CHAPTER 2
Linear Models, Equations, and Inequalities

Toolbox Exercises

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
$\frac{x}{3} = 6$
$3\left(\frac{x}{3}\right) = 3(6)$
$x = 18$

6. $-5x = 10$
Division Property
$\frac{-5x}{-5} = \frac{10}{-5}$
$x = -2$

7. $2x + 8 = -12$
Subtraction Property and Division Property
$2x + 8 = -12$
$2x + 8 - 8 = -12 - 8$
$2x = -20$
$\frac{2x}{2} = \frac{-20}{2}$
$x = -10$

8. $\frac{x}{4} - 3 = 5$
Addition Property and Multiplication Property
$\frac{x}{4} - 3 = 5$
$\frac{x}{4} - 3 + 3 = 5 + 3$
$\frac{x}{4} = 8$
$4\left(\frac{x}{4}\right) = 4(8)$
$x = 32$

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

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

$10x-2=4$

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

$10x=6$

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

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

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

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

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

$3x=48$

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

$x=16$

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

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

$5x=-20$

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

$x=-4$

13.

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

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

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

$5x-15=-5$

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

$5x=10$

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

$x=2$

14.

$-2(3x-1)=4x-8$

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

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

$-10x+2=-8$

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

$-10x=-10$

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

$x=1$

15.

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

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

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

$18x-7=2$

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

$18x=9$

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

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

16.

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

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

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

$-13x+12=-1$

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

$-13x=-13$

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

$x=1$

17. $y=2x$ 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. There are 6 significant digits.

34. There are 4 significant digits.

35. There are 2 significant digits.

36. There are 5 significant digits.

37. There are 5 significant digits.

38. There are 2 significant digits.

39. **a.** $f(x)=0.008x^2-632.578x+480.650$

b. $f(x)=0.00754x^2-633x+481$

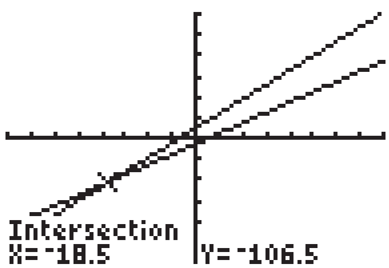
c. $f(x)=0.007453x^2-632.6x+480.7$

Section 2.1 Skills Check

1.

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

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]

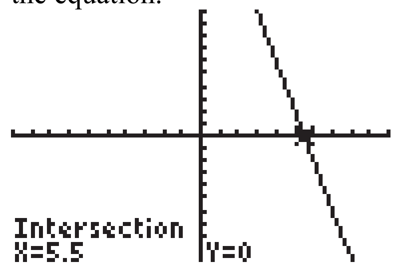
2.

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

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.

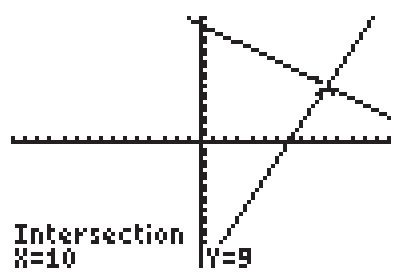


[–10, 10] by [–10, 10]

3.

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

Applying the intersections of graphs method yields:



[–15, 15] by [–20, 20]

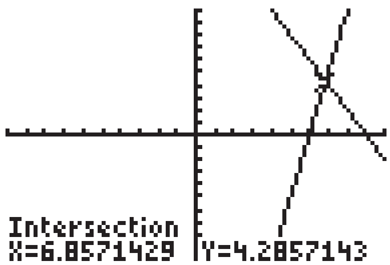
4. $5(y-6)=18-2y$

$$5y-30=18-2y$$

$$7y=48$$

$$y=\frac{48}{7}\approx 6.8571429$$

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.

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

$LCD:12$

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

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

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

$$-24x-10=3$$

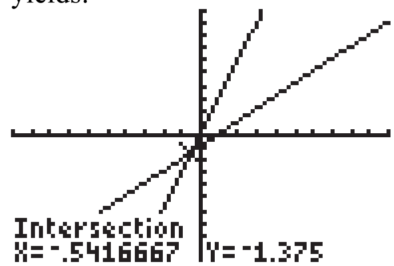
$$-24x-10+10=3+10$$

$$-24x=13$$

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

$$x=-\frac{13}{24}\approx -0.5416667$$

Applying the intersections of graphs method yields:



[–10, 10] by [–10, 10]

6.

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

$LCD:12$

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

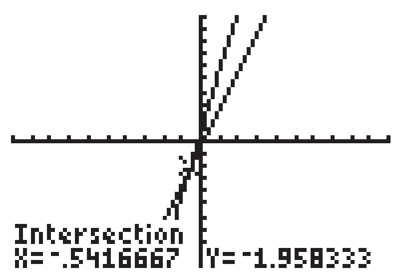
$$36x-4=60x+9$$

$$-24x-4=9$$

$$-24x=13$$

$$x=-\frac{13}{24}\approx -0.5416667$$

Applying the intersections of graphs method yields:

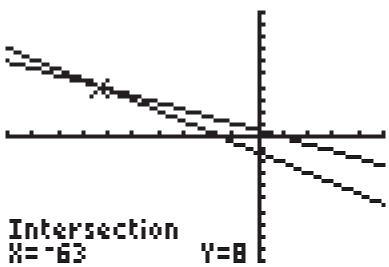


[–10, 10] by [–10, 10]

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:

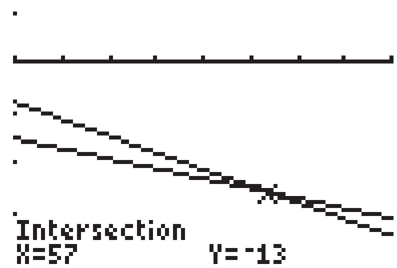


[–100, 50] by [–20, 20]

8.

$$\frac{4(y-2)}{5}-y=6-\frac{y}{3}$$
$$LCD:15$$
$$15\left[\frac{4(y-2)}{5}-y\right]=15\left[6-\frac{y}{3}\right]$$
$$3\left[4(y-2)\right]-15y=90-5y$$
$$12(y-2)-15y=90-5y$$
$$12y-24-15y=90-5y$$
$$-3y-24=90-5y$$
$$2y=114$$
$$y=57$$

Applying the intersections of graphs method yields:

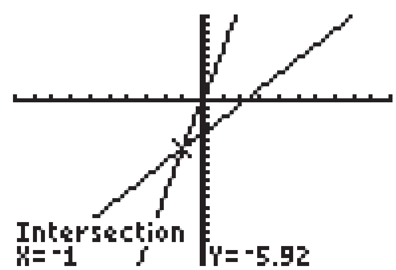


[30, 70] by [–20, 5]

