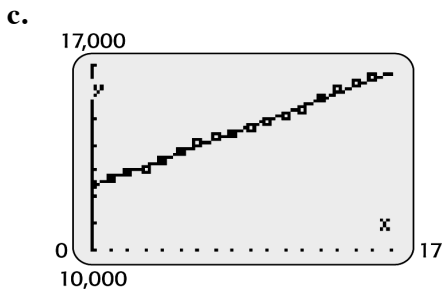
- c. For $x = 30,100$, $T = \$3732.50$, and for $x = 30,300$, $T = \$3762.50$. These results agree with the values found in the table.
- d. For $x = 30,125$, $T = \$3736.25$. Since 30,125 is within the given tables values, the result is an interpolation from the data.
- e. No, just for income in the 15% tax bracket.

28. a. No, the first differences are not equal.

29. a. Using a spreadsheet program yields



b. $y = 253.267x + 12,409.686$



The model and the scatterplot appear to be a good fit.

30. a. Using a spreadsheet program yields



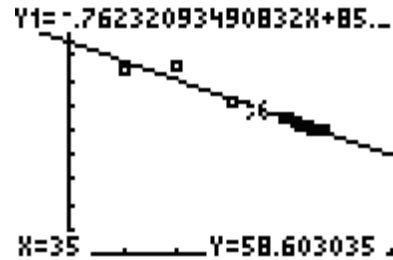
b. Let $x = 1985 - 1950 = 35$, and solve for y .

$$y = -0.762(35) + 85.284$$

$$y = 58.614 \approx 58.6$$

The model predicts 58.6 marriages per 1000 unmarried women.

Using the unrounded model yields



$[-10, 60]$ by $[0, 100]$

c. Let $y = 50$, and solve for x .

$$50 = -0.762x + 85.284$$

$$50 - 85.284 = -0.762x$$

$$-0.762x = -35.284$$

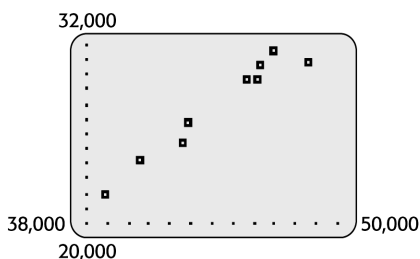
$$x = \frac{-35.284}{-0.762} = 46.304 \approx 46.3$$

50 marriages per 1000 unmarried women occurs in approximately 1997.

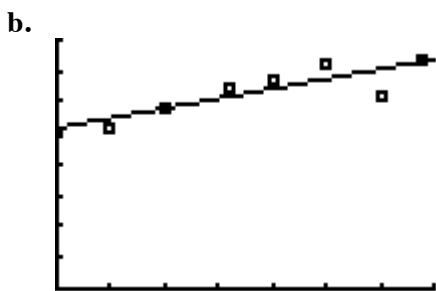
d. The answer in part c) is an approximation based on the model. Considering the data, the marriage rate fell below 50 in 1996.

- 31. a.** $y = 17.906x + 857.886$
- b.** For $x = 9$, $y = 1019.04$ million, or 1.01904 billion.
- c.** Let $y = 983.23$, and solve for x .
 $983.23 = 17.906x + 857.886$
 $125.344 = 17.906x$
 $x \approx 7$
 $1999 + 7 = 2006$
 Thus in the year 2006, there were 983.23 million people who took trips of 50 miles or more.

- 32. a.** Using a spreadsheet program yields



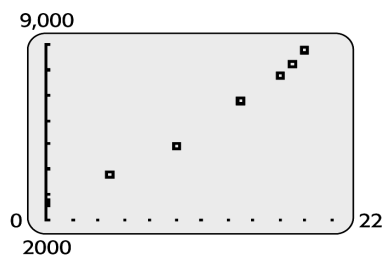
- b.** $y = 1.052x - 18691.28$
- c.** The slope is 1.052, and for each increase of \$1.00 of median salary for whites, the black median salary will increase by \$1.05.
- 33. a.** $y = 0.316x + 25.860$



[0, 35] by [0, 40]
 Not close to an exact fit.

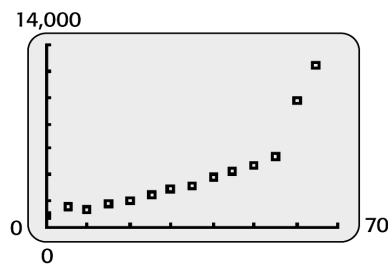
- 34. a.** $y = 10.53x + 112.86$
- b.** When the CPI = 449.82, $x = 32$, which represents the year 2017, 32 years after 1985.

- 35. a.** Using a spreadsheet program yields

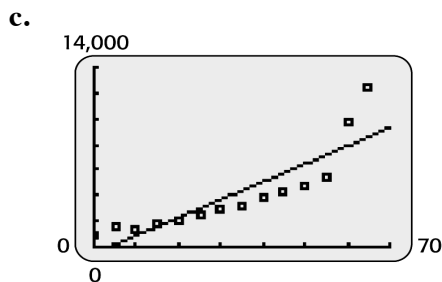


- b.** Yes the fit appears to be a reasonable one for this data.
- c.** $y = 299.635x + 2409.236$
- d.** The U.S. personal consumption for 2008 is estimated to be \$9300.84 billion.

- 36. a.** Using a spreadsheet program yields

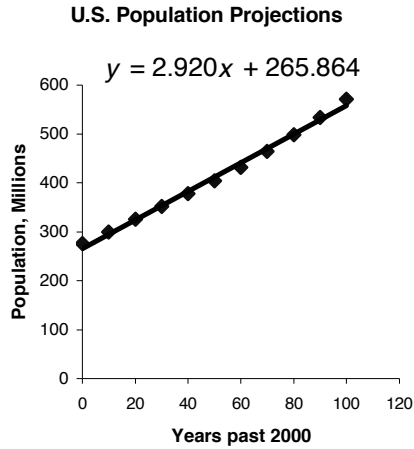


- b.** $y = 139.415x - 509.543$

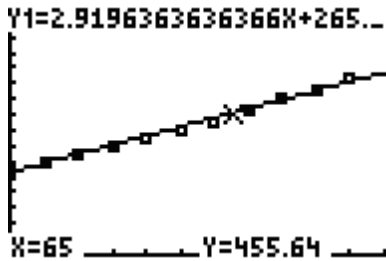


Not a good fit.

37. a. Using a spreadsheet program yields



b. Using the unrounded model,
 $f(65) \approx 455.64$.

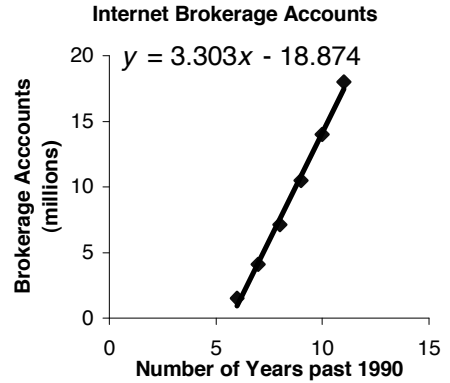


[0, 100] by [0, 800]

In 2065, the projected U.S. population is 455.64 million or 455,640,000.

c. In 2080, $x = 80$. The population is predicted to be 499.5 million people, fairly close to the value in the table.

38. a. Using a spreadsheet program yields



b. Considering the slope of the linear model, a one year increase in time corresponds to a 3.3 million unit increase in Internet brokerage accounts.

c. Let $y = 20$, and solve for x .

$$20 = 3.303x - 18.874$$

$$20 + 18.874 = 3.303x$$

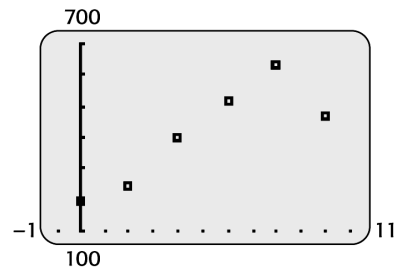
$$38.874 = 3.303x$$

$$x = \frac{38.874}{3.303} = 11.7693 \approx 11.77$$

Based on the model, the number of Internet brokerage accounts will be 20 million in the year 2002.

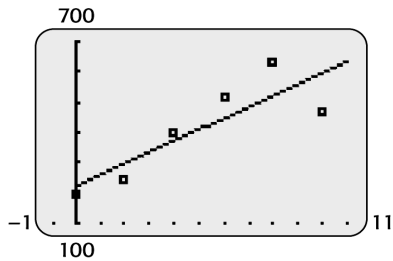
d. The model may no longer be valid due to economic and social instability resulting from the terrorist attacks on September 11, 2001.

39. a. Using a spreadsheet program yields



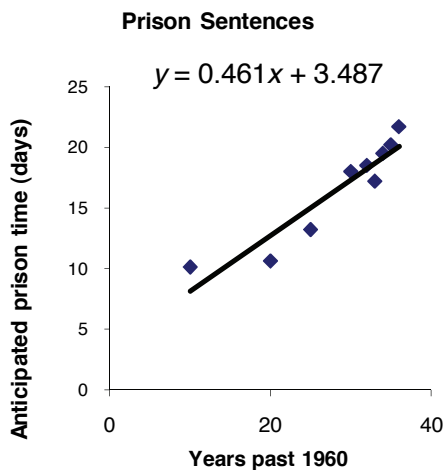
b. $y = 37.7x + 221.333$

c.



A line will not fit this data well.

40. a. Using a spreadsheet program yields



b. Let $x = 15$, and solve for y .

$$y = 0.461(15) + 3.487$$

$$y = 10.402$$

Based on the model the anticipated prison time in 1975 is approximately 10.4 days.

c. Let $y = 23$, and solve for x :

$$23 = 0.461x + 3.487$$

$$19.513 = 0.461x$$

$$x = 42.3$$

Based on the model, the anticipated prison time of 23 days occurred in the year 2002.

41. a. $P = 17W + 25$

b. Fits exactly

c. For $W = 6$, $P = 127$ cents, or \$1.27.

d. Discretely.

42. a. $P = 0.388W + 3.49$

b. It is not a perfect fit.

c. Discretely.

43. a. $y = -0.720x + 37.644$

b. For $x = 21$ (2006 – 1985), $y = 22.5$.

c. When $y = 0$, indicating zero percent of U.S. residents smoking, $x = 52.283$. This indicates that in the year 2038 (1985 + 52.3), the percent is zero and beyond that year, the percent would be negative.

44. a. $y = 9.029x + 70.343$, where $x = 0$ in 1990.

b. For $x = 15$ (2005 – 1990), $y = 206$

c. Let $y = 115$, and solve for x :

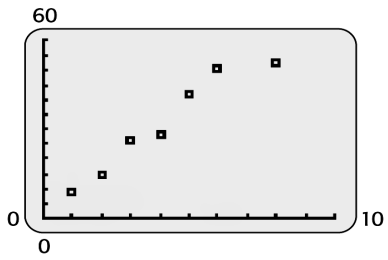
$$115 = 9.029x + 70.343$$

$$44.657 = 9.029x$$

$$x = 4.946$$

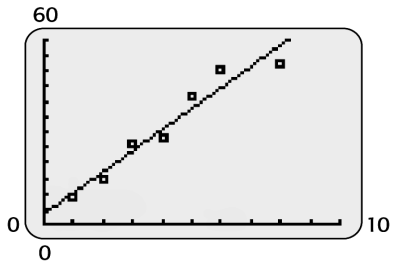
Thus in 1995 (1990 + 4.9 years), the average daily number of inmates was 115.

45. a.



b. $y = 6.888x + 3.180$

c.



The model fits the data well.

Section 2.3 Skills Check

1. Applying the substitution method

$$y = 3x - 2 \text{ and } y = 3 - 2x$$

$$3 - 2x = 3x - 2$$

$$3 - 2x - 3x = 3x - 3x - 2$$

$$3 - 5x = -2$$

$$-5x = -5$$

$$x = 1$$

Substituting to find y

$$y = 3(1) - 2 = 1$$

(1,1) is the intersection point.

2. Applying the elimination method

$$\begin{cases} 3x + 2y = 5 & (\text{Eq 1}) \\ 5x - 3y = 21 & (\text{Eq 2}) \end{cases}$$

$$\begin{cases} 3x + 2y = 5 & 3 \times (\text{Eq 1}) \\ 5x - 3y = 21 & 2 \times (\text{Eq 2}) \end{cases}$$

$$\begin{cases} 9x + 6y = 15 & 3 \times (\text{Eq 1}) \\ 10x - 6y = 42 & 2 \times (\text{Eq 2}) \end{cases}$$

$$\begin{cases} 9x + 6y = 15 & 3 \times (\text{Eq 1}) \\ 10x - 6y = 42 & 2 \times (\text{Eq 2}) \end{cases}$$

$$19x = 57$$

$$x = \frac{57}{19} = 3$$

Substituting to find y

$$3(3) + 2y = 5$$

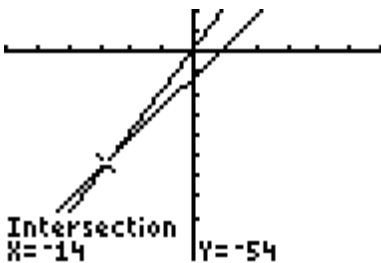
$$9 + 2y = 5$$

$$2y = -4$$

$$y = -2$$

(3,-2) is the intersection point.

3. Applying the intersection of graphs method,
-
- for
- $y = 3x - 12$
- and
- $y = 4x + 2$



[-30, 30] by [-100, 20]

The solution is (-14, -54).

4. Solving the equations for
- y

$$2x - 4y = 6$$

$$-4y = -2x + 6$$

$$y = \frac{-2x + 6}{-4}$$

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

and

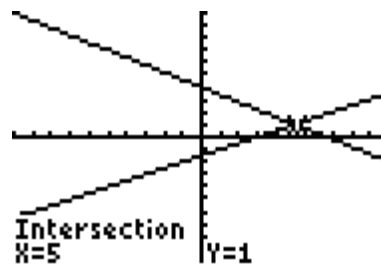
$$3x + 5y = 20$$

$$5y = -3x + 20$$

$$y = \frac{-3x + 20}{5}$$

$$y = -\frac{3}{5}x + 4$$

Applying the intersection of graphs method



[-10, 10] by [-10, 10]

The solution is (5,1).

5. Solving the equations for y

$$4x - 3y = -4$$

$$-3y = -4x - 4$$

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

$$y = \frac{4}{3}x + \frac{4}{3}$$

and

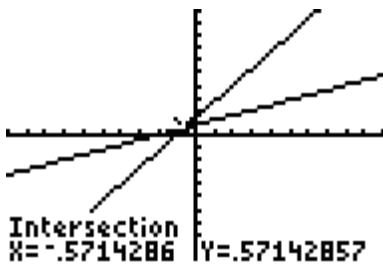
$$2x - 5y = -4$$

$$-5y = -2x - 4$$

$$y = \frac{-2x - 4}{-5}$$

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

Applying the intersection of graphs method



[-10, 10] by [-10, 10]

The solution is $(-0.5714, 0.5714)$ or

$$\left(-\frac{4}{7}, \frac{4}{7}\right).$$

6. Solving the equations for y

$$5x - 6y = 22$$

$$-6y = -5x + 22$$

$$y = \frac{-5x + 22}{-6}$$

$$y = \frac{5}{6}x - \frac{11}{3}$$

and

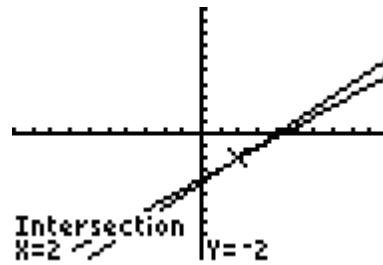
$$4x - 4y = 16$$

$$-4y = -4x + 16$$

$$y = \frac{-4x + 16}{-4}$$

$$y = x - 4$$

Applying the intersection of graphs method



[-10, 10] by [-10, 10]

The solution is $(2, -2)$.

7.
$$\begin{cases} 2x + 5y = 6 & (Eq 1) \\ x + 2.5y = 3 & (Eq 2) \end{cases}$$
- $$\begin{cases} 2x + 5y = 6 & (Eq 1) \\ -2x - 5y = -6 & -2 \times (Eq 2) \end{cases}$$
- $$0 = 0$$

There are infinitely many solutions to the system. The graphs of both equations represent the same line.

$$8. \begin{cases} 6x + 4y = 3 & (Eq 1) \\ 3x + 2y = 3 & (Eq 2) \end{cases}$$

$$\begin{cases} 6x + 4y = 3 & (Eq 1) \\ -6x - 4y = -6 & -2 \times (Eq 2) \end{cases}$$

$$0 = -3$$

There is no solution to the system. The graphs of the equations represent parallel lines.

$$9. \begin{cases} x = 5y + 12 \\ 3x + 4y = -2 \end{cases}$$

Substituting the first equation into the second equation

$$3(5y + 12) + 4y = -2$$

$$15y + 36 + 4y = -2$$

$$19y + 36 = -2$$

$$19y = -38$$

$$y = -2$$

Substituting to find x

$$x = 5(-2) + 12$$

$$x = -10 + 12$$

$$x = 2$$

The solution is $(2, -2)$.

$$10. \begin{cases} 2x - 3y = 2 \\ y = 5x - 18 \end{cases}$$

Substituting the second equation into the first equation

$$2x - 3(5x - 18) = 2$$

$$2x - 15x + 54 = 2$$

$$-13x + 54 = 2$$

$$-13x = -52$$

$$x = 4$$

Substituting to find y

$$2(4) - 3y = 2$$

$$8 - 3y = 2$$

$$-3y = -6$$

$$y = 2$$

The solution is $(4, 2)$.

$$11. \begin{cases} 2x - 3y = 5 \\ 5x + 4y = 1 \end{cases}$$

Solving the first equation for x

$$2x - 3y = 5$$

$$2x = 3y + 5$$

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

Substituting into the second equation

$$5\left(\frac{3y + 5}{2}\right) + 4y = 1$$

$$2\left[5\left(\frac{3y + 5}{2}\right) + 4y\right] = 2[1]$$

$$15y + 25 + 8y = 2$$

$$23y + 25 = 2$$

$$23y = -23$$

$$y = -1$$

Substituting to find x

$$2x - 3(-1) = 5$$

$$2x + 3 = 5$$

$$2x = 2$$

$$x = 1$$

The solution is $(1, -1)$.

$$12. \begin{cases} 4x - 5y = -17 \\ 3x + 2y = -7 \end{cases}$$

Solving the first equation for x

$$4x - 5y = -17$$

$$4x = 5y - 17$$

$$x = \frac{5y - 17}{4}$$

Substituting into the second equation

$$3\left(\frac{5y - 17}{4}\right) + 2y = -7$$

$$4\left[3\left(\frac{5y - 17}{4}\right) + 2y\right] = 4[-7]$$

$$15y - 51 + 8y = -28$$

$$23y - 51 = -28$$

$$23y = 23$$

$$y = 1$$

Substituting to find x

$$4x - 5(1) = -17$$

$$4x - 5 = -17$$

$$4x = -12$$

$$x = -3$$

The solution is $(-3, 1)$.

$$13. \begin{cases} x + 3y = 5 & (Eq1) \\ 2x + 4y = 8 & (Eq2) \end{cases}$$

$$\begin{cases} -2x - 6y = -10 & -2 \times (Eq1) \\ 2x + 4y = 8 & (Eq2) \end{cases}$$

$$-2y = -2$$

$$y = 1$$

Substituting to find x

$$x + 3(1) = 5$$

$$x + 3 = 5$$

$$x = 2$$

The solution is $(2, 1)$.

$$14. \begin{cases} 4x - 3y = -13 & (Eq1) \\ 5x + 6y = 13 & (Eq2) \end{cases}$$

$$\begin{cases} 8x - 6y = -26 & 2 \times (Eq1) \\ 5x + 6y = 13 & (Eq2) \end{cases}$$

$$13x = -13$$

$$x = -1$$

Substituting to find y

$$4(-1) - 3y = -13$$

$$-4 - 3y = -13$$

$$-3y = -9$$

$$y = 3$$

The solution is $(-1, 3)$.

$$15. \begin{cases} 5x + 3y = 8 & (Eq1) \\ 2x + 4y = 8 & (Eq2) \end{cases}$$

$$\begin{cases} -10x - 6y = -16 & -2 \times (Eq1) \\ 10x + 20y = 40 & 5 \times (Eq2) \end{cases}$$

$$14y = 24$$

$$y = \frac{24}{14} = \frac{12}{7}$$

Substituting to find x

$$2x + 4\left(\frac{12}{7}\right) = 8$$

$$7\left[2x + \left(\frac{48}{7}\right)\right] = 7[8]$$

$$14x + 48 = 56$$

$$14x = 8$$

$$x = \frac{8}{14} = \frac{4}{7}$$

The solution is $\left(\frac{4}{7}, \frac{12}{7}\right)$.

$$16. \begin{cases} 3x + 3y = 5 & (Eq1) \\ 2x + 4y = 8 & (Eq2) \end{cases}$$

$$\begin{cases} -12x - 12y = -20 & -4 \times (Eq1) \\ 6x + 12y = 24 & 3 \times (Eq2) \end{cases}$$

$$-6x = 4$$

$$x = \frac{4}{-6} = -\frac{2}{3}$$

Substituting to find y

$$3\left(-\frac{2}{3}\right) + 3y = 5$$

$$-2 + 3y = 5$$

$$3y = 7$$

$$y = \frac{7}{3}$$

The solution is $\left(-\frac{2}{3}, \frac{7}{3}\right)$.

$$17. \begin{cases} 0.3x + 0.4y = 2.4 & (Eq1) \\ 5x - 3y = 11 & (Eq2) \end{cases}$$

$$\begin{cases} 9x + 12y = 72 & 30 \times (Eq1) \\ 20x - 12y = 44 & 4 \times (Eq2) \end{cases}$$

$$29x = 116$$

$$x = \frac{116}{29} = 4$$

Substituting to find y

$$5(4) - 3y = 11$$

$$20 - 3y = 11$$

$$-3y = -9$$

$$y = 3$$

The solution is $(4, 3)$.

$$18. \begin{cases} 8x - 4y = 0 & (Eq1) \\ 0.5x + 0.3y = 2.2 & (Eq2) \end{cases}$$

$$\begin{cases} 24x - 12y = 0 & 3 \times (Eq1) \\ 20x + 12y = 88 & 40 \times (Eq2) \end{cases}$$

$$44x = 88$$

$$x = 2$$

Substituting to find y

$$8(2) - 4y = 0$$

$$16 - 4y = 0$$

$$4y = 16$$

$$y = 4$$

The solution is (2,4).

$$19. \begin{cases} 3x + 6y = 12 & (Eq1) \\ 2x + 4y = 8 & (Eq2) \end{cases}$$

$$\begin{cases} -6x - 12y = -24 & -2 \times (Eq1) \\ 6x + 12y = 24 & 3 \times (Eq2) \end{cases}$$

$$0 = 0$$

Infinitely many solutions. The lines are the same. This is a dependent system.

$$20. \begin{cases} -4x + 6y = 12 & (Eq1) \\ 10x - 15y = -30 & (Eq2) \end{cases}$$

$$\begin{cases} -20x + 30y = 60 & 5 \times (Eq1) \\ 20x - 30y = -60 & 2 \times (Eq2) \end{cases}$$

$$0 = 0$$

Infinitely many solutions. The lines are the same. This is a dependent system.

$$21. \begin{cases} 6x - 9y = 12 & (Eq1) \\ 3x - 4.5y = -6 & (Eq2) \end{cases}$$

$$\begin{cases} 6x - 9y = 12 & (Eq1) \\ -6x + 9y = 12 & -2 \times (Eq2) \end{cases}$$

$$0 = 24$$

No solution. Lines are parallel.

$$22. \begin{cases} 4x - 8y = 5 & (Eq1) \\ 6x - 12y = 10 & (Eq2) \end{cases}$$

$$\begin{cases} 12x - 24y = 15 & 3 \times (Eq1) \\ -12x + 24y = -20 & -2 \times (Eq2) \end{cases}$$

$$0 = -5$$

No solution. Lines are parallel.

$$23. \begin{cases} y = 3x - 2 \\ y = 5x - 6 \end{cases}$$

Substituting the first equation into the second equation

$$3x - 2 = 5x - 6$$

$$-2x - 2 = -6$$

$$-2x = -4$$

$$x = 2$$

Substituting to find y

$$y = 3(2) - 2 = 6 - 2 = 4$$

The solution is (2,4).

$$24. \begin{cases} y = 8x - 6 \\ y = 14x - 12 \end{cases}$$

Substituting the first equation into the second equation

$$8x - 6 = 14x - 12$$

$$-6x = -6$$

$$x = 1$$

Substituting to find y

$$y = 14(1) - 12$$

$$y = 2$$

The solution is (1,2).

$$25. \begin{cases} 4x + 6y = 4 \\ x = 4y + 8 \end{cases}$$

Substituting the second equation into the first equation

$$4(4y + 8) + 6y = 4$$

$$16y + 32 + 6y = 4$$

$$22y + 32 = 4$$

$$22y = -28$$

$$y = \frac{-28}{22} = -\frac{14}{11}$$

Substituting to find x

$$x = 4\left(-\frac{14}{11}\right) + 8$$

$$x = -\frac{56}{11} + \frac{88}{11} = \frac{32}{11}$$

The solution is $\left(\frac{32}{11}, -\frac{14}{11}\right)$.

$$26. \begin{cases} y = 4x - 5 \\ 3x - 4y = 7 \end{cases}$$

Substituting the first equation into the second equation

$$3x - 4(4x - 5) = 7$$

$$3x - 16x + 20 = 7$$

$$-13x = -13$$

$$x = 1$$

Substituting to find y

$$y = 4(1) - 5$$

$$y = -1$$

The solution is $(1, -1)$.

$$27. \begin{cases} 2x - 5y = 16 & (Eq1) \\ 6x - 8y = 34 & (Eq2) \end{cases}$$

$$\begin{cases} -6x + 15y = -48 & -3 \times (Eq1) \\ 6x - 8y = 34 & (Eq2) \end{cases}$$

$$7y = -14$$

$$y = -2$$

Substituting to find x

$$2x - 5(-2) = 16$$

$$2x + 10 = 16$$

$$2x = 6$$

$$x = 3$$

The solution is $(3, -2)$.

$$28. \begin{cases} 4x - y = 4 & (Eq1) \\ 6x + 3y = 15 & (Eq2) \end{cases}$$

$$\begin{cases} 12x - 3y = 12 & 3 \times (Eq1) \\ 6x + 3y = 15 & (Eq2) \end{cases}$$

$$18x = 27$$

$$x = \frac{27}{18} = \frac{3}{2}$$

Substituting to find y

$$4\left(\frac{3}{2}\right) - y = 4$$

$$6 - y = 4$$

$$-y = -2$$

$$y = 2$$

The solution is $\left(\frac{3}{2}, 2\right)$.

$$29. \begin{cases} 3x - 7y = -1 & (Eq1) \\ 4x + 3y = 11 & (Eq2) \end{cases}$$

$$\begin{cases} -12x + 28y = 4 & -4 \times (Eq1) \\ 12x + 9y = 33 & 3 \times (Eq2) \end{cases}$$

$$37y = 37$$

$$y = \frac{37}{37} = 1$$

Substituting to find x

$$3x - 7(1) = -1$$

$$3x - 7 = -1$$

$$3x = 6$$

$$x = 2$$

The solution is $(2, 1)$.

$$30. \begin{cases} 5x - 3y = 12 & (Eq1) \\ 3x - 5y = 8 & (Eq2) \end{cases}$$

$$\begin{cases} -15x + 9y = -36 & -3 \times (Eq1) \\ 15x - 25y = 40 & 5 \times (Eq2) \end{cases}$$

$$-16y = 4$$

$$y = \frac{4}{-16} = -\frac{1}{4}$$

Substituting to find x

$$5x - 3\left(-\frac{1}{4}\right) = 12$$

$$5x + \frac{3}{4} = 12$$

$$4\left(5x + \frac{3}{4}\right) = 4(12)$$

$$20x + 3 = 48$$

$$20x = 45$$

$$x = \frac{45}{20} = \frac{9}{4}$$

The solution is $\left(\frac{9}{4}, -\frac{1}{4}\right)$.

$$31. \begin{cases} 4x - 3y = 9 & (Eq1) \\ 8x - 6y = 16 & (Eq2) \end{cases}$$

$$\begin{cases} -8x + 6y = -18 & -2 \times (Eq1) \\ 8x - 6y = 16 & (Eq2) \end{cases}$$

$$0 = -2$$

No solution. Lines are parallel.

$$32. \begin{cases} 5x - 4y = 8 & (Eq1) \\ -15x + 12y = -12 & (Eq2) \end{cases}$$

$$\begin{cases} 15x - 12y = 24 & 3 \times (Eq1) \\ -15x + 12y = -12 & (Eq2) \end{cases}$$

$$0 = 12$$

No solution. Lines are parallel.

Section 2.3 Exercises

33. $R = C$

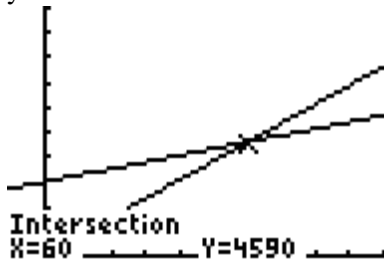
$$76.50x = 2970 + 27x$$

$$49.50x = 2970$$

$$x = \frac{2970}{49.50}$$

$$x = 60$$

Applying the intersections of graphs method yields $x = 60$.