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

9. $5.92t=1.78t-4.14$
$$5.92t-1.78t=-4.14$$
$$4.14t=-4.14$$
$$\frac{4.14t}{4.14}=\frac{-4.14}{4.14}$$
$$t=-1$$

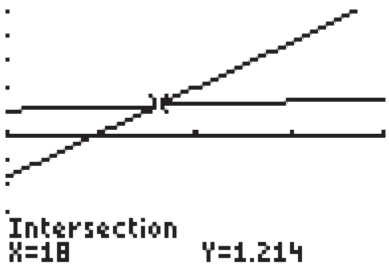
Applying the intersections of graphs method yields:



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

$LCD=60$

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

$45+12x-20=48x$

$-36x=-25$

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

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

$LCD=30$

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

$20x-36=15+25x$

$-5x=51$

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

13. $3(x-1)+5=4(x-3)-2(2x-3)$

$3x-3+5=4x-12-4x+6$

$3x+2=-6$

$3x=-8$

$x=-\frac{8}{3}$

14. $5x-(x-2)+7=-(2x-9)-8(3x+6)$

$5x-x+2+7=-2x+9-24x-48$

$4x+9=-26x-39$

$30x=-48$

$x=-\frac{48}{30}=-\frac{8}{5}$

15. $2[3(x-10)-3(2x+1)]=3[-(x-6)-5(2x-4)]$

$2[3x-30-6x-3]=3[-x+6-10x+20]$

$6x-60-12x-6=-3x+18-30x+60$

$-6x-66=-33x+78$

$27x=144$

$x=\frac{144}{27}=\frac{16}{3}$

16. $\frac{3x}{5}-\frac{x-2}{6}=\frac{2x+3}{4}-1$

$LCD=60$

$60\left(\frac{3x}{5}-\frac{x-2}{6}\right)=60\left(\frac{2x+3}{4}-\frac{1}{1}\right)$

$12(3x)-10(x-2)=15(2x+3)-60(1)$

$36x-10x+20=30x+45-60$

$26x+20=30x-15$

$-4x=-35$

$x=\frac{-35}{-4}=\frac{35}{4}$

17. $\frac{6-x}{4}-2-\frac{6-2x}{3}=-\left[\frac{5x-2}{3}-\frac{x}{5}\right]$

$LCD=60$

$60\left(\frac{6-x}{4}-2-\frac{6-2x}{3}\right)=60\left(-\left[\frac{5x-2}{3}-\frac{x}{5}\right]\right)$

$90-15x-120-120+40x=-100x+40+12x$

$25x-150=-88x+40$

$113x=190$

$x=\frac{190}{113}$

18. $12-\frac{3-2x}{5}-\frac{4-x}{3}=-5\left[\frac{5x}{2}-\frac{2(3x+2)}{5}\right]$

$$12-\frac{3-2x}{5}-\frac{4-x}{3}=\frac{-25x}{2}+\frac{10(3x+2)}{5}$$
$$LCD=30$$
$$30\left(12-\frac{3-2x}{5}-\frac{4-x}{3}\right)=30\left(\frac{-25x}{2}+\frac{10(3x+2)}{5}\right)$$
$$22x+302=-195x+120$$
$$217x=-182$$
$$x=-\frac{182}{217}=-\frac{26}{31}$$

19. 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.

20. 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.

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

$$\frac{3}{2}x-6=0$$
$$LCD:2$$
$$2\left(\frac{3}{2}x-6\right)=2(0)$$
$$3x-12=0$$
$$3x=12$$
$$x=4$$

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

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

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

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

23. **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 for the function. Therefore, the solution to $f(x)=0$ is 2.

24. a. The x-intercept is –5, since an input of –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 for the function. Therefore, the solution to $f(x)=0$ is –5.

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

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

27. Using the first screen, the equation that would need to be solved is $2x-5=3(x-2)$. Using the second screen, the y values are the same when $x=1$.

28. Using the first screen, the equation that would need to be solved is $-5(2x+4)=3x-7$. Using the second screen, the y values are the same when $x=-1$.

29. 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.

30. 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.

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

$$330+40x=0$$
$$40x=-330$$
$$x=-8.25$$

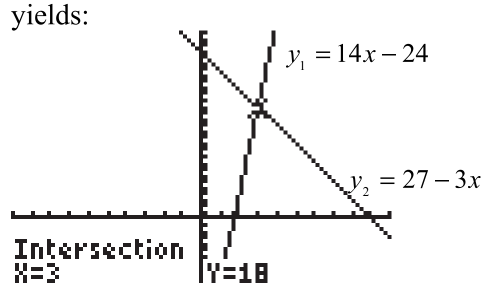
The zero of the function, the x-intercept of the graph of the function, and the solution to $f(x)=0$ are all –8.25.

32. 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.

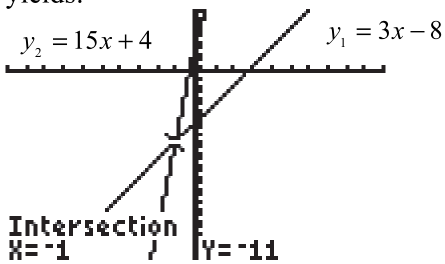
33. Applying the intersections of graphs method yields:



[–10, 10] by [–10. 30]

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

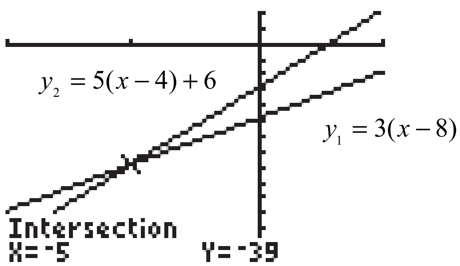
34. Applying the intersections of graphs method yields:



[–10, 10] by [–30. 10]

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

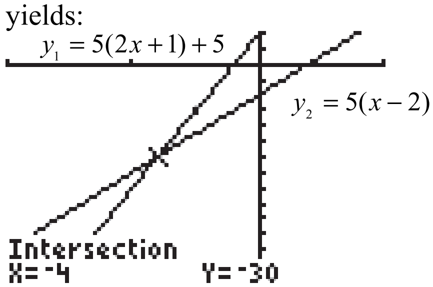
35. Applying the intersections of graphs method yields:



[–10, 5] by [–70, 10]

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

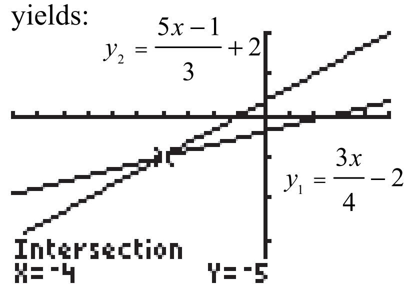
36. Applying the intersections of graphs method yields:



[–10, 5] by [–70, 10]

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

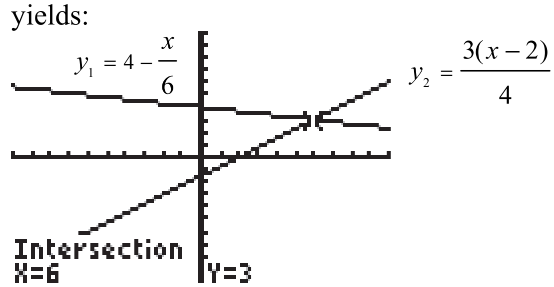
37. Applying the intersections of graphs method yields:



[–10, 5] by [–20, 10]

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

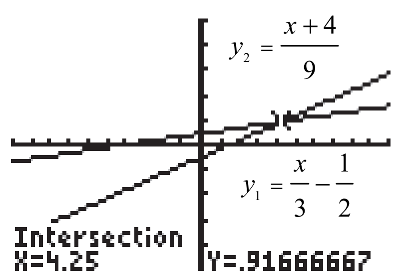
38. Applying the intersections of graphs method yields:



[–10, 10] by [–10, 10]

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

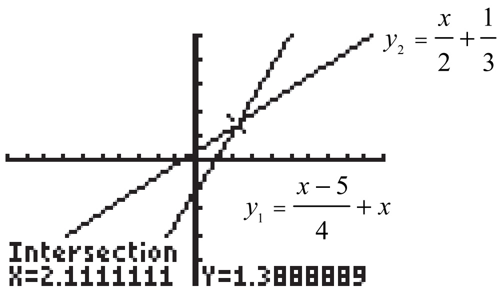
39. Applying the intersections of graphs method yields:



[–10, 10] by [–5, 5]

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

40. Applying the intersections of graphs method yields:



[–10, 10] by [–5, 5]

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

41.
$$A = P(1+rt)$$
$$A = P + Prt$$
$$A - P = P - P + Prt$$
$$A - P = Prt$$
$$\frac{A-P}{Pt} = \frac{Prt}{Pt}$$
$$\frac{A-P}{Pt} = r \text{ or } r = \frac{A-P}{Pt}$$

42.
$$V = \frac{1}{3}\pi r^2 h$$
$$LCD: 3$$
$$3(V) = 3\left(\frac{1}{3}\pi r^2 h\right)$$
$$3V = \pi r^2 h$$
$$\frac{3V}{\pi r^2} = \frac{\pi r^2 h}{\pi r^2}$$
$$\frac{3V}{\pi r^2} = h \text{ or } h = \frac{3V}{\pi r^2}$$

43.
$$5F - 9C = 160$$
$$5F - 9C + 9C = 160 + 9C$$
$$5F = 160 + 9C$$
$$\frac{5F}{5} = \frac{160+9C}{5}$$
$$F = \frac{9}{5}C + \frac{160}{5}$$
$$F = \frac{9}{5}C + 32$$

44.
$$4(a-2x) = 5x + \frac{c}{3}$$
$$LCD: 3$$
$$3\left(4(a-2x)\right) = 3\left(5x + \frac{c}{3}\right)$$
$$12(a-2x) = 15x + c$$
$$12a - 24x = 15x + c$$
$$12a - 24x - 15x = 15x - 15x + c$$
$$12a - 39x = c$$
$$12a - 12a - 39x = c - 12a$$
$$-39x = c - 12a$$
$$x = \frac{c-12a}{-39} \text{ or}$$
$$x = \left(\frac{-1}{-1}\right)\left(\frac{c-12a}{-39}\right) = \frac{12a-c}{39}$$

45.

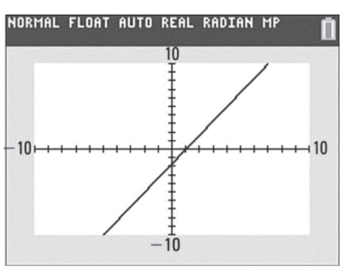
$$\frac{P}{2}+A=5m-2n$$
$$LCD:2$$
$$2\left(\frac{P}{2}+A\right)=2(5m-2n)$$
$$P+2A=10m-4n$$
$$P+2A-10m=10m-4n-10m$$
$$\frac{P+2A-10m}{-4}=\frac{-4n}{-4}$$
$$\frac{P+2A-10m}{-4}=n$$
$$n=\frac{P}{-4}+\frac{2A}{-4}-\frac{10m}{-4}$$
$$n=\frac{5m}{2}-\frac{P}{4}-\frac{A}{2}$$

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

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

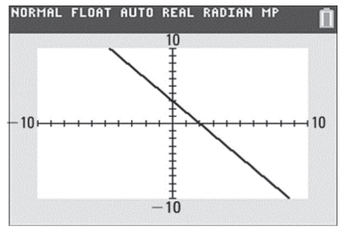
47. $5x-3y=5$

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



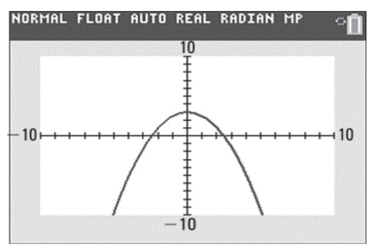
48. $3x+2y=6$

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



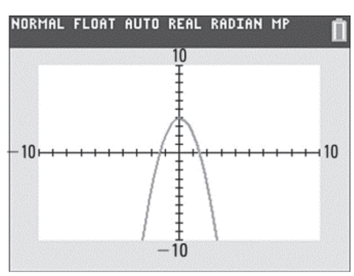
49. $x^2+2y=6$

$$2y=6-x^2$$
$$y=\frac{6-x^2}{2}$$
$$y=3-\frac{1}{2}x^2 \quad \text{or}$$
$$y=-\frac{1}{2}x^2+3$$



50. $4x^2+2y=8$

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



Section 2.1 Exercises

51. 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.

52. 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.

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

$$9000 = P(1 + (0.10)(5))$$
$$9000 = P(1 + 0.50)$$
$$9000 = 1.5P$$
$$P = \frac{9000}{1.5} = 6000$$

$6000 must be invested as the principal.

54. $I = t - 0.55(1 - h)(t - 58)$

$$84.7 = 88 - 0.55(1 - h)(88 - 58)$$
$$84.7 = 88 - 0.55(1 - h)(30)$$
$$84.7 = 88 - 16.5(1 - h)$$
$$84.7 = 88 - 16.5 + 16.5h$$
$$84.7 = 71.5 + 16.5h$$
$$16.5h = 13.2$$
$$h = \frac{13.2}{16.5}$$
$$h = 0.8$$

A relative humidity of 80% gives an index value of 84.7.

55. $M = 0.819W - 3.214$

$$41.52 = 0.819W - 3.214$$
$$0.819W = 44.734$$
$$W = \frac{44.734}{0.819} = 54.620$$

The median annual salary for whites is approximately $54,620.