$[-10, 100]$ by $[-10, 10,000]$

Break-even occurs when the number of units produced and sold is 60.

34. $R = C$

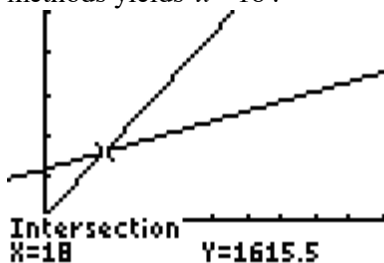
$$89.75x = 23.50x + 1192.50$$

$$66.25x = 1192.50$$

$$x = \frac{1192.50}{66.25}$$

$$x = 18$$

Applying the intersections of graphs methods yields $x = 18$.



$[-10, 100]$ by $[-1000, 5000]$

Break-even occurs when the number of units produced and sold is 18.

35. $R = C$

$$136.50x = 9661.60 + 43.60x$$

$$92.90x = 9661.60$$

$$x = \frac{9661.60}{92.90}$$

$$x = 104$$

Break-even occurs when the number of units produced and sold is 104.

36. $R = C$

$$15.80x = 8593.20 + 3.20x$$

$$12.60x = 8593.20$$

$$x = \frac{8593.20}{12.60}$$

$$x = 682$$

Break-even occurs when the number of units produced and sold is 682.

37. a. Let $p = 60$ and solve for q .

Supply function

$$60 = 5q + 20$$

$$5q = 40$$

$$q = 8$$

Demand function

$$60 = 128 - 4q$$

$$-4q = -68$$

$$q = \frac{-68}{-4} = 17$$

When the price is \$60, the quantity supplied is 8, while the quantity demanded is 17.

- b. Equilibrium occurs when the demand equals the supply,

$$5q + 20 = 128 - 4q$$

$$9q + 20 = 128$$

$$9q = 108$$

$$q = \frac{108}{9} = 12$$

Substituting to calculate the price p :

$$p = 5(12) + 20 = 80$$

When the price is \$80, 12 units are produced and sold. This level of production and price represents equilibrium.

$$38. \begin{cases} p + 2q = 320 & (Eq1) \\ p - 8q = 20 & (Eq2) \end{cases}$$

$$\begin{cases} 4p + 8q = 1280 & 4 \times (Eq1) \\ p - 8q = 20 & (Eq2) \end{cases}$$

$$5p = 1300$$

$$p = \frac{1300}{5} = 260$$

Substituting to find the quantity q :

$$260 - 8q = 20$$

$$-8q = -240$$

$$q = \frac{-240}{-8} = 30$$

Equilibrium occurs when 30 units are demanded and supplied at a price of \$260 per unit.

39. Equilibrium occurs when the demand equals the supply,

$$1 + .02q = 4 - .01q$$

$$.03q = 3$$

$$q = 100$$

Substituting to calculate the price p :

$$p = 1 + .02(100) = \$3$$

When the price is \$3, the market equilibrium for the studs will be reached.

40. Equilibrium occurs when the demand equals the supply,

$$50.50 + .80q = 400 - .70q$$

$$1.50q = 349.50$$

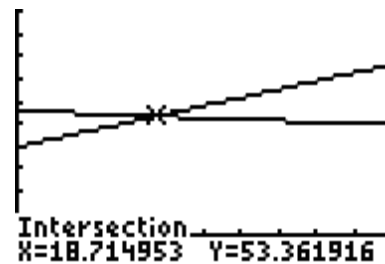
$$q = 233$$

Substituting to calculate the price p :

$$p = 50.50 + .80(233) = \$236.90$$

When the price is \$236.90, the market equilibrium for the printers will be reached.

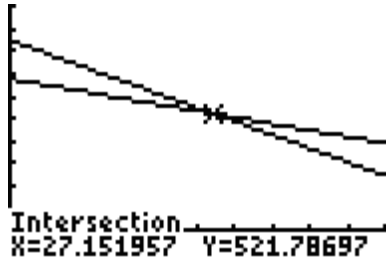
41. Applying the intersection of graphs method



$[0, 50]$ by $[-10, 100]$

The solution is $(18.715, 53.362)$. The percentage of male students enrolled in college within 12 months of high school graduation equals the percentage of female students enrolled in college within 12 months of high school graduation in 1979.

42. a. Applying the intersection of graphs method



$[0, 50]$ by $[-100, 1000]$

The solution is $(27.152, 521.787)$. The number of active duty Navy personnel equals the number of active duty Air Force personnel in 1987.

- b. Considering the solution in part *a*, approximately 521,787 people will be on active duty in each service branch.

$$43. \begin{cases} B_1 = 0.6234W + 0.3785 \\ B_2 = 1.05W - 18.691 \end{cases}$$

Setting the first equation equal to the second equation:

$$0.6234W + 0.3785 = 1.05W - 18.691$$

$$-0.4266W = -19.0695$$

$$W = \frac{-19.0695}{-0.4266} = \$44,701$$

Thus, the annual earning amount by whites that will give the same median annual earnings for blacks in both models is \$44,701.

$$44. a. \begin{cases} y = 24.5x + 93.5 \\ y = -0.2x + 1007 \end{cases}$$

Substituting the first equation into the second equation

$$24.5x + 93.5 = -0.2x + 1007$$

$$10(24.5x + 93.5) = 10(-0.2x + 1007)$$

$$245x + 935 = -2x + 10,070$$

$$247x + 935 = 10,070$$

$$247x = 9135$$

$$x = \frac{9135}{247} = 36.9838 \approx 37$$

- b. In $1990 + 37 = 2027$, mint sales and gum sales are equal.
- c. The graphs are misleading. Notice that the scales are different. Mint sales are measured between \$0 and \$300 million, while gum sales are measured between \$0 and \$1000 million. Also note that the first tick mark on the y-axis for each graph represents inconsistent units when compared with the remainder of the graph.

45. Let l = the 2008 revenue, and let h = the 2009 revenue.

$$\begin{cases} h + 2l = 2144.9 & (Eq1) \end{cases}$$

$$\begin{cases} h - l = 135.5 & (Eq2) \end{cases}$$

$$\begin{cases} h + 2l = 2144.9 & (Eq1) \\ 2h - 2l = 271 & 2 \times (Eq2) \end{cases}$$

$$3h = 2415.9$$

$$3h = 2415.9$$

$$h = \frac{2415.9}{3} = 805.3$$

Substituting to calculate l

$$805.3 - l = 135.5$$

$$-l = -669.8$$

$$l = 669.8$$

The 2008 revenue is \$669.8 million, while the 2009 revenue is \$805.3 million.

46. Let l = the low stock price, and let h = the high stock price.

$$\begin{cases} h + l = 83.5 & (Eq1) \\ h - l = 21.88 & (Eq2) \end{cases}$$

$$\begin{cases} h + l = 83.5 & (Eq1) \\ h - l = 21.88 & (Eq2) \end{cases}$$

$$2h = 105.38$$

$$h = \frac{105.38}{2} = 52.69$$

Substituting to calculate l

$$52.69 + l = 83.5$$

$$l = 30.81$$

The high stock price is \$52.69, while the low stock price is \$30.81.

47. a. $x + y = 2400$

b. $30x$

c. $45y$

d. $30x + 45y = 84,000$

e.

$$\begin{cases} x + y = 2400 & (Eq1) \\ 30x + 45y = 84,000 & (Eq2) \end{cases}$$

$$\begin{cases} 30x + 45y = 84,000 & (Eq2) \\ -30x - 30y = -72,000 & -30 \times (Eq1) \end{cases}$$

$$\begin{cases} -30x - 30y = -72,000 & -30 \times (Eq1) \\ 30x + 45y = 84,000 & (Eq2) \end{cases}$$

$$15y = 12,000$$

$$y = \frac{12,000}{15} = 800$$

Substituting to calculate x

$$x + 800 = 2400$$

$$x = 1600$$

The promoter needs to sell 1600 tickets at \$30 per ticket and 800 tickets at \$45 per ticket.

48. a. $x + y = 250,000$

b. $10\%x$ or $0.10x$

c. $12\%y$ or $0.12y$

d. $0.10x + 0.12y = 26,500$

$$\begin{cases} x + y = 250,000 & (Eq1) \\ 0.10x + 0.12y = 26,500 & (Eq2) \end{cases}$$

$$-0.10x - 0.10y = -25,000 \quad -0.10 \times (Eq1)$$

$$0.10x + 0.12y = 26,500 \quad (Eq2)$$

$$0.02y = 1500$$

$$y = \frac{1500}{0.02} = 75,000$$

Substituting to calculate x

$$x + 75,000 = 250,000$$

$$x = 175,000$$

\$175,000 is invested in the 10% property, and \$75,000 is invested in the 12% property.

49. a. Let x = the amount in the safer account, and let y = the amount in the riskier account.

$$\begin{cases} x + y = 100,000 & (Eq1) \\ 0.08x + 0.12y = 9000 & (Eq2) \end{cases}$$

$$-0.08x - 0.08y = -8000 \quad -0.08 \times (Eq1)$$

$$0.08x + 0.12y = 9000 \quad (Eq2)$$

$$0.04y = 1000$$

$$y = \frac{1000}{0.04} = 25,000$$

Substituting to calculate x

$$x + 25,000 = 100,000$$

$$x = 75,000$$

\$75,000 is invested in the 8% account, and \$25,000 is invested in the 12% account.

- b. Using two accounts minimizes investment risk.

- 50.** Let x = the amount in the safer fund, and
let y = the amount in the riskier fund.

$$\begin{cases} x + y = 52,000 & (Eq1) \\ 0.10x + 0.14y = 5720 & (Eq2) \end{cases}$$

$$-0.10x - 0.10y = -5200 \quad -0.10 \times (Eq1)$$

$$0.10x + 0.14y = 5720 \quad (Eq2)$$

$$0.04y = 520$$

$$y = \frac{520}{0.04} = 13,000$$

Substituting to calculate x

$$x + 13,000 = 52,000$$

$$x = 39,000$$

\$39,000 is invested in the 10% fund, and
\$13,000 is invested in the 14% fund.

- 51.** Let x = the amount in the money market
fund, and let y = the amount in the
mutual fund.

$$\begin{cases} x + y = 250,000 & (Eq1) \\ 0.066x + 0.086y = .07(x + y) & (Eq2) \end{cases}$$

$$66x + 86y = 70x + 70y \quad 1000 \times (Eq2)$$

$$16y = 4x$$

$$4y = x$$

Then substituting $4y$ for x in Eq1, gives

$$4y + y = 250,000$$

$$5y = 250,000$$

$$y = 50,000$$

Substituting to calculate x

$$x + 50,000 = 250,000$$

$$x = 200,000$$

Thus, \$200,000 is invested in the money
market fund, and \$50,000 is invested in the
mutual fund.

- 52.** Let x = the amount in the money market
fund, and let y = the amount in the
mutual fund.

$$\begin{cases} x + y = 300,000 & (Eq1) \\ 0.062x + 0.092y = .076(x + y) & (Eq2) \end{cases}$$

$$62x + 92y = 76x + 76y \quad 1000 \times (Eq2)$$

$$16y = 14x$$

$$y = \frac{14}{16}x = \frac{7}{8}x$$

Then substituting $\frac{7}{8}x$ for y in Eq1,

gives

$$x + \frac{7}{8}x = 300,000$$

$$8x + 7x = 2,400,000$$

$$15x = 2,400,000$$

$$x = 160,000$$

Substituting to calculate y

$$y = \frac{7}{8}(160,000) = 140,000$$

Thus, \$160,000 is invested in the money
market fund, and \$140,000 is invested in the
mutual fund.

- 53.** Let x = the amount (cc's) of the 10% solution,
and let y = the amount (cc's) of the 5% solution.

$$\begin{cases} x + y = 100 \text{ (cc's of the final solution)} & (Eq1) \\ 0.10x + 0.05y = 0.08(100) & (Eq2) \end{cases}$$

$$10x + 5y = 80 \quad 100 \times (Eq2)$$

$$-5x - 5y = -500 \quad -5 \times (Eq1)$$

- 52.** Then using the elimination method

$$5x = 300$$

$$x = 60 \text{ cc's of the 10% solution}$$

Substituting to calculate y

$$y = 40 \text{ cc's of the 5% solution}$$

- 54.** Let x = the amount (cc's) of the 16% solution,
and let y = the amount (cc's) of the 6% solution.

$$\begin{cases} x + y = 200 \text{ (cc's of the final solution)} & (Eq1) \\ 0.16x + 0.06y = 0.12(200) & (Eq2) \end{cases}$$

$$16x + 6y = 2400 \qquad 100 \times (Eq2)$$

$$-6x - 6y = -1200 \qquad -6 \times (Eq1)$$

Then using the elimination method

$$10x = 1200$$

$$x = 120 \text{ cc's of the 16\% solution}$$

Substituting to calculate y

$$y = 80 \text{ cc's of the 6\% solution}$$

- 55.** Let x = the number of glasses of milk, and
let y = the number of 1/4-pound servings of meat.

Protein equation:

$$8.5x + 22y = 69.5$$

Iron equation:

$$0.1x + 3.4y = 7.1$$

$$\begin{cases} 8.5x + 22y = 69.5 & (Eq1) \\ 0.1x + 3.4y = 7.1 & (Eq2) \end{cases}$$

$$8.5x + 22y = 69.5 \qquad (Eq1)$$

$$-8.5x - 289y = -603.5 \qquad -85 \times (Eq2)$$

$$-267y = -534$$

$$y = \frac{-534}{-267} = 2$$

Substituting to calculate x

$$8.5x + 22(2) = 69.5$$

$$8.5x + 44 = 69.5$$

$$8.5x = 25.5$$

$$x = \frac{25.5}{8.5} = 3$$

Thus, 3 glasses of milk and 2 servings of meat

- 56.** Let x = the amount of substance A, and
let y = the amount of substance B.

Nutrient equation:

$$6\%x + 10\%y = 100\%$$

$$\begin{cases} x + y = 14 & (Eq1) \end{cases}$$

$$\begin{cases} 0.06x + 0.10y = 1 & (Eq2) \end{cases}$$

$$-0.06x - 0.06y = -0.84 \quad -0.06 \times (Eq1)$$

$$0.06x + 0.10y = 1 \quad (Eq2)$$

$$0.04y = 0.16$$

$$y = \frac{0.16}{0.04} = 4$$

Substituting to calculate x

$$x + 4 = 14$$

$$x = 10$$

The patient needs to consume 10 ounces of substance A and 4 ounces of substance B to reach the required nutrient level of 100%.

- 57.** Let x = the amount of 10% solution, and
let y = the amount of 5% solution.

$$x + y = 20$$

Medicine concentration:

$$10\%x + 5\%y = 8\%(20)$$

$$\begin{cases} x + y = 20 & (Eq1) \end{cases}$$

$$\begin{cases} 0.10x + 0.05y = 1.6 & (Eq2) \end{cases}$$

$$-0.10x - 0.10y = -2 \quad -0.10 \times (Eq1)$$

$$0.10x + 0.05y = 1.6 \quad (Eq2)$$

$$-0.05y = -0.4$$

$$y = \frac{-0.4}{-0.05} = 8$$

Substituting to calculate x

$$x + 8 = 20$$

$$x = 12$$

The nurse needs to mix 12 cc of the 10% solution with 8 cc of the 5% solution to obtain 20 cc of an 8% solution.

- 58.** Let x = the amount of the 30% solution, and
let y = the amount of the 15% solution.

$$x + y = 45$$

Medicine concentration:

$$30\%x + 15\%y = 20\%(45)$$

$$\begin{cases} x + y = 45 & (Eq1) \end{cases}$$

$$\begin{cases} 0.30x + 0.15y = 9 & (Eq2) \end{cases}$$

$$-0.30x - 0.30y = -13.5 \quad -0.30 \times (Eq1)$$

$$0.30x + 0.15y = 9 \quad (Eq2)$$

$$-0.15y = -4.5$$

$$y = \frac{-4.5}{-0.15} = 30$$

Substituting to calculate x

$$x + 30 = 45$$

$$x = 15$$

The nurse needs to mix 15 cc of the 30% solution with 30 cc of the 15% solution to obtain 45 cc of a 20% solution.

L1	L2	L3	1
50	210	0	
60	190	40	
70	170	80	
80	150	120	
100	110	200	
-----	-----	-----	

$$L1(1) = 50$$

- a. Demand function: Finding a linear model using L_2 as input and L_1 as output yields $p = -\frac{1}{2}q + 155$.

$$\begin{array}{l} \text{LinReg} \\ y = ax + b \\ a = -.5 \\ b = 155 \end{array}$$

- b. Supply function: Finding a linear model using L_3 as input and L_1 as output yields

$$p = \frac{1}{4}q + 50.$$

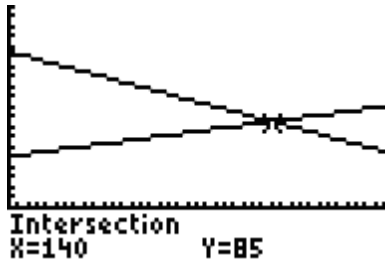
```
LinReg
y=ax+b
a=.25
b=50
```

- Supply function: Finding a linear model using L_3 as input and L_1 as output yields

$$p = \frac{1}{2}q + 0 \text{ or } p = \frac{1}{2}q.$$

```
LinReg
y=ax+b
a=.5
b=0
```

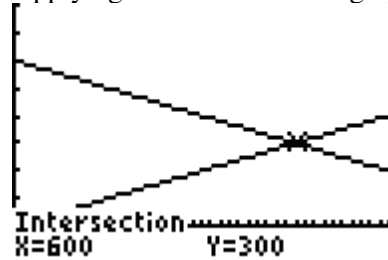
- c. Applying the intersection of graphs method



$[0, 200]$ by $[-50, 200]$

When the price is \$85, 140 units are both supplied and demanded. Therefore, equilibrium occurs when the price is \$85 per unit.

- Applying the intersection of graphs method



$[0, 800]$ by $[-100, 800]$

When the price is \$300, 600 units are both supplied and demanded. Therefore equilibrium occurs when the price is \$300 per unit

60.

L1	L2	L3	1
800	400	400	
400	200	800	
600	0	1200	

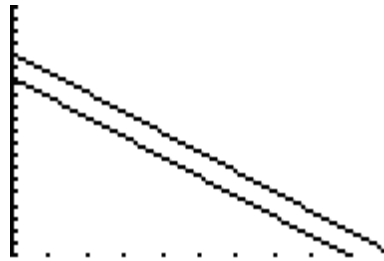
$L1(1) = 200$			

- Demand function: Finding a linear model using L_3 as input and L_2 as output yields

$$p = -\frac{1}{2}q + 600.$$

```
LinReg
y=ax+b
a=-.5
b=600
```

61. Applying the intersection of graphs method



$[0, 10]$ by $[55, 75]$

Note that the lines do not intersect. The slopes are the same, but the y-intercepts are different. There is no solution to the system. Based on the two models, the percentages are never equal.

62. $20\%x + 5\%y = 15.5\%(x + y)$

$$0.20x + 0.05y = 0.155x + 0.155y$$

$$0.045x = 0.105y$$

$$\frac{0.045x}{0.105} = \frac{0.105y}{0.105}$$

$$y = \frac{3}{7}x$$

Therefore, the amount of y must equal $\frac{3}{7}$ of the amount of x .

$$\text{If } x = 7, y = \frac{3}{7}(7) = 3.$$

The 5% concentration must be increased by 3 cc.

63. a. $300x + 200y = 100,000$

b. $x = 2y$

$$300(2y) + 200y = 100,000$$

$$800y = 100,000$$

$$y = \frac{100,000}{800} = 125$$

Substituting to calculate x

$$x = 2(125) = 250$$

There are 250 clients in the first group and 125 clients in the second group.

64. The slope of the demand function is

$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{350 - 300}{800 - 1200} = \frac{50}{-400} = -\frac{1}{8}.$$

Calculating the equation

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

$$y - 300 = -\frac{1}{8}(x - 1200)$$

$$y - 300 = -\frac{1}{8}x + 150$$

$$y = -\frac{1}{8}x + 450 \text{ or}$$

$$p = -\frac{1}{8}q + 450$$

Likewise, the slope of the supply function is

$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{280 - 385}{700 - 1400} = \frac{-105}{-700} = \frac{3}{20}.$$

Calculating the equation

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

$$y - 385 = \frac{3}{20}(x - 1400)$$

$$y - 385 = \frac{3}{20}x - 210$$

$$y = \frac{3}{20}x + 175 \text{ or}$$

$$p = \frac{3}{20}q + 175$$

Solving to find q :

$$\frac{-1}{8}q + 450 = \frac{3}{20}q + 175$$

LCM: 40

$$40\left(\frac{-1}{8}q + 450\right) = 40\left(\frac{3}{20}q + 175\right)$$

$$-5q + 18,000 = 6q + 7000$$

$$-11q = -11,000$$

$$q = \frac{-11,000}{-11} = 1000$$

The quantity, q , that produces market equilibrium is 1000.

Solving to find p :

$$p = \frac{3}{20}q + 175$$

$$p = \frac{3}{20}(1000) + 175 = 325$$

The price, p , at market equilibrium, is \$325.

1000 units priced at \$325 represents the market equilibrium.

65. The slope of the demand function is

$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{10 - 60}{900 - 400} = \frac{-50}{500} = \frac{-1}{10}.$$

Calculating the equation:

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

$$y - 60 = \frac{-1}{10}(x - 400)$$

$$y - 60 = \frac{-1}{10}x + 40$$

$$y = \frac{-1}{10}x + 100 \text{ or}$$

$$p = \frac{-1}{10}q + 100$$

Likewise, the slope of the supply function is

$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{30 - 50}{700 - 1400} = \frac{-20}{-700} = \frac{2}{70}.$$

Calculating the equation

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

$$y - 50 = \frac{2}{70}(x - 1400)$$

$$y - 50 = \frac{2}{70}x - 40$$

$$y = \frac{2}{70}x + 10 \text{ or}$$

$$p = \frac{2}{70}q + 10$$

Solving to find q :

$$\frac{-1}{10}q + 100 = \frac{2}{70}q + 10$$

$$70\left(\frac{-1}{10}q + 100\right) = 70\left(\frac{2}{70}q + 10\right)$$

$$-7q + 7000 = 2q + 700$$

$$-9q = -6300$$

$$q = \frac{-6300}{-9} = 700$$

The quantity, q , that produces market equilibrium is 700.

Solving to find p :

$$p = \frac{2}{70}(700) + 10$$

$$p = 2(10) + 10$$

$$p = 30$$

The price, p , at market equilibrium, is \$30.

700 units priced at \$30 represents the market equilibrium.

Section 2.4 Skills Check

1. Algebraically:

$$3x - 7 \leq 5 - x$$

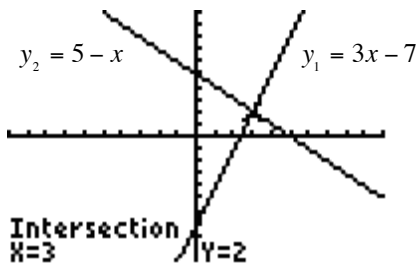
$$4x - 7 \leq 5$$

$$4x \leq 12$$

$$x \leq \frac{12}{4}$$

$$x \leq 3$$

Graphically:

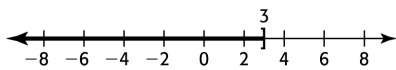


$[-10, 10]$ by $[-10, 10]$

$3x - 7 \leq 5 - x$ implies that the solution region is $x \leq 3$.

The interval notation is $(-\infty, 3]$.

The graph of the solution is:



2. Algebraically:

$$2x + 6 < 4x + 5$$

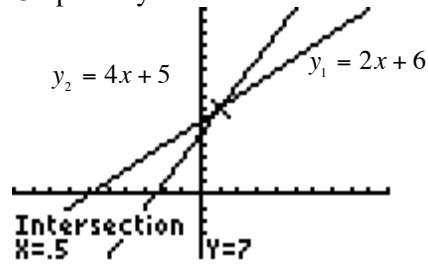
$$-2x + 6 < 5$$

$$-2x < -1$$

$$\frac{-2x}{-2} > \frac{-1}{-2} \quad (\text{Note the inequality sign switch})$$

$$x > \frac{1}{2}$$

Graphically:

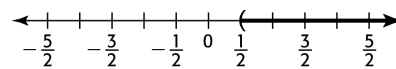


$[-5, 5]$ by $[-5, 15]$

$2x + 6 < 4x + 5$ implies that the solution region is $x > \frac{1}{2}$.

The interval notation is $(\frac{1}{2}, \infty)$.

The graph of the solution is:



3. Algebraically:

$$4(3x - 2) \leq 5x - 9$$

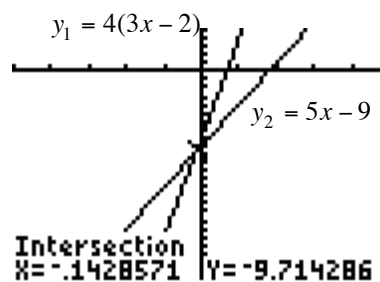
$$12x - 8 \leq 5x - 9$$

$$7x \leq -1$$

$$\frac{7x}{7} \leq \frac{-1}{7}$$

$$x \leq -\frac{1}{7}$$

Graphically:

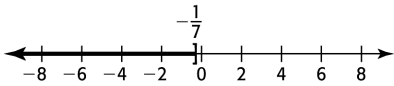


$[-5, 5]$ by $[-25, 5]$

$4(3x - 2) \leq 5x - 9$ implies that the solution region is $x \leq -\frac{1}{7}$.

The interval notation is $\left(-\infty, -\frac{1}{7}\right]$.

The graph of the solution is:



4. Algebraically:

$$5(2x - 3) > 4x + 6$$

$$10x - 15 > 4x + 6$$

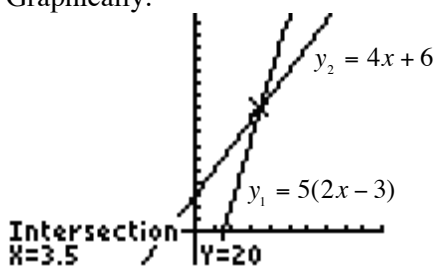
$$6x - 15 > 6$$

$$6x > 21$$

$$x > \frac{21}{6}$$

$$x > \frac{7}{2}$$

Graphically:



$[-10, 10]$ by $[-5, 35]$

$5(2x - 3) > 4x + 6$ implies that the solution region is $x > \frac{7}{2}$.

The interval notation is $\left(\frac{7}{2}, \infty\right)$.

The graph of the solution is:



5. Algebraically:

$$4x + 1 < -\frac{3}{5}x + 5$$

$$5(4x + 1) < 5\left(-\frac{3}{5}x + 5\right)$$

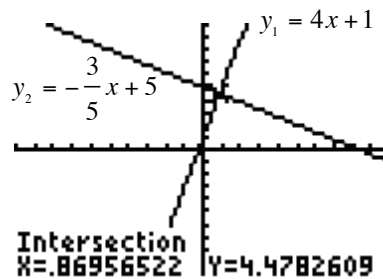
$$20x + 5 < -3x + 25$$

$$23x + 5 < 25$$

$$23x < 20$$

$$x < \frac{20}{23}$$

Graphically:

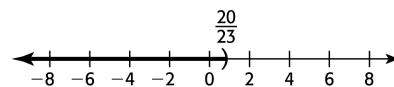


$[-10, 10]$ by $[-10, 10]$

$4x + 1 < -\frac{3}{5}x + 5$ implies that the solution region is $x < \frac{20}{23}$.

The interval notation is $\left(-\infty, \frac{20}{23}\right)$.

The graph of the solution is:



6. Algebraically:

$$4x - \frac{1}{2} \leq -2 + \frac{x}{3}$$

$$6\left(4x - \frac{1}{2}\right) \leq 6\left(-2 + \frac{x}{3}\right)$$

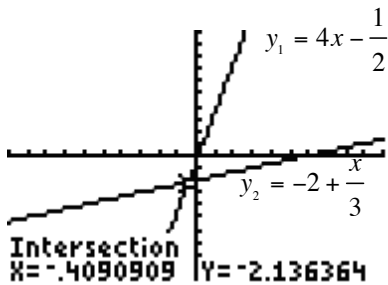
$$24x - 3 \leq -12 + 2x$$

$$22x - 3 \leq -12$$

$$22x \leq -9$$

$$x \leq -\frac{9}{22}$$

Graphically:

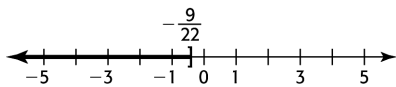


$[-10, 10]$ by $[-10, 10]$

$4x - \frac{1}{2} \leq -2 + \frac{x}{3}$ implies that the solution region is $x \leq -\frac{9}{22}$.

The interval notation is $\left(-\infty, -\frac{9}{22}\right]$.

The graph of the solution is:



7. Algebraically:

$$\frac{x-5}{2} < \frac{18}{5}$$

$$10\left(\frac{x-5}{2}\right) < 10\left(\frac{18}{5}\right)$$

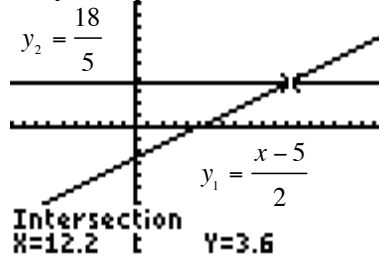
$$5(x-5) < 2(18)$$

$$5x - 25 < 36$$

$$5x < 61$$

$$x < \frac{61}{5}$$

Graphically:

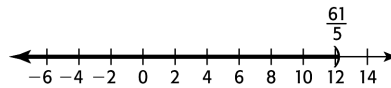


$[-10, 20]$ by $[-10, 10]$

$\frac{x-5}{2} < \frac{18}{5}$ implies that the solution region is $x < \frac{61}{5}$.