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

$$5C - 9C = 160$$
$$-4C = 160$$
$$C = \frac{160}{-4}$$
$$C = -40$$

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

57. Let $f(x) = 8351.64$, and calculate x.

$$8351.64 = 486.48x + 3486.84$$
$$486.48x = 4864.8$$
$$x = \frac{4864.8}{486.48} = 10$$

In the year 2020, 10 years after 2010, the federal income tax per capita will be \$8,351.64.

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

$$259.4 = 0.155x + 255.37$$
$$259.4 - 255.37 = 0.155x$$
$$4.03 = 0.155x$$
$$x = \frac{4.03}{0.155}$$
$$x = 26$$

An x-value of 26 corresponds to the year 1996 (1970 + 26). The average reading score was 259.4 in 1996.

59. Let $y = 3236$, and solve for x.

$$3236 = -286.8x + 8972$$
$$-5736 = -286.8x$$
$$x = \frac{-5736}{-286.8}$$
$$x = 20$$

An x-value of 20 corresponds to the year 2026 (2006 + 20). The number of banks will be 3236 in 2026.

60. **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 specialty golf hats 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 specialty golf hats will avoid a loss.

61. Let $y = 4.29$, and calculate x.

$$132x + 1000(4.29) = 9570$$
$$132x + 4290 = 9570$$
$$132x = 5280$$
$$x = \frac{5280}{132} = 40$$

In the year 2020 (1980 + 40), the marriage rate per 1000 population will be 4.29.

62. Let $f(x) = 29.44$, and calculate x.

$$29.44 = -0.065x + 31.39$$
$$0.065x = 1.95$$
$$x = \frac{1.95}{0.065} = 30$$

In the year 2020 (1990 + 30), the percent of world forest area land will be 29.44%

63. Note that p is in millions. A population of 320,000,000 corresponds to a p-value of 320. Let $p = 320$ and solve for x.

$$320 = 2.6x + 177$$
$$320 - 177 = 2.6x$$
$$143 = 2.6x$$
$$x = \frac{143}{2.6}$$
$$x = 55$$

An x-value of 55 corresponds to the year 2015 (1960 + 55). Based on the model, in 2015, the population is estimated to be 320,000,000.

64. Let $D(x)$ = 12.88, and calculate x.

$$12.88 = 0.328x + 6.32$$
$$6.56 = 0.328x$$
$$x = \frac{6.56}{0.328} = 20$$

An x-value of 20 corresponds to the year 2020 (2000 + 20). The total disposable income for the U.S. is projected to be \$12.88 billion in 2020.

65. a. Let H = 130, and calculate t.

$$130 = -0.65x + 143$$
$$-13 = -0.65x$$
$$x = \frac{-13}{-0.65} = 20$$

A person 20 years old should have the desired heart rate for weight loss of 130.

b. Let H = 104, and calculate t.

$$104 = -0.65x + 143$$
$$-39 = -0.65x$$
$$x = \frac{-39}{-0.65} = 60$$

A person 60 years old should have the desired heart rate for weight loss of 104.

66. When the number of females under 18 is 38,169,750, then y = 38,169.75. Let y = 38,169.75, and solve for x.

$$38{,}169.75 = 154.03x + 34{,}319$$
$$3{,}850.75 = 154.03x$$
$$x = \frac{3{,}850.75}{154.03}$$
$$x = 25$$

In the year 2025 (2000 + 25), the population of females under 18 will be 38,169,750.

67. Let y = 14.8, and solve for x.

$$14.8 = 0.876x + 6.084$$
$$14.8 - 6.084 = 0.876x$$
$$8.716 = 0.876x$$
$$x = \frac{8.716}{0.876}$$
$$x = 9.94977 \approx 10$$

An x-value of 10 corresponds to the year 1990 (1980 + 10). The model shows that it was in 1990 that the number of Hispanics in the U.S. civilian population was 14.8 million.

68. Let y = 96, and solve for x.

$$96 = 1.36x + 68.8$$
$$27.2 = 1.36x$$
$$x = \frac{27.2}{1.36}$$
$$x = 20$$

An x-value of 20 corresponds to the year 2020 (2000 + 20). Based on the model, the U.S. population with internet access will reach 96% in 2020.

69. Let y = 20, and solve for x.

$$20 = 0.077x + 14$$
$$6 = 0.077x$$
$$x = \frac{6}{0.077}$$
$$x \approx 78$$

An x-value of approximately 78 corresponds to the year 2028 (1950 + 78). Based on the model, the life expectancy at age 65 will reach 20 additional years in 2028.

70. Let $y = 9.43$, and solve for x.

$$\begin{aligned}9.43 &= 0.234x + 6.856\\ 2.574 &= 0.234x\\ x &= \frac{2.574}{0.234} = 11\end{aligned}$$

An x-value of 11 corresponds to the year 2021 (2010 + 11). The model indicates that there will be 9.43 billion subscribers in 2021.

71. Let x represent the score on the fifth exam.

$$90 = \frac{92+86+79+96+x}{5}$$

LCD: 5

$$5(90) = 5\left(\frac{92+86+79+96+x}{5}\right)$$

$$450 = 353 + x$$

$$x = 97$$

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

72. 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 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.

73. 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.

74. 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.

75. 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.

$$40{,}000x = 10{,}000$$

$$x = 0.25 = 25\%$$

76. 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.

$95,000x=9500$

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

77. Total cost = Original price + Sales tax

Let x = original price.

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

$29,998=x+0.06x$

$29,998=1.06x$

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

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

78. 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.

79. $A=P+Prt$

$A-P=P-P+Prt$

$A-P=Prt$

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

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

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

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

81.

$A=P(1+rt)$

$A=P+Prt$

$A-P=P-P+Prt$

$A-P=Prt$

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

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

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

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

$r=.1=10\%$

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

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

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

$P=\$3200$

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

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

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

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

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

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

85. Yes, the circumference of a circle varies directly with the radius of a circle since the relationship fits the direct variation format of $y = kx$, or in the case of a circle, $C = 2\pi r$, where the constant of variation is 2π.

86. Since $y = kx$ is the direct variation format, let $y = H$ (heat) and $x = A$ (amount of protein).

$H = kA$

$32 = k(1)$, so $k = 32$

Then $H = 32A$

$180 = 32A$

$A = 5.625$

Thus the amount of proteins to be burned to produce 180 calories is 5.625 grams.

87. a. Since $y = kx$ is the direct variation format, let $y = B$ (BMI) and $x = w$ (weight of person in kilograms).

$B = kw$

$20 = k(45)$, so $k = \frac{4}{9}$

Thus the constant of variation is 4/9.

b. Then $32 = \frac{4}{9}A$

$\frac{9}{4}(32) = A$

$A = 72$

The woman would weigh 72 kilograms.