The interval notation is $\left(-\infty, \frac{61}{5}\right)$.

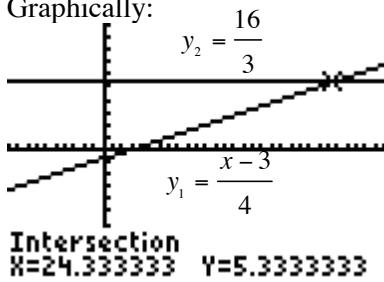
The graph of the solution is



8. Algebraically:

$$\begin{aligned} \frac{x-3}{4} &< \frac{16}{3} \\ 12\left(\frac{x-3}{4}\right) &< 12\left(\frac{16}{3}\right) \\ 3(x-3) &< 64 \\ 3x-9 &< 64 \\ 3x &< 73 \\ x &< \frac{73}{3} \end{aligned}$$

Graphically:



$[-10, 30]$ by $[-10, 10]$

$\frac{x-3}{4} < \frac{16}{3}$ implies that the solution region is $x < \frac{73}{3}$.

The interval notation is $\left(-\infty, \frac{73}{3}\right)$.

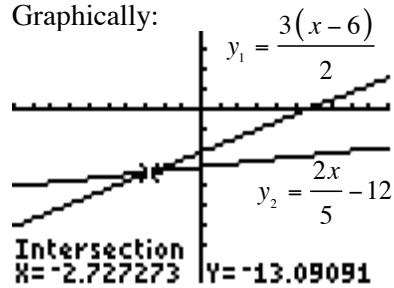
The graph of the solution is:



9. Algebraically:

$$\begin{aligned} \frac{3(x-6)}{2} &\geq \frac{2x}{5} - 12 \\ 10\left(\frac{3(x-6)}{2}\right) &\geq 10\left(\frac{2x}{5} - 12\right) \\ 5(3(x-6)) &\geq 2(2x) - 120 \\ 15(x-6) &\geq 4x - 120 \\ 15x - 90 &\geq 4x - 120 \\ 11x - 90 &\geq -120 \\ 11x &\geq -30 \\ x &\geq -\frac{30}{11} \end{aligned}$$

Graphically:

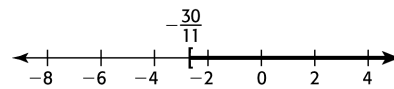


$[-10, 10]$ by $[-35, 15]$

$\frac{3(x-6)}{2} \geq \frac{2x}{5} - 12$ implies that the solution region is $x \geq -\frac{30}{11}$.

The interval notation is $\left[-\frac{30}{11}, \infty\right)$.

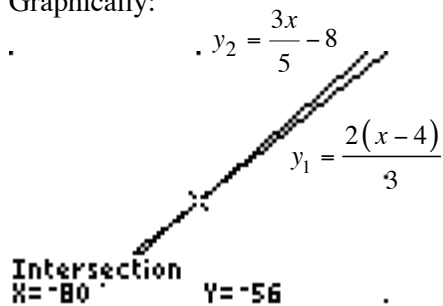
The graph of the solution is:



10. Algebraically:

$$\begin{aligned}\frac{2(x-4)}{3} &\geq \frac{3x}{5} - 8 \\ 15\left[\frac{2(x-4)}{3}\right] &\geq 15\left[\frac{3x}{5} - 8\right] \\ 10x - 40 &\geq 9x - 120 \\ x &\geq -80\end{aligned}$$

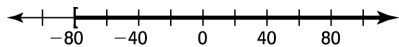
Graphically:



$[-90, -70]$ by $[-60, -50]$

$$\begin{aligned}\frac{2(x-4)}{3} \geq \frac{3x}{5} - 8 \text{ implies that the solution} \\ \text{region is } x \geq -80. \\ \text{The interval notation is } [-80, \infty).\end{aligned}$$

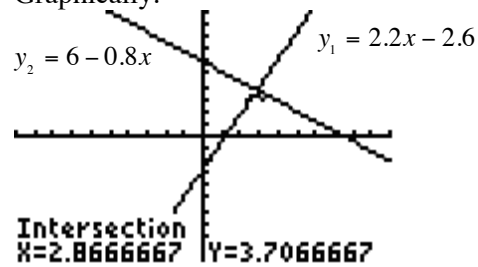
The graph of the solution is:



11. Algebraically:

$$\begin{aligned}2.2x - 2.6 &\geq 6 - 0.8x \\ 3.0x - 2.6 &\geq 6 \\ 3.0x &\geq 8.6 \\ x &\geq \frac{8.6}{3.0} \\ x &\geq 2.8\bar{6}\end{aligned}$$

Graphically:

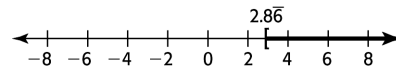


$[-10, 10]$ by $[-10, 10]$

$2.2x - 2.6 \geq 6 - 0.8x$ implies that the solution region is $x \geq 2.8\bar{6}$.

The interval notation is $[2.8\bar{6}, \infty)$.

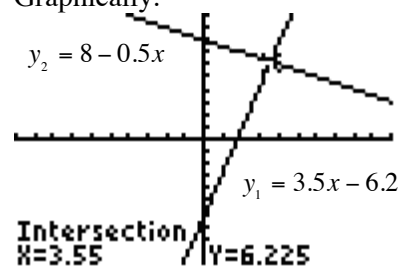
The graph of the solution is:



12. Algebraically:

$$\begin{aligned}3.5x - 6.2 &\leq 8 - 0.5x \\ 4x &\leq 14.2 \\ x &\leq \frac{14.2}{4} \\ x &\leq 3.55\end{aligned}$$

Graphically:

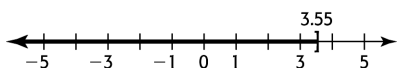


$[-10, 10]$ by $[-10, 10]$

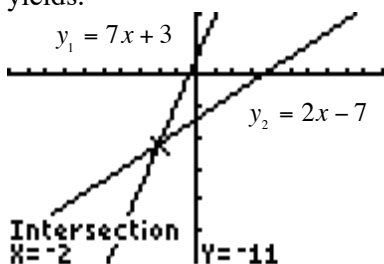
$3.5x - 6.2 \leq 8 - 0.5x$ implies that the solution region is $x \leq 3.55$.

The interval notation is $(-\infty, 3.55]$.

The graph of the solution is:



13. Applying the intersection of graphs method yields:

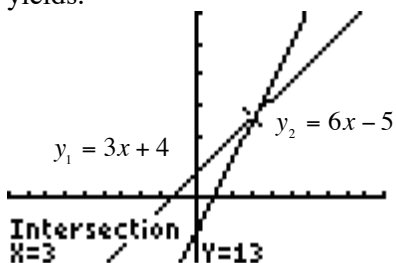


$[-10, 10]$ by $[-30, 10]$

$7x + 3 < 2x - 7$ implies that the solution region is $x < -2$.

The interval notation is $(-\infty, -2)$.

14. Applying the intersection of graphs method yields:



$[-10, 10]$ by $[-10, 30]$

$3x + 4 \leq 6x - 5$ implies that the solution region is $x \geq 3$.

The interval notation is $[3, \infty)$.

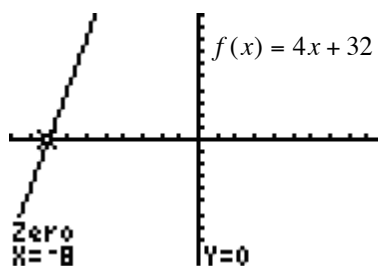
15. To apply the x -intercept method, first rewrite the inequality so that zero is on one side of the inequality.

$$5(2x + 4) \geq 6(x - 2)$$

$$10x + 20 \geq 6x - 12$$

$$4x + 32 \geq 0$$

Let $f(x) = 4x + 32$, and determine graphically where $f(x) \geq 0$.



$[-10, 10]$ by $[-10, 10]$

$f(x) \geq 0$ implies that the solution region is $x \geq -8$.

The interval notation is $[-8, \infty)$.

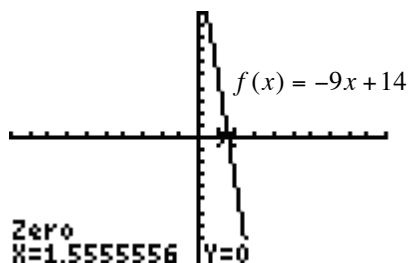
16. To apply the x -intercept method, first rewrite the inequality so that zero is on one side of the inequality.

$$-3(x - 4) < 2(3x - 1)$$

$$-3x + 12 < 6x - 2$$

$$-9x + 14 < 0$$

Let $f(x) = -9x + 14$, and determine graphically where $f(x) < 0$.



$[-10, 10]$ by $[-10, 10]$

$f(x) < 0$ implies that the solution region is $x > 1.\bar{5}$.

The interval notation is $\left(\frac{14}{9}, \infty\right)$.

17. a. The x -coordinate of the intersection point is the solution. $x = -1$.

b. $(-\infty, -1)$

18. a. $x = 10$

b. $(-\infty, 30]$

c. No solution. $f(x)$ is never less than $h(x)$.

19. $17 \leq 3x - 5 < 31$

$$17 + 5 \leq 3x - 5 + 5 < 31 + 5$$

$$22 \leq 3x < 36$$

$$\frac{22}{3} \leq \frac{3x}{3} < \frac{36}{3}$$

$$\frac{22}{3} \leq x < 12$$

The interval notation is $\left[\frac{22}{3}, 12\right)$.

20. $120 < 20x - 40 \leq 160$

$$120 + 40 < 20x - 40 + 40 \leq 160 + 40$$

$$160 < 20x \leq 200$$

$$8 < x \leq 10$$

The interval notation is $(8, 10]$.

21. $2x + 1 \geq 6$ and $2x + 1 \leq 21$

$$6 \leq 2x + 1 \leq 21$$

$$5 \leq 2x \leq 20$$

$$\frac{5}{2} \leq x \leq 10$$

$$x \geq \frac{5}{2} \text{ and } x \leq 10$$

The interval notation is $\left[\frac{5}{2}, 10\right]$.

22. $16x - 8 > 12$ and $16x - 8 < 32$

$$12 < 16x - 8 < 32$$

$$20 < 16x < 40$$

$$\frac{20}{16} < \frac{16x}{16} < \frac{40}{16}$$

$$\frac{5}{4} < x < \frac{5}{2}$$

$$x > \frac{5}{4} \text{ and } x < \frac{5}{2}$$

The interval notation is $\left(\frac{5}{4}, \frac{5}{2}\right)$.

23. $3x + 1 < -7$ and $2x - 5 > 6$

Inequality 1

$$3x + 1 < -7$$

$$3x < -8$$

$$x < -\frac{8}{3}$$

Inequality 2

$$2x - 5 > 6$$

$$2x > 11$$

$$x > \frac{11}{2}$$

$$x < -\frac{8}{3} \text{ and } x > \frac{11}{2}, \text{ indicates there is}$$

no solution in this system of inequalities.

24. $6x - 2 \leq -5$ or $3x + 4 > 9$

Inequality 1

$$6x - 2 \leq -5$$

$$6x \leq -3$$

$$x \leq -\frac{1}{2}$$

Inequality 2

$$3x + 4 > 9$$

$$3x > 5$$

$$x > \frac{5}{3}$$

$$x \leq -\frac{1}{2} \text{ or } x > \frac{5}{3}$$

$$25. \frac{3}{4}x - 2 \geq 6 - 2x \text{ or } \frac{2}{3}x - 1 \geq 2x - 2$$

Inequality 1

$$4\left(\frac{3}{4}x - 2\right) \geq 4(6 - 2x)$$

$$3x - 8 \geq 24 - 8x$$

$$11x \geq 32$$

$$x \geq \frac{32}{11}$$

Inequality 2

$$3\left(\frac{2}{3}x - 1\right) \geq 3(2x - 2)$$

$$2x - 3 \geq 6x - 6$$

$$-4x \geq -3$$

$$x \leq \frac{3}{4}$$

$$x \geq \frac{32}{11} \text{ or } x \leq \frac{3}{4}$$

$$26. \frac{1}{2}x - 3 < 5x \text{ or } \frac{2}{5}x - 5 > 6x$$

Inequality 1

$$2\left(\frac{1}{2}x - 3\right) < 2(5x)$$

$$x - 6 < 10x$$

$$-9x < 6$$

$$x > -\frac{2}{3}$$

Inequality 2

$$5\left(\frac{2}{5}x - 5\right) > 5(6x)$$

$$2x - 25 > 30x$$

$$-28x > 25$$

$$x < -\frac{25}{28}$$

$$x > -\frac{2}{3} \text{ or } x < -\frac{25}{28}$$

$$27. \quad 37.002 \leq 0.554x - 2.886 \leq 77.998$$

$$37.002 + 2.886 \leq 0.554x - 2.886 + 2.886 \leq 77.998 + 2.886$$

$$39.888 \leq 0.554x \leq 80.884$$

$$\frac{39.888}{0.554} \leq \frac{0.554x}{0.554} \leq \frac{80.884}{0.554}$$

$$72 \leq x \leq 146$$

The interval notation is $[72, 146]$.

$$28. \quad 70 \leq \frac{60 + 88 + 73 + 65 + x}{5} < 80$$

$$70 \leq \frac{286 + x}{5} < 80$$

$$5(70) \leq 5\left(\frac{286 + x}{5}\right) \leq 5(80)$$

$$350 \leq 286 + x \leq 400$$

$$350 - 286 \leq 286 - 286 + x \leq 400 - 286$$

$$64 \leq x < 114$$

The interval notation is $[64, 114)$.

Section 2.4 Exercises

29. a. $V = 12,000 - 2000t$

b. $12,000 - 2000t < 8000$

c. $12,000 - 2000t \geq 6000$

30. a. $p \geq 0.1$

- b. Considering x as a discrete variable representing the number of drinks, then if $x \geq 6$, the 220-lb male is intoxicated.

31. $F \leq 32$

$$\frac{9}{5}C + 32 \leq 32$$

$$\frac{9}{5}C \leq 0$$

$$C \leq 0$$

A Celsius temperature at or below zero degrees is "freezing."

32. $C \geq 100$

$$\frac{5}{9}(F - 32) \geq 100$$

$$9\left[\frac{5}{9}(F - 32)\right] \geq 9[100]$$

$$5F - 160 \geq 900$$

$$5F \geq 1060$$

$$F \geq 212$$

A Fahrenheit temperature at or above 212 degrees is "boiling."

33. Position 1 income = 3100

Position 2 income = $2000 + 0.05x$, where x represents the sales within a given month

When does the income from the second position exceed the income from the first position? Consider the inequality $2000 + 0.05x > 3100$

$$0.05x > 1100$$

$$x > \frac{1100}{0.05}$$

$$x > 22,000$$

When monthly sales exceed \$22,000, the second position is more profitable than the first position.

34. Original value = $(1000)(22) = \$22,000$

$$\text{Adjusted value} = 22,000 - (22,000)(20\%)$$

$$= 22,000 - 4400$$

$$= 17,600$$

Let x = percentage increase

$$17,600 + 17,600x > 22,000$$

$$17,600x > 4400$$

$$x > \frac{4400}{17,600}$$

$$x > 0.25$$

$$x > 25\%$$

The percentage increase must be greater than 25% in order to ensure a profit.

- 35.** Let x = Jill's final exam grade.

$$80 \leq \frac{78 + 69 + 92 + 81 + 2x}{6} \leq 89$$

$$6(80) \leq 6\left(\frac{78 + 69 + 92 + 81 + 2x}{6}\right) \leq 6(89)$$

$$480 \leq 320 + 2x \leq 534$$

$$480 - 320 \leq 320 - 320 + 2x \leq 534 - 320$$

$$160 \leq 2x \leq 214$$

$$\frac{160}{2} \leq \frac{2x}{2} \leq \frac{214}{2}$$

$$80 \leq x \leq 107$$

If the final exam does not contain any bonus points, Jill needs to score between 80 and 100 to earn a grade of B for the course.

- 36.** Let x = John's final exam grade.

$$70 \leq \frac{78 + 62 + 82 + 2x}{5} \leq 79$$

$$5(70) \leq 5\left(\frac{78 + 62 + 82 + 2x}{5}\right) \leq 5(79)$$

$$350 \leq 222 + 2x \leq 395$$

$$128 \leq 2x \leq 173$$

$$\frac{128}{2} \leq \frac{2x}{2} \leq \frac{173}{2}$$

$$64 \leq x \leq 86.5$$

John needs to score between 64 and 86.5 to earn a grade of C for the course.

- 37.** Let $x = 6$, and solve for p .

$$30p - 19(6) = 1$$

$$30p - 114 = 1$$

$$30p = 115$$

$$p = \frac{115}{30} = 3.8\bar{3}$$

Let $x = 10$, and solve for p .

$$30p - 10(19) = 1$$

$$30p - 190 = 1$$

$$30p = 191$$

$$p = \frac{191}{30} = 6.3\bar{6}$$

Therefore, between 1996 and 2000, the percentage of marijuana use is between 3.83% and 6.37%. In symbols, $3.83 \leq p \leq 6.37$.

- 38.** If x is the number of years from 1995, and if $y = 6.9x - 3.18$, then the percent of households in the U.S. with Internet access greater than 52 is given by:

$$6.9x - 3.18 \geq 52$$

$$6.9x \geq 55.18$$

$$x \geq 7.997 \approx 8$$

Therefore, 8 years from 1995 is 2003 and after

39. a. $y \geq 1000$

$$0.97x + 128.3829 \geq 1000$$

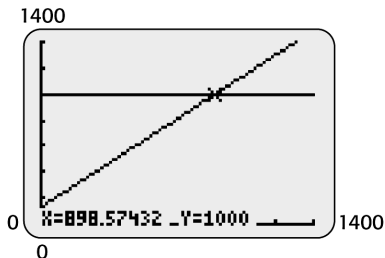
$$0.97x \geq 871.6171$$

$$x \geq \frac{871.6171}{0.97}$$

$$x \geq 898.57 \text{ or approximately } x \geq 899$$

Old scores greater than or equal to 899 are equivalent to new scores.

b.



40. a. $y = 1000$

$$9.3451x + 649.3385 = 1000$$

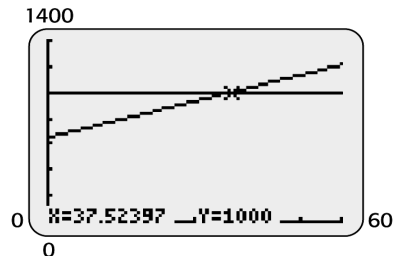
$$9.3451x = 350.6615$$

$$x = \frac{350.6615}{9.3451}$$

$$x = 37.5235685.$$

Thus, the per capita world production of cigarettes is 1000 in the year 1988.

b.



- c.** Prior to 1988, cigarette production was less than 1000 cigarettes per person per year.

- 41.** Let x represent the actual life of the HID headlights.

$$1500 - 10\%(1500) \leq x \leq 1500 + 10\%(1500)$$

$$1500 - 150 \leq x \leq 1500 + 150$$

$$1350 \leq x \leq 1650$$

- 42.** Remember to convert years into months.

$$4(12) < y < 6(12)$$

$$48 < 0.554x - 2.886 < 72$$

$$48 + 2.886 < 0.554x - 2.886 + 2.886 < 72 + 2.886$$

$$50.886 < 0.554x < 74.886$$

$$\frac{50.886}{0.554} < \frac{0.554x}{0.554} < \frac{74.886}{0.554}$$

$$91.85198556 < x < 135.1732852$$

or approximately,

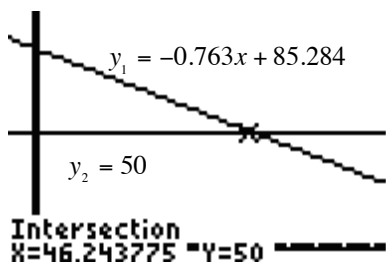
$$92 < x < 135$$

The prison sentence needs to be between 92 months and 135 months.

43. a. Let $y > 50$.

$$-0.763x + 85.284 > 50$$

Applying the intersection of graphs method:



$$[-5, 75] \text{ by } [-5, 100]$$

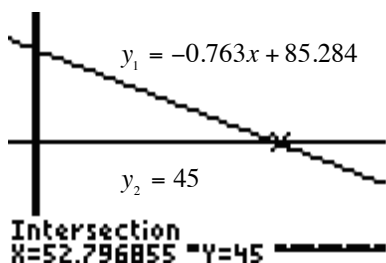
When $x < 46.24$, $y > 50$.

The marriage rate per 1000 women is greater than 50 prior to 1996.

- b. Let $y < 45$.

$$-0.763x + 85.284 < 45$$

Applying the intersection of graphs method:



$$[-5, 75] \text{ by } [-5, 100]$$

When $x > 52.80$, $y < 45$.

The marriage rate per 1000 women will be less than 45 beyond 2002.

44. Note that W and B are in thousands.

$$B \geq 100$$

$$1.05W - 18.691 \geq 100$$

$$1.05W \geq 118.691$$

$$W \geq \frac{118.691}{1.05}$$

$$W \geq 113.039$$

The median salary for whites needs to be approximately \$113,039 or greater.

45. a. Since the rate of increase is constant, the equation modeling the value of the home is linear.

$$\begin{aligned} m &= \frac{y_2 - y_1}{x_2 - x_1} \\ &= \frac{270,000 - 190,000}{4 - 0} \\ &= \frac{80,000}{4} \\ &= 20,000 \end{aligned}$$

Solving for the equation:

$$\begin{aligned} y - y_1 &= m(x - x_1) \\ y - 190,000 &= 20,000(x - 0) \\ y - 190,000 &= 20,000x \\ y &= 20,000x + 190,000 \end{aligned}$$

- b. $y > 400,000$

$$20,000x + 190,000 > 400,000$$

$$20,000x > 210,000$$

$$x > \frac{210,000}{20,000}$$

$$x > 10.5$$

2010 corresponds to

$$x = 2010 - 1996 = 14.$$

Therefore, $11 \leq x \leq 14$.

Or, $y > 400,000$

between 2007 and 2010, inclusive.

The value of the home will be greater than \$400,000 between 2007 and 2010.

46. Cost of 12 cars = $(12)(32,500) = 390,000$

Cost of 11 cars = $(11)(32,500) = 357,500$

Let x = profit on the sale of the 12th car.

$$(5.5\%)(357,500) + x \geq (6\%)(390,000)$$

$$19,662.50 + x \geq 23,400$$

$$x \geq 3737.50$$

The price of the 12th car needs to be at least

$$32,500 + 3737.50 = 36,237.50 \text{ or } \$36,238.$$

47. $P(x) > 10,900$

$$6.45x - 2000 > 10,900$$

$$6.45x > 12,900$$

$$x > \frac{12,900}{6.45}$$

$$x > 2000$$

A production level above 2000 units will yield a profit greater than \$10,900.

48. $P(x) > 84,355$

$$-40,255 + 9.80x > 84,355$$

$$9.80x > 124,610$$

$$x > \frac{124,610}{9.80}$$

$$x > 12,715.30612$$

Rounding since the data is discrete:

$$x > 12,715$$

The number of units sold needs to exceed 12,715.

49. $P(x) \geq 0$

$$6.45x - 9675 \geq 0$$

$$6.45x \geq 9675$$

$$x \geq \frac{9675}{6.45}$$

$$x \geq 1500$$

Sales of 1500 feet or more of PVC pipe will avoid a loss for the hardware store.

50. Generating a loss implies that $P(x) < 0$.

$$P(x) < 0$$

$$-40,255 + 9.80x < 0$$

$$9.80x < 40,255$$

$$x < \frac{40,255}{9.80}$$

$$x < 4107.653061$$

Rounding since the data is discrete:

$$x < 4108$$

Producing and selling fewer than 4108 units results in a loss.

51. Recall that Profit = Revenue - Cost.

Let x = the number of boards manufactured and sold.

$$P(x) = R(x) - C(x)$$

$$R(x) = 489x$$

$$C(x) = 125x + 345,000$$

$$P(x) = 489x - (125x + 345,000)$$

$$P(x) = 489x - 125x - 345,000$$

$$P(x) = 364x - 345,000$$

To make a profit, $P(x) > 0$.

$$364x - 345,000 > 0$$

52. $T \leq 85$

$$0.43m + 76.8 \leq 85$$

$$0.43m \leq 8.2$$

$$m \leq \frac{8.2}{0.43}$$

$$m \leq 19.06976744 \text{ or approximately,}$$

$$m \leq 19$$

The temperature will be at most 85°F for the first 19 minutes.

$$\begin{aligned}
 53. \quad & 245 < y < 248 \\
 & 245 < 0.155x + 244.37 < 248 \\
 245 - 244.37 < 0.155x + 244.37 - 244.37 < 248 - 244.37 \\
 & 0.63 < 0.155x < 3.63 \\
 & \frac{0.63}{0.155} < \frac{0.155}{0.155}x < \frac{3.63}{0.155} \\
 & 4.06 < x < 23.42
 \end{aligned}$$

Considering x as a discrete variable yields $4 < x < 23$.

From 1974 until 1993 the reading scores were between 245 and 248.

$$\begin{aligned}
 54. \text{ a. } & 63.20 - 0.26x < 52 \\
 & -0.26x < -11.2 \\
 & x > \frac{-11.2}{-0.26} \quad (\text{Note the inequality sign switch.}) \\
 & x > 43.08 \approx 43 \\
 & \text{The voting percentage is less than 52 after the year 1993.}
 \end{aligned}$$

$$\begin{aligned}
 \text{b. } & 63.20 - 0.26x > 60 \\
 & -0.26x > -3.20 \\
 & x < \frac{-3.20}{-0.26} \quad (\text{Note the inequality sign switch.}) \\
 & x < 12.3 \\
 & x \approx 12 \\
 & \text{The voting percentage is greater than 60 before the year 1962.}
 \end{aligned}$$

$$\begin{aligned}
 \text{c. } & 50 \leq 63.20 - 0.26x \leq 60 \\
 50 - 63.20 \leq 63.20 - 63.20 - 0.26x \leq 60 - 63.20 \\
 -13.20 \leq -0.26x \leq -3.20 \\
 \frac{-13.20}{-0.26} \leq \frac{-0.26x}{-0.26} \leq \frac{-3.20}{-0.26} & \quad (\text{Note the inequality sign switch.}) \\
 50.8 \geq x \geq 12.3 \\
 51 \geq x \geq 12 \\
 12 \leq x \leq 51 \\
 & \text{The voting percentage is between 50 and 60 between the years 1962 and 2001, inclusive.}
 \end{aligned}$$

55. a. $t = 2008 - 1990 = 18$

$$\begin{aligned} p(18) &= 75.751 - 0.743(18) \\ &= 75.751 - 13.374 \\ &= 62.377 \approx 62.4\% \end{aligned}$$

In 2008 the percent of high school seniors who have tried cigarettes is estimated to be 62.4%.

b.

X	Y ₁
19	61.634
20	60.891
21	60.148
22	59.405
23	58.662
24	57.919
25	57.176

X=22

$$p \geq 59.405 \text{ when } t \leq 22$$

- c. Considering part b) above, the model suggests that the percent is at least 59.405% before the year 2012.

56. a. $t = 2008 - 1950 = 58$

$$\begin{aligned} p(58) &= 63.20 - 0.26(58) \\ &= 48.12 \approx 48.12\% \end{aligned}$$

In 2008 the percent of the voting population who vote in the presidential election is estimated to be 48.12%.

b.

X	Y ₁
57	48.38
58	48.12
59	47.86
60	47.6
61	47.34
62	47.08
63	46.82

X=60

$$p \leq 47.6 \text{ when } t \geq 60$$

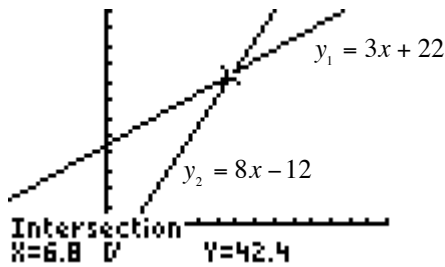
- c. Considering part b) above, the model suggests that the percent is no more than 47.6% during the year 2010 and after.

Chapter 2 Skills Check

1. a.

$$\begin{aligned}
 3x + 22 &= 8x - 12 \\
 3x - 8x + 22 &= 8x - 8x - 12 \\
 -5x + 22 &= -12 \\
 -5x + 22 - 22 &= -12 - 22 \\
 -5x &= -34 \\
 \frac{-5x}{-5} &= \frac{-34}{-5} \\
 x &= \frac{34}{5}
 \end{aligned}$$

- b. Applying the intersection of graphs method yields $x = 6.8$.

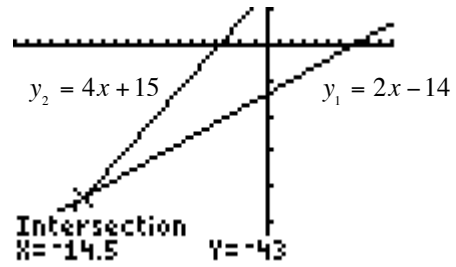


$[-5, 15]$ by $[-10, 60]$

2. a.

$$\begin{aligned}
 2(x - 7) &= 5(x + 3) - x \\
 2x - 14 &= 5x + 15 - x \\
 2x - 14 &= 4x + 15 \\
 2x - 4x - 14 &= 4x - 4x + 15 \\
 -2x - 14 &= 15 \\
 -2x - 14 + 14 &= 15 + 14 \\
 -2x &= 29 \\
 \frac{-2x}{-2} &= \frac{29}{-2} \\
 x &= -\frac{29}{2} = -14.5
 \end{aligned}$$

- b. Applying the intersection of graphs method yields $x = -14.5$.