88. Since $y = kx$ is the direct variation format, let $y = C$ (cost of land) and $x = S$ (size of land).

$C = kS$

$172{,}800 = k(2500)$, so $k = 69.12$

Then $C = 69.12(5500)$

$C = 380{,}160$

Thus the cost of a piece of land that is 5500 square feet would be $380,160.

Section 2.2 Skills Check

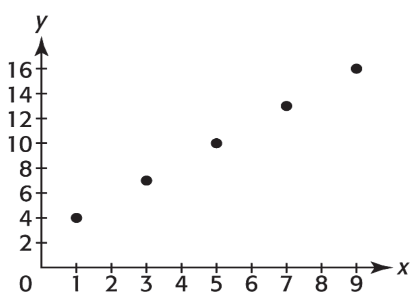
1. No. The data points do not lie close to a straight line.

2. Yes. The data points lie approximately in a straight line.

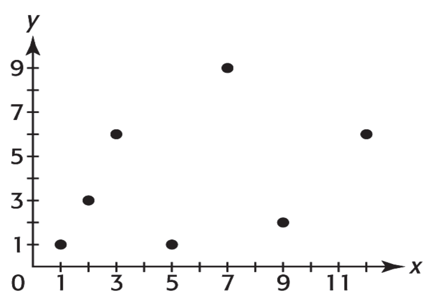
3. Can be modeled approximately since not all points lie exactly on a line.

4. Can be modeled exactly since all points line up with a straight edge.

5.



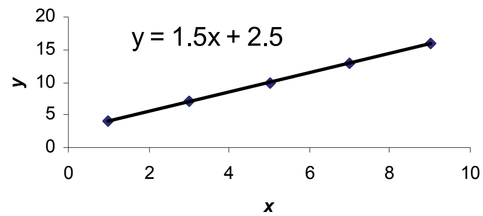
6.



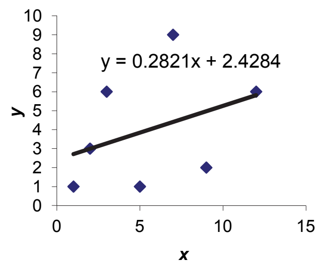
7. Exactly. The differences of the inputs and outputs are constant for the first three.

8. No. The differences for the inputs and outputs are not constant. Also, a line will not connect perfectly the points on the scatter plot.

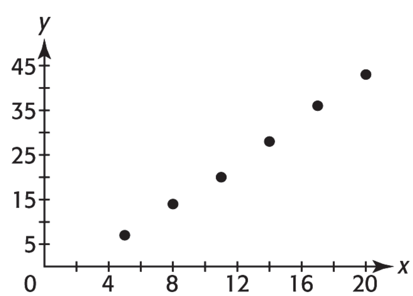
9. Using a spreadsheet program yields



10. Using a spreadsheet program yields

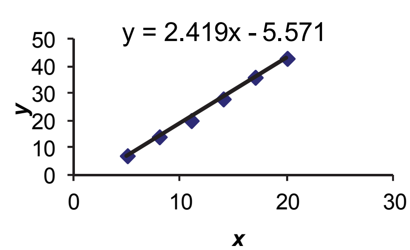


11.



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

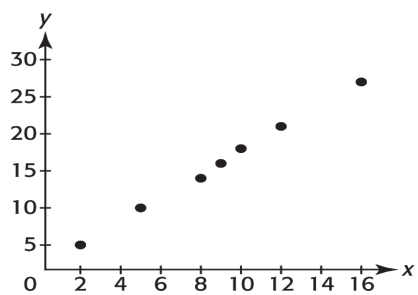
13. Using a spreadsheet program yields



14. $f(3) = 2.419(3) - 5.571$
$= 7.257 - 5.571$
$= 1.686 \approx 1.7$

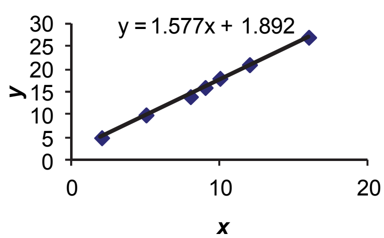
$f(5) = 2.419(5) - 5.571$
$= 12.095 - 5.571$
$= 6.524 \approx 6.5$

15.



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

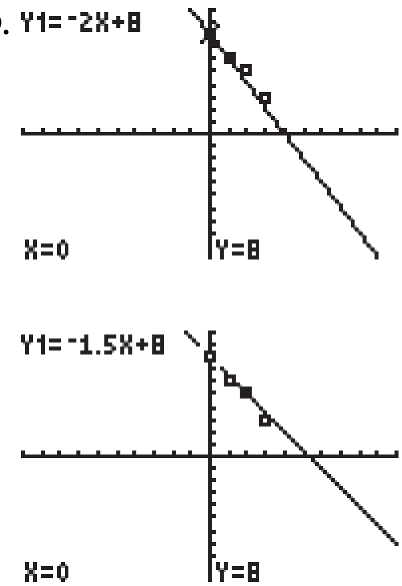
17.



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

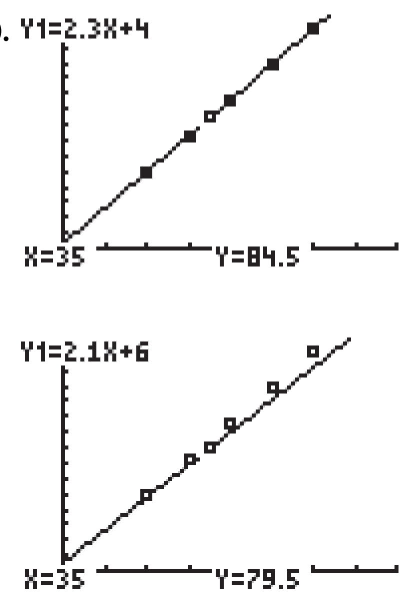
$f(5) = 1.577(5) + 1.892$
$= 7.885 + 1.892$
$= 9.777 \approx 9.8$

19.



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

20.



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 vary, but don't grow at an approximately constant rate.

c. Approximately linear. The first differences increase at a constant rate.

22. The difference between inputs is not constant. The inputs are not equally spaced.

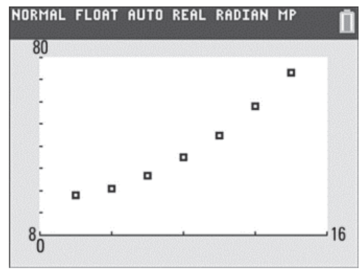
Section 2.2 Exercises

23. 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 better.

24. a.



b. No. A line would not fit the points on the scatter plot.

25. a. No; increases from one year to the next are not constant.

b. Yes; increases from one year to the next are constant.

c. $m = \frac{1320 - 1000}{70 - 66} = \frac{320}{4} = 80$

$S - s_1 = m(x - x_1)$

$S - 1000 = 80(x - 66)$

$S = 80x - 4280$

26. 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 7^{th} year is $1420. This is an extrapolation since the result is beyond the original table values.

d. Discretely, since the interest payments occur only at the end of the years.