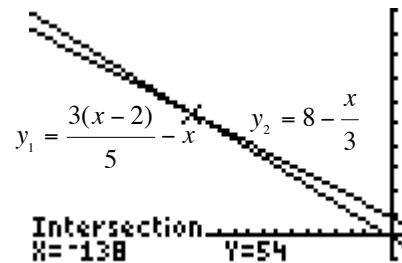


$[-20, 10]$ by $[-50, 10]$

3. a.

$$\begin{aligned}
 \frac{3(x-2)}{5} - x &= 8 - \frac{x}{3} \\
 \text{LCD: } 15 & \\
 15\left(\frac{3(x-2)}{5} - x\right) &= 15\left(8 - \frac{x}{3}\right) \\
 3(3(x-2)) - 15x &= 120 - 5x \\
 3(3x - 6) - 15x &= 120 - 5x \\
 9x - 18 - 15x &= 120 - 5x \\
 -6x - 18 &= 120 - 5x \\
 -1x - 18 &= 120 \\
 -1x &= 138 \\
 x &= -138
 \end{aligned}$$

- b. Applying the intersection of graphs method yields $x = -138$.



$[-250, 10]$ by $[-10, 100]$

4. a. $\frac{6x+5}{2} = \frac{5(2-x)}{3}$

$$\frac{6x+5}{2} = \frac{10-5x}{3}$$

LCD: 6

$$6\left(\frac{6x+5}{2}\right) = 6\left(\frac{10-5x}{3}\right)$$

$$3(6x+5) = 2(10-5x)$$

$$18x+15 = 20-10x$$

$$18x+15+10x = 20-10x+10x$$

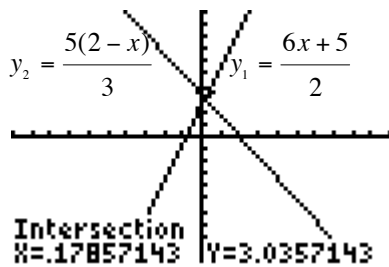
$$28x+15 = 20$$

$$28x+15-15 = 20-15$$

$$28x = 5$$

$$x = \frac{5}{28}$$

b. Applying the intersection of graphs method yields $x = 5 / 28 \approx 0.179$.



$[-10, 10]$ by $[-10, 10]$

5. a. $\frac{3x}{4} - \frac{1}{3} = 1 - \frac{2}{3}\left(x - \frac{1}{6}\right)$

$$\frac{3x}{4} - \frac{1}{3} = 1 - \frac{2}{3}x + \frac{1}{9}$$

LCD: 36

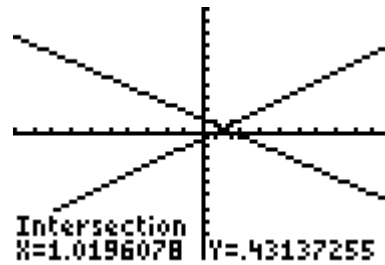
$$36\left(\frac{3x}{4} - \frac{1}{3}\right) = 36\left(1 - \frac{2}{3}x + \frac{1}{9}\right)$$

$$27x - 12 = 36 - 24x + 4$$

$$51x = 52$$

$$x = \frac{52}{51}$$

b. Applying the intersection of graphs method yields $x = 52 / 51 \approx 1.0196$.



$[-10, 10]$ by $[-10, 10]$

6. a.

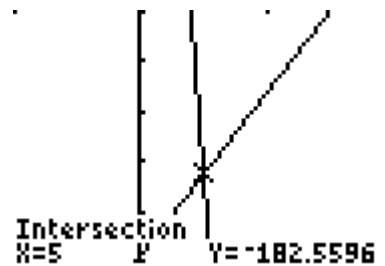
$$3.259x - 198.8546 = -3.8(8.625x + 4.917)$$

$$3.259x - 198.8546 = -32.775x - 18.6846$$

$$36.034x = 180.17$$

$$x = 5$$

b. Applying the intersection of graphs method yields $x = 5$.



$[-10, 20]$ by $[-200, -150]$

7. a. $f(x) = 7x - 105$

$$7x - 105 = 0$$

$$7x = 105$$

$$x = 15$$

b. The x-intercepts of the graph are the same as the zeros of the function.

c. Solving the equation $f(x) = 0$ is the same as finding the zeros of the function and the x-intercepts of the graph.

8. Solve for y :

$$P(a - y) = 1 + \frac{m}{3}$$

$$Pa - Py = 1 + \frac{m}{3}$$

$$-Py = 1 + \frac{m}{3} - Pa$$

$$-Py = \left(\frac{3 + m - 3Pa}{3} \right)$$

$$y = \left(\frac{3 + m - 3Pa}{-3P} \right)$$

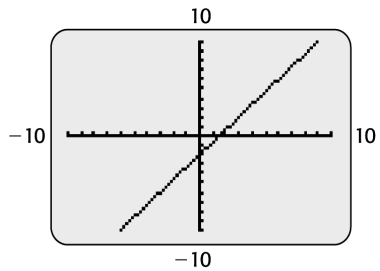
9. Solving for y :

$$4x - 3y = 6$$

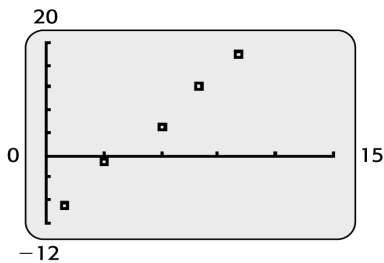
$$-3y = -4x + 6$$

$$y = \frac{-4x + 6}{-3}$$

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

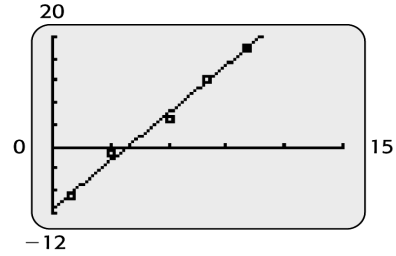


10.



11. $y = 2.8947x - 11.211$

12.



13. No. Data points do not necessarily fit a linear model exactly.

$$\begin{cases} 3x + 2y = 0 & (Eq1) \\ 2x - y = 7 & (Eq2) \end{cases}$$

$$\begin{cases} 3x + 2y = 0 & (Eq1) \\ 4x - 2y = 14 & 2 \times (Eq2) \end{cases}$$

$$7x = 14$$

$$x = 2$$

Substituting to find y

$$3(2) + 2y = 0$$

$$6 + 2y = 0$$

$$2y = -6$$

$$y = -3$$

The solution is $(2, -3)$.

$$15. \begin{cases} 3x + 2y = -3 & (Eq1) \\ 2x - 3y = 3 & (Eq2) \end{cases}$$

$$\begin{cases} 9x + 6y = -9 & 3 \times (Eq1) \\ 4x - 6y = 6 & 2 \times (Eq2) \end{cases}$$

$$13x = -3$$

$$x = -\frac{3}{13}$$

Substituting to find y

$$3\left(-\frac{3}{13}\right) + 2y = -3$$

$$-\frac{9}{13} + 2y = -\frac{39}{13}$$

$$2y = -\frac{30}{13}$$

$$y = -\frac{15}{13}$$

The solution is $\left(-\frac{3}{13}, -\frac{15}{13}\right)$.

$$16. \begin{cases} -4x + 2y = -14 & (Eq1) \\ 2x - y = 7 & (Eq2) \end{cases}$$

$$\begin{cases} -4x + 2y = -14 & (Eq1) \\ 4x - 2y = 14 & 2 \times (Eq2) \end{cases}$$

$$0 = 0$$

Dependent system. Infinitely many solutions.

$$17. \begin{cases} -6x + 4y = 10 & (Eq1) \\ 3x - 2y = 5 & (Eq2) \end{cases}$$

$$\begin{cases} -6x + 4y = 10 & (Eq1) \\ 6x - 4y = 10 & 2 \times (Eq2) \end{cases}$$

$$0 = 10$$

No solution. Lines are parallel.

$$18. \begin{cases} 2x + 3y = 9 & (Eq1) \\ -x - y = -2 & (Eq2) \end{cases}$$

$$\begin{cases} 2x + 3y = 9 & (Eq1) \\ -2x - 2y = -4 & 2 \times (Eq2) \end{cases}$$

$$y = 5$$

Substituting to find x

$$2x + 3(5) = 9$$

$$2x + 15 = 9$$

$$2x = -6$$

$$x = -3$$

The solution is $(-3, 5)$.

$$19. \begin{cases} 2x + y = -3 & (Eq1) \\ 4x - 2y = 10 & (Eq2) \end{cases}$$

$$\begin{cases} 4x + 2y = -6 & 2 \times (Eq1) \\ 4x - 2y = 10 & (Eq2) \end{cases}$$

$$8x = 4$$

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

Substituting to find y

$$2\left(\frac{1}{2}\right) + y = -3$$

$$1 + y = -3$$

$$y = -4$$

The solution is $\left(\frac{1}{2}, -4\right)$.

20. Algebraically:

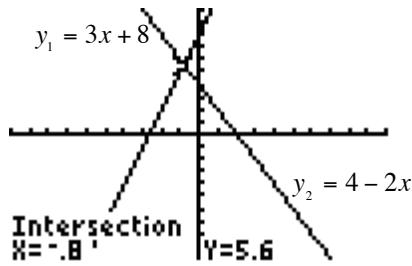
$$3x + 8 < 4 - 2x$$

$$5x + 8 < 4$$

$$5x < -4$$

$$x < -\frac{4}{5}$$

Graphically:



$[-10, 10]$ by $[-10, 10]$

$3x + 8 < 4 - 2x$ implies that the solution region is $x < -\frac{4}{5}$.

The interval notation is $\left(-\infty, -\frac{4}{5}\right)$.

21. Algebraically:

$$3x - \frac{1}{2} \leq \frac{x}{5} + 2$$

$$10\left(3x - \frac{1}{2}\right) \leq 10\left(\frac{x}{5} + 2\right)$$

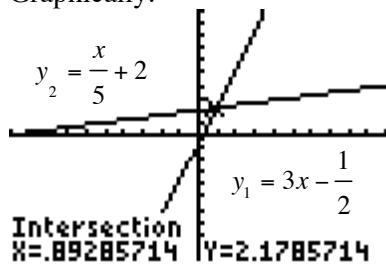
$$30x - 5 \leq 2x + 20$$

$$28x - 5 \leq 20$$

$$28x \leq 25$$

$$x \leq \frac{25}{28}$$

Graphically:



$[-10, 10]$ by $[-10, 10]$

$3x - \frac{1}{2} \leq \frac{x}{5} + 2$ implies that the solution region is $x \leq \frac{25}{28}$.

The interval notation is $\left(-\infty, \frac{25}{28}\right]$.

22. Algebraically:

$$18 \leq 2x + 6 < 42$$

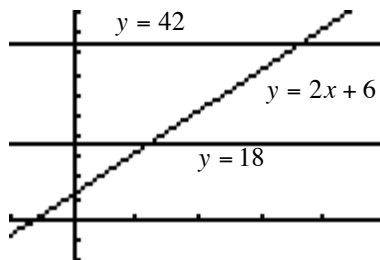
$$18 - 6 \leq 2x + 6 - 6 < 42 - 6$$

$$12 \leq 2x < 36$$

$$\frac{12}{2} \leq \frac{2x}{2} < \frac{36}{2}$$

$$6 \leq x < 18$$

Graphically:



$[-5, 25]$ by $[-10, 50]$

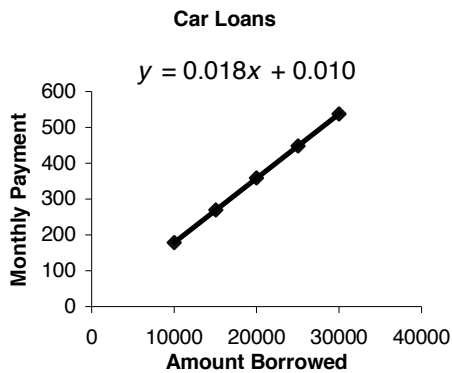
$18 \leq 2x + 6 < 42$ implies that the solution region is $6 \leq x < 18$.

The interval notation is $[6, 18)$.

Chapter 2 Review Exercises

23. a. Yes. As each amount borrowed increases by \$5000, the monthly payment increases by \$89.62.
- b. Yes. Since the first differences are constant, a linear model will fit the data exactly.

24. a.



Rounded model:

$$P = f(A) = 0.018A + 0.010$$

Unrounded model:

$$f(A) = 0.017924A + 0.010$$

b. Using the unrounded model from part a):

$$\begin{aligned} f(28,000) &= 0.017924(28,000) + 0.010 \\ &= 501.88 \end{aligned}$$

The predicted monthly payment on a car loan of \$28,000 is \$501.88.

c. Yes. Any input could be used for A .

d.

$$\begin{aligned} f(A) &\leq 500 \\ 0.017924A + 0.010 &\leq 500 \\ 0.017924A &\leq 499.99 \\ A &\leq \frac{499.99}{0.017924} \\ A &\leq 27,895.00 \end{aligned}$$

The loan amount needs to be less than or equal to approximately \$27,895.00.

25. $982.06t + 32,903.77 = 40,760.25$

$$t = 8, \text{ and the year is } 1998.$$

26. $f(x) = 4500$

27. a. Let x = the number of months past May 1998, and $f(x)$ = average weekly hours worked. Then $f(x) = 34.6$.

b. Yes. The average rate of change is zero.

28. a. Let x = monthly sales.

$$2100 = 1000 + 5\%x$$

$$2100 = 1000 + 0.05x$$

$$1100 = 0.05x$$

$$x = \frac{1100}{0.05} = 22,000$$

If monthly sales are \$22,000, both positions will yield the same monthly income.

b. Considering the solution from part a), if sales exceed \$22,000 per month, the 2nd position will yield a greater salary.

29. Profit = $10\%(24,000 \cdot 12) = 28,800$

$$\text{Cost} = 24,000 \cdot 12 = 288,000$$

Revenue = $8(24,000 + 12\% \cdot 24,000) + 4x$, where x is the selling price of the remaining four cars.

$$\text{Profit} = \text{Revenue} - \text{Cost}$$

$$28,800 = (215,040 + 4x) - 288,000$$

$$28,800 = 4x - 72,960$$

$$4x = 101,760$$

$$x = \frac{101,760}{4} = 25,440$$

The remaining four cars should be sold for \$25,440 each.