27. a. Yes, the first differences are constant for uniform inputs.

b. Two; two point are needed to find the equation of any linear equation.

c. $m = \dfrac{45-40}{99-88} = \dfrac{5}{11}$

$D - d_1 = m(w - w_1)$

$D - 40 = \dfrac{5}{11}(w - 88)$

$D = \dfrac{5}{11}w$

d. For $w = 209$,

$D = \dfrac{5}{11}w$

$D = \dfrac{5}{11} \cdot 209$

$D = 95$

A dosage of 95 mg would be needed for a 209 pound patient.

28. a. Yes, the first differences are constant for uniform inputs.

b. $m = \dfrac{152-160}{30-20} = \dfrac{-8}{10} = -0.8$

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

$y - 160 = -0.8(x - 20)$

$y = -0.8x + 176$

29. a. No, the first differences are not constant for uniform inputs.

b. Using a graphing calculator and the linear regression function, the equation of the model will be $y = 0.328x + 6.316.$

c. Let $x = 23$,

$y = 0.328x + 6.316$

$y = 0.328(23) + 6.316$

$y = 7.544 + 6.316$

$y = 13.86$

The total disposable income in 2023 in projected to be $13.86 billion.

30. a. Using a graphing calculator and the linear regression function, the equation of the model will be $y = 6.39x + 169.86.$

b. No; the differences are not constant for uniform inputs.

c. Let $x = 8$,

$y = 6.39x + 169.86$

$y = 6.39(8) + 169.86$

$y = 51.12 + 169.86$

$y = 220.98$

The net expenditures in 2023 in projected to be $220.98 billion.

d. Let $y = 208.2$,

$y = 6.39x + 169.86$

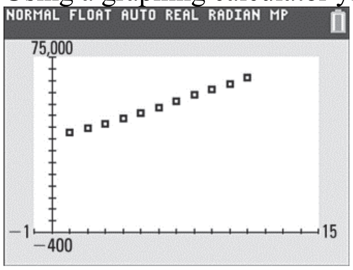
$208.2 = 6.39x + 169.86$

$38.34 = 6.39x$

$x = 6$

The net expenditures will reach $208.2 billion in the year 2021 (2015 + 6).

31. a. Using a graphing calculator yields

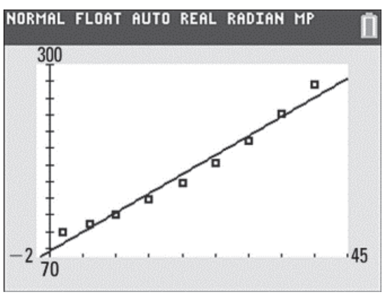


b. Using a graphing calculator and the linear regression function, the equation of the model will be $y = 2375x + 39{,}630.$.

c. The slope is 2375; the average annual wage is expected to increase $2375 per year.

32. a. Using a graphing calculator and the linear regression function, the equation of the model will be $y = 4.594x + 77.130.$

b.



c. The slope is 4.594; the consumer price index is expected to increase by approximately $4.59 per year.

33. a. Using a graphing calculator and the linear regression function, the equation of the model will be $y = 0.465x + 16.696.$

b. Let $x = 17,$

$y = 0.465x + 16.696$

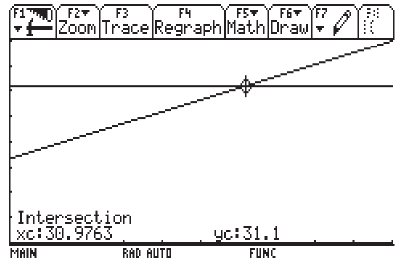
$y = 0.465(17) + 16.696$

$y = 7.905 + 16.696$

$y = 24.601$

The percent of U.S. adults with diabetes in 2027 in projected to be 24.6%.

c.

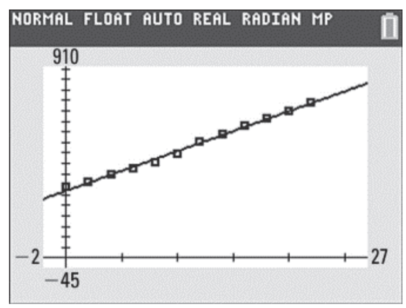


[0, 50] by [0, 40]

According to the graph, in the year 2041, the percent of U.S. adults with diabetes will be 31.1%.

34. a. Using a graphing calculator and the linear regression function, the equation of the model will be $y = 18.962x + 321.509.$

b.



The model is a good fit.

c. Let $x = 17,$

$y = 18.962x + 321.509$

$y = 18.962(17) + 321.509$

$y = 322.354 + 321.509$

$y = 643.863$

The metric tons of carbon monoxide emissions in 2027 is projected to be 643.9.

d. Let $y = 776.6$,

$$y = 18.962x + 321.509$$
$$776.6 = 18.962x + 321.509$$
$$455.091 = 18.962x$$
$$x = 24$$

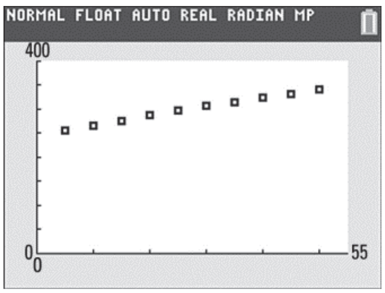
The metric tons of carbon dioxide emissions will reach 776.6 in the year 2034 (2010 + 24).

e. Let $y = 336.827$,

$$y = 1.890x + 247.994$$
$$336.827 = 1.890x + 247.994$$
$$88.833 = 1.890x$$
$$x = 47$$

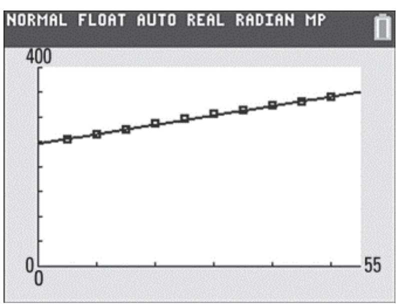
The U.S. population for residents over age 16 will reach 336.827 million in the year 2057 (2010 + 57).

35. a. Using a graphing calculator yields



b. Using a graphing calculator and the linear regression function, the equation of the model will be $y = 1.890x + 247.994$.

c.



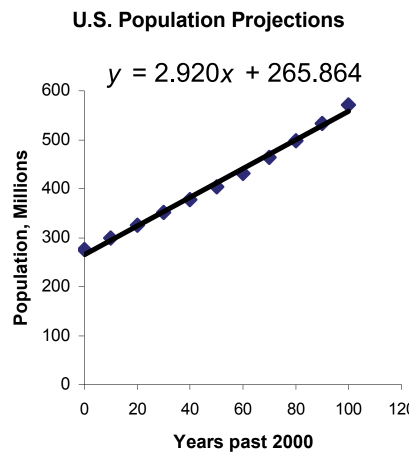
The model is a good fit.

d. Let $x = 32$,

$$y = 1.890x + 247.994$$
$$y = 1.890(32) + 247.994$$
$$y = 60.48 + 247.994$$
$$y = 308.474$$

The U.S. population for residents over age 16 in 2042 in projected to be 308.474 million.

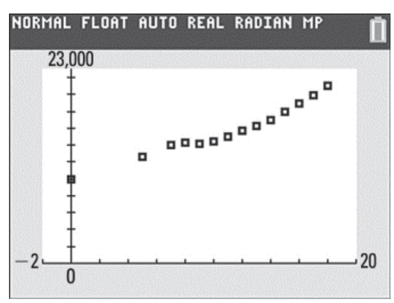
36. a. Using a spreadsheet program yields



b. $f(65) \approx 455.7$. The projected population in the year 2065 is 455.7 million.

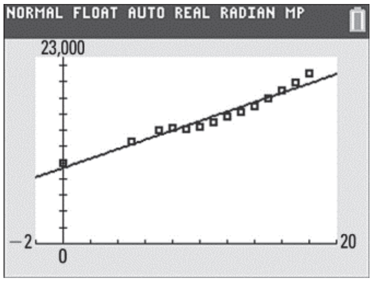
c. In 2080, $x = 80$. The population is predicted to be 499.5 million people, fairly close to the value in the table.

37. a. Using a graphing calculator yields



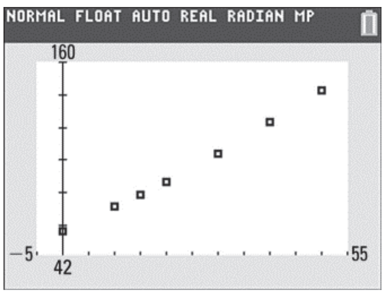
b. $y = 579x + 9410$

c.



It appears to not be a good fit.

38. a. Using a graphing calculator yields



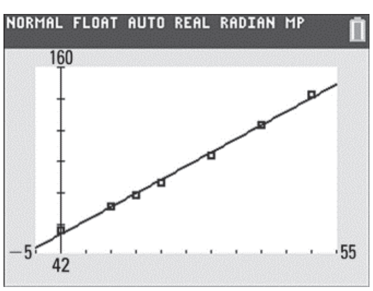
b. $y = 1.731x + 54.087$

c. Let $x = 35$,

$$y = 1.731x + 54.087$$
$$y = 1.731(35) + 54.087$$
$$y = 60.585 + 54.087$$
$$y = 114.672$$

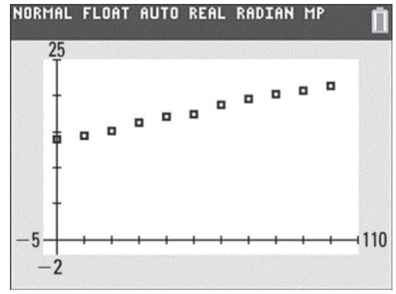
The number of individuals in the U.S. civilian non-institutional population 16 years and older who are non-White or Hispanic in 2035 is projected to be 114.7 million.

d.



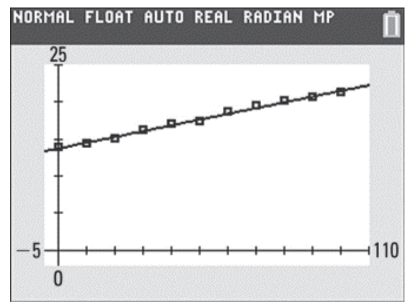
It appears to be a good fit.

39. a. Using a graphing calculator yields



b. $y = 0.077x + 13.827$

c.



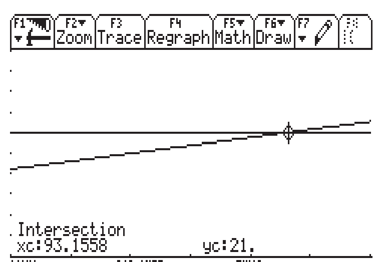
It appears to be a good fit.

d. Let $x = 72$,

$$y = 0.077x + 13.827$$
$$y = 0.077(72) + 13.827$$
$$y = 5.544 + 13.827$$
$$y = 19.371$$

The additional years of life expectancy at age 65 in 2022 is projected to be 19.4 years.

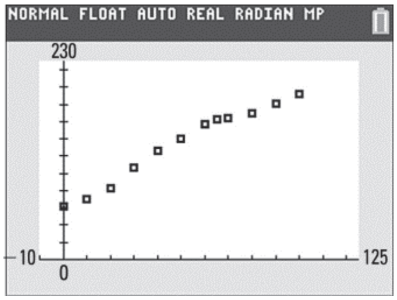
e.



[70, 100] by [15, 35]

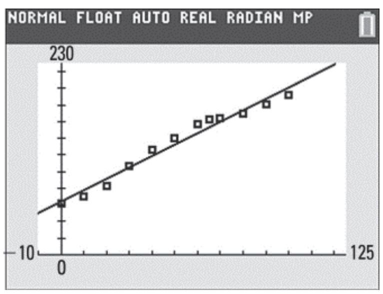
According to the graph, in the year 2043 (when $x = 93$), the additional life expectancy at age 65 will be 21 years.

40. a. Using a graphing calculator yields



b. $y = 1.377x + 64.068$

c.



It appears to not be a good fit.

d. Let $x = 95$,

$y = 1.377x + 64.068$

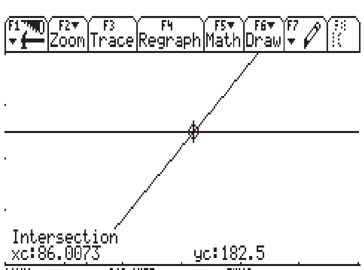
$y = 1.377(95) + 64.068$

$y = 130.815 + 64.068$

$y = 194.883$

The size of the U.S. workforce in 2045 is projected to be 194.9 million.

e.

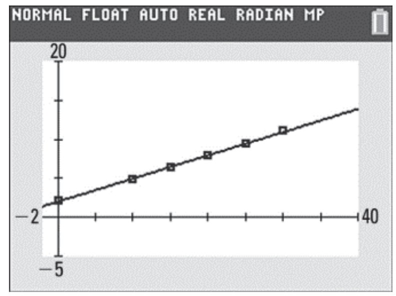


[70, 100] by [170, 190]

According to the graph, in the year 2036 (when $x = 86$), the size of the U.S. workforce will be 182.5 million.