- 30.** Let x = amount invested in the safe account, and let $420,000 - x$ = amount invested in the risky account.

$$6\%x + 10\%(420,000 - x) = 30,000$$

$$0.06x + 42,000 - 0.10x = 30,000$$

$$-0.04x = -12,000$$

$$x = \frac{-12,000}{-0.04}$$

$$x = 300,000$$

The couple invests \$300,000 in the safe account and \$120,000 in the risky account.

- 31.** Let $y = 285$, and solve for x .

$$285 = -0.629x + 293.871$$

$$285 - 293.871 =$$

$$-0.629x + 293.871 - 293.871$$

$$-8.871 = -0.629x$$

$$\frac{-0.629x}{-0.629} = \frac{-8.871}{-0.629}$$

$$x \approx 14.1$$

Therefore, the writing score is 285 in $1980 + 14 = 1994$.

- 32.** Profit occurs when $R(x) > C(x)$.

$$500x > 48,000 + 100x$$

$$400x > 48,000$$

$$x > 120$$

The company will make a profit when producing and selling more than 120 units.

33. a.
$$\begin{aligned} P(x) &= 564x - (40,000 + 64x) \\ &= 564x - 40,000 - 64x \\ &= 500x - 40,000 \end{aligned}$$

b.
$$\begin{aligned} 500x - 40,000 &> 0 \\ 500x &> 40,000 \\ x &> 80 \end{aligned}$$

- c.** There is a profit when more than 80 units are produced and sold.

34. a.
$$y + 15,000x = 300,000$$

$$y = 300,000 - 15,000x$$

$$300,000 - 15,000x < 150,000$$

$$-15,000x < -150,000$$

$$x > 10$$

- b.** After 10 years, the property value will be below \$150,000.

35. a.
$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{895 - 455}{250 - 150} = \frac{440}{100} = 4.4$$

The average rate of change is \$4.40 per unit.

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

$$y - 455 = 4.4(x - 150)$$

$$y - 455 = 4.4x - 660$$

$$y = 4.4x - 205$$

$$P(x) = 4.4x - 205$$

- b.** Profit occurs when $P(x) > 0$.

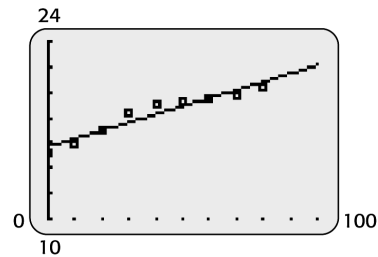
$$4.4x - 205 > 0$$

$$4.4x > 205$$

$$x = \frac{205}{4.4} = 46.5909 \approx 47$$

The company will make a profit when selling at least 47 units.

36. a.
$$y = 0.0638x + 15.702$$



- b.** See part a) above.

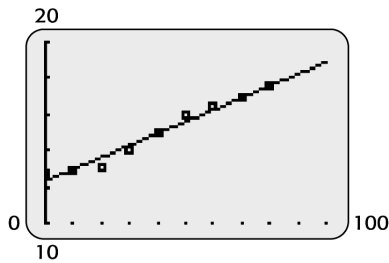
c. $f(99) = 0.0638(99) + 15.702$
 $= 22.018$

In 2049 the average woman is expected to live 22 years beyond age 65. Her life expectancy is 87 years.

d. $y > 84 - 65$
 $0.0638x + 15.702 > 19$
 $0.0638x > 3.298$
 $x > \frac{3.298}{0.0638}$
 $x > 51.69$

For years 2002 and beyond, the average woman is expected to live more than 84 years.

37. a. $y = 0.0655x + 12.324$



b. See part a) above.

c. $g(130) = 0.0655(130) + 12.324$
 $= 8.515 + 12.324$
 $= 20.839 \approx 20.8$

In 2080 (1950 + 130), a 65-year old male is expected to live 20.8 more years. The overall life expectancy is 86 years.

d. A life expectancy of 90 years translates into $90 - 65 = 25$ years beyond age 65.

Therefore, let $g(x) = 25$.

$$0.0655x + 12.324 = 25$$

$$0.0655x = 25 - 12.324$$

$$0.0655x = 12.676$$

$$x = \frac{12.676}{0.0655} = 193.527 \approx 194$$

In approximately the year 2144 (1950 + 194), male life expectancy will be 90 years.

e. A life expectancy of 81 years translates into $81 - 65 = 16$ years beyond age 65.

$$g(x) \leq 16$$

$$0.0655x + 12.324 \leq 16$$

$$0.0655x \leq 3.676$$

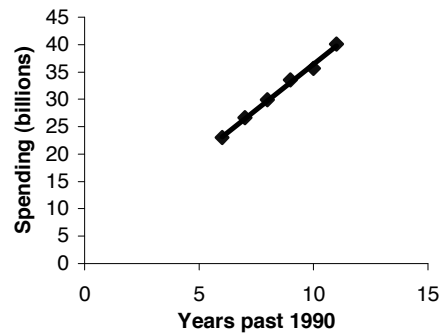
$$x \leq \frac{3.676}{0.0655}$$

$$x \leq 56.1$$

Up to approximately the year 2006 (1950 + 56), male life expectancy will be less than 81 years.

38. a.

Education Spending
 $y = 3.317x + 3.254$



A linear model is reasonable.

b. See part a) above.

c. $y = 3.3171429x + 3.2542857$
 $y = 3.3171429(2002 - 1990)$
 $\quad + 3.2542857$
 $y = 3.3171429(12) + 3.2542857$
 $y = 43.06$
 Approximately \$43.1 billion

$y = 285.269(22) + 9875.170$
 $= 6275.918 + 9875.170$
 $= 16,151.088$

In 2002, the predicted population is 16,151,088.

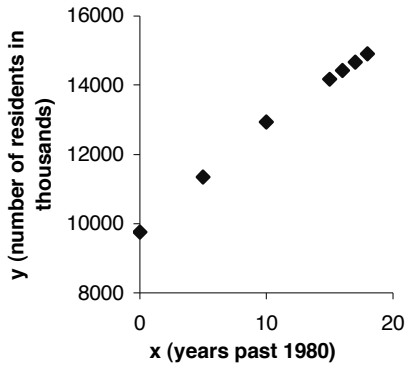
Using the unrounded model:

X	Y ₁
18	15010
19	15295
20	15581
21	15866
22	16151
23	16436
24	16722

$Y_1 = 16151.0938134$

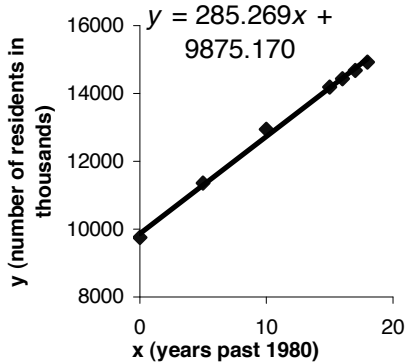
The unrounded model predicts that the population in 2002 will be approximately 16,151,094.

39. a.



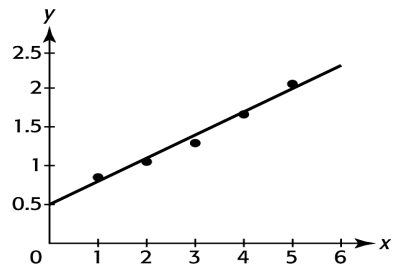
Yes. A linear model would fit the data well. The data points lie approximately along a line.

b.



c. In 2002, $x = 2002 - 1980 = 22$.

40. a. $y = 0.301x + 0.477$



A linear model is reasonable.

b. See part a) above.

c. See part a) above. The line seems to fit the data points very well.

41. a.

$$\begin{aligned}
 y &> 48.66 \\
 -0.763x + 85.284 &> 48.66 \\
 -0.763x &> -36.624 \\
 x &< \frac{-36.624}{-0.763} \\
 x &< 48
 \end{aligned}$$

(Note the inequality sign switch.)

For years less than $1950 + 48 = 1998$, the marriage rate was greater than 48.66 per 1000 women.

b.

$$\begin{aligned}
 y &< 41.03 \\
 -0.763x + 85.284 &< 41.03 \\
 -0.763x &< -44.254 \\
 x &> \frac{-44.254}{-0.763} \\
 x &> 58
 \end{aligned}$$

(Note the inequality sign switch.)

For years beyond $1950 + 58 = 2008$, the marriage rate per 1000 women will be less than 41.03.

42. $30p - 19x = 1$

Let $p = 3.2$.

$30(3.2) - 19x = 1$

$96 - 19x = 1$

$-19x = -95$

$x = \frac{-95}{-19} = 5$

The year is $1990 + 5 = 1995$.

Let $p = 7$.

$30(7) - 19x = 1$

$210 - 19x = 1$

$-19x = -209$

$x = \frac{-209}{-19} = 11$

The year is $1990 + 11 = 2001$

From 1995 until 2001, Marijuana use is in the range of 3.2%-7%.

43. Let $3(12) \leq x \leq 5(12)$ or

$36 \leq x \leq 60$.

Then

$0.554(36) - 2.886 \leq y \leq 0.554(60) - 2.886$.

Therefore, $17.058 \leq y \leq 30.354$. Or, rounding to the nearest month,

$17 \leq y \leq 30$.

The criminal is expected to serve between 17 and 30 months inclusive.

44. Let x = the amount in the safer fund, and y = the amount in the riskier fund.

$$x + y = 240,000 \quad (\text{Eq1})$$

$$0.08x + 0.12y = 23,200 \quad (\text{Eq2})$$

$$-0.08x - 0.08y = -19,200 \quad -0.08 \times (\text{Eq1})$$

$$0.08x + 0.12y = 23,200 \quad (\text{Eq2})$$

$$0.04y = 4000$$

$$y = \frac{4000}{0.04} = 100,000$$

Substituting to calculate x

$$x + 100,000 = 240,000$$

$$x = 140,000$$

The safer fund contains \$140,000, while the riskier fund contains \$100,000.

45. Let x = number of units.

$$R = C$$

$$565x = 6000 + 325x$$

$$240x = 6000$$

$$x = 25$$

The number of units that produced to create a break even point is 25.

46. Let x = dosage of Medication A, and
let y = dosage of Medication B.

$$\begin{cases} 6x + 2y = 25.2 & (Eq1) \end{cases}$$

$$\begin{cases} \frac{x}{y} = \frac{2}{3} & (Eq2) \end{cases}$$

Solving (Eq2) for x yields

$$3x = 2y$$

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

Substituting

$$6\left(\frac{2}{3}y\right) + 2y = 25.2$$

$$4y + 2y = 25.2$$

$$6y = 25.2$$

$$y = 4.2$$

Substituting to calculate x

$$x = \frac{2}{3}(4.2)$$

$$x = 2.8$$

Medication A dosage is 2.8 mg while
Medication B dosage is 4.2 mg.

47. Let p = price and q = quantity.

$$\begin{cases} 3q + p = 340 & (Eq1) \end{cases}$$

$$\begin{cases} -4q + p = -220 & (Eq2) \end{cases}$$

$$\begin{cases} -3q - 1p = -340 & -1 \times (Eq1) \end{cases}$$

$$\begin{cases} -4q + p = -220 & (Eq2) \end{cases}$$

$$-7q = -560$$

$$q = \frac{-560}{-7} = 80$$

Substituting to calculate p

$$3(80) + p = 340$$

$$240 + p = 340$$

$$p = 100$$

Equilibrium occurs when the price is \$100,
and the quantity is 80 pairs.

48. Let p = price and q = quantity.

$$\begin{cases} p = \frac{q}{10} + 8 & (Eq1) \end{cases}$$

$$\begin{cases} 10p + q = 1500 & (Eq2) \end{cases}$$

Substituting

$$10\left(\frac{q}{10} + 8\right) + q = 1500$$

$$q + 80 + q = 1500$$

$$2q = 1420$$

$$q = 710$$

Substituting to calculate p

$$p = \frac{710}{10} + 8$$

$$p = 79$$

Equilibrium occurs when the price is \$79,
and the quantity is 710 units.

49. a. $x + y = 2600$

b. $40x$

c. $60y$

d. $40x + 60y = 120,000$

e.
$$\begin{cases} x + y = 2600 & (Eq1) \\ 40x + 60y = 120,000 & (Eq2) \end{cases}$$

$$\begin{cases} -40x - 40y = -104,000 & -40 \times (Eq1) \\ 40x + 60y = 120,000 & (Eq2) \end{cases}$$

$$20y = 16,000$$

$$y = \frac{16,000}{20} = 800$$

Substituting to calculate x

$$x + 800 = 2600$$

$$x = 1800$$

The promoter needs to sell 1800 tickets at \$40 per ticket and 800 tickets at \$60 per ticket.

50. a. $x + y = 500,000$

b. $0.12x$

c. $0.15y$

d. $0.12x + 0.15y = 64,500$

e.
$$\begin{cases} x + y = 500,000 & (Eq1) \\ 0.12x + 0.15y = 64,500 & (Eq2) \end{cases}$$

$$\begin{cases} -0.12x - 0.12y = -60,000 & -0.12 \times (Eq1) \\ 0.12x + 0.15y = 64,500 & (Eq2) \end{cases}$$

$$0.03y = 4500$$

$$y = \frac{4500}{0.03} = 150,000$$

Substituting to calculate x

$$x + 150,000 = 500,000$$

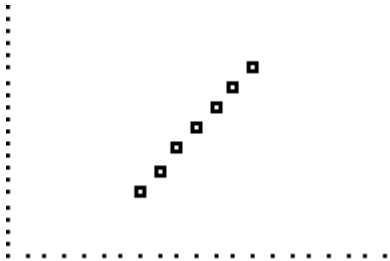
$$x = 350,000$$

Devote \$350,000 in the 12% investment and \$150,000 in the 15% investment.

Group Activity/Extended Application I: Taxes

1. Domain is Taxable Income: $\{63,700; 63,800; 63,900; 64,000; 64,100; 64,200; 64,300\}$
 Range is Income Tax Due: $\{8779, 8804, 8829, 8854, 8879, 8904, 8929\}$

2.



[63000, 65000] by [8700, 9000]

3. Yes, the points appear to lie on a line.
4. Yes, the inputs change by \$100, and the outputs change by \$25.
5. Yes, the rate of change is constant, and is \$.25 per \$1.00 of income.
6. Yes, a linear function will fit the data points exactly.
7. Using the first data point, $(63700, 8779)$
 $y - 8779 = .25(x - 63700)$
 $y - 8779 = .25x - 15925$
 $y = .25x - 7146$
8. Using $x = 63900$
 $y = .25(63900) - 7146 = 8829$,
 Using $x = 64100$
 $y = .25(64100) - 7146 = 8879$
 Both results match the table values.
9. The table is a discrete function.
10. Yes, the model can be used for any taxable income between \$63,700 and \$64,300, and therefore is a continuous function.
11. For $x = 64150$
 $y = .25(64150) - 7146 = 8891.50$.
 Thus the tax due on \$64,150 is \$8891.50.