41. a. $y = 0.297x + 2.043$

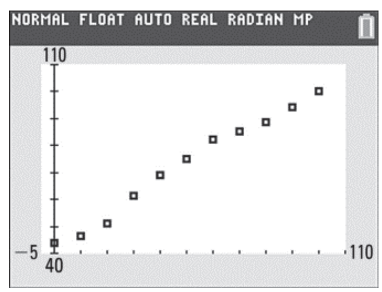
b. Using a graphing calculator yields



It appears to be a good fit.

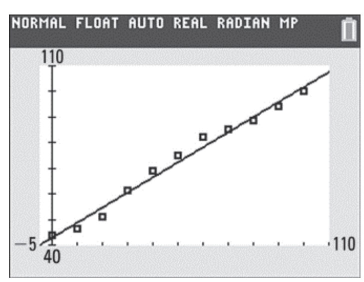
c. The slope of the equation is approximately 0.3 percentage points per year.

42. a. Using a graphing calculator yields



b. $y = 0.587x + 43.145$

c.

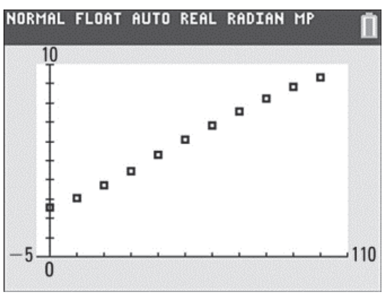


It appears to be a good fit.

d. Let $x = 101$,
$y = 0.587x + 43.145$
$y = 0.587(101) + 43.145$
$y = 59.287 + 43.145$
$y = 102.432$
The number of men in the workforce in 2051 is projected to be 102.432 million.

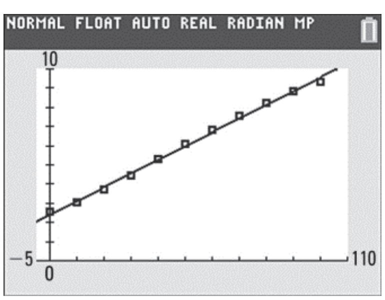
e. Let $y = 99.5$,
$y = 0.587x + 43.145$
$99.5 = 0.587x + 43.145$
$56.355 = 0.587x$
$x = 96$
The number of men in the workforce is expected to 99.5 million in the year 2046 (1950 + 96).

43. a. Using a graphing calculator yields



b. $y = 0.0715x + 2.42$

c.



It appears to be a good fit.

d. Let $x = 57$,
$y = 0.0715x + 2.42$
$y = 0.0715(57) + 2.42$
$y = 4.0755 + 2.42$
$y = 6.4955$
The total world population 2007 was 6.5 billion people.

e. Let $y = 10$,
$y = 0.0715x + 2.42$
$10 = 0.0715x + 2.42$
$7.58 = 0.0715x$
$x = 106$
The total world population is expected to be 10 billion people in the year 2056 (1950 + 106).

44. a. $y = 486.5x + 3487$

b. Let $x = 10$,
$y = 486.5x + 3487$
$y = 486.5(10) + 3487$
$y = 4865 + 3487$
$y = 8352$
The income tax per capita in 2020 is projected to be \$8352.

c. Let $y = 10{,}784$
$y = 486.5x + 3487$
$10{,}784 = 486.5x + 3487$
$7297 = 486.5x$
$x = 15$
The income tax per capita is expected to be \$10,784 in the year 2025 (2010 + 15).

45. a. $y = 138.217x + 97.867$

b. Let $x = 28$,

$$y = 138.217x + 97.867$$
$$y = 138.217(28) + 97.867$$
$$y = 3870.076 + 97.867$$
$$y = 3967.943$$

The expenditures for health care in the U.S. in 2018 is projected to be \$3967.943 billion.

c. Let $y = 4659$

$$y = 138.217x + 97.867$$
$$4659 = 138.217x + 97.867$$
$$4561.133 = 138.217x$$
$$x = 33$$

The expenditures for health care is expected to be \$4659 billion in the year 2023 (1990 + 33).

Section 2.3 Skills Check

1. To determine if an ordered pair is a solution of the system of equations, substitute each ordered pair into both equations.

a. For the first equation, and the point (2,1)

$2x + 3y = -1$

$2(2) + 3(1) = 4 + 3 = 7$

For the second equation, and the point (2,1)

$x - 4y = -6$

$(2) - 4(1) = 2 - 4 = -2$

The point (2, 1) works in neither equation, thus is not a solution of the system.

b. For the first equation, and the point $(-2,1)$

$2x + 3y = -1$

$2(-2) + 3(1) = -4 + 3 = -1$

For the second equation, and the point $(-2,1)$

$x - 4y = -6$

$(-2) - 4(1) = -2 - 4 = -6$

The point $(-2,1)$ works in both of the equations, thus is a solution of the system.

2. To determine if an ordered pair is a solution of the system of equations, substitute each ordered pair into both equations.

a.

For the first equaton, and the point $(\frac{3}{2}, -\frac{1}{2})$

$4x - 2y = 7$

$4(\frac{3}{2}) - 2(-\frac{1}{2}) = 6 + 1 = 7$

For the second equaton, and the point $(\frac{3}{2}, -\frac{1}{2})$

$-2x + 2y = -4$

$-2(\frac{3}{2}) + 2(-\frac{1}{2}) = -3 - 1 = -4$

The point $(\frac{3}{2}, -\frac{1}{2})$ works in both of the equations, thus is a solution of the system.

b.

For the first equaton, and the point $(\frac{1}{2}, -\frac{3}{2})$

$4x - 2y = 7$

$4(\frac{1}{2}) - 2(-\frac{3}{2}) = 2 + 3 = 5$

For the second equaton, and the point $(\frac{1}{2}, -\frac{3}{2})$

$-2x + 2y = -4$

$-2(\frac{1}{2}) + 2(-\frac{3}{2}) = -1 - 3 = -4$

The point $(\frac{1}{2}, -\frac{3}{2})$ works in only one of the equations, thus is not a solution of the system.

3. Applying the substitution method

$y = 3x - 2$ and $y = 3 - 2x$

$3 - 2x = 3x - 2$

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

$3 - 5x = -2$

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

$-5x = -5$

$x = 1$

Substituting to find y

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

$(1,1)$ is the intersection point.

4. Applying the elimination method

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

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

$19x = 57$

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

Substituting to find y

$3(3) + 2y = 5$

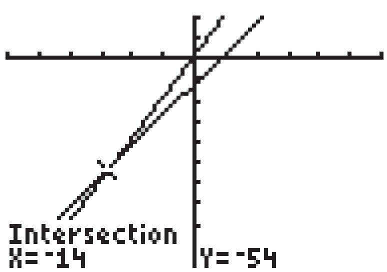
$9 + 2y = 5$

$2y = -4$

$y = -2$

$(3,-2)$ is the intersection point.

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



[–30, 30] by [–100, 20]

The solution for #5 is $(-14,-54)$.

6. 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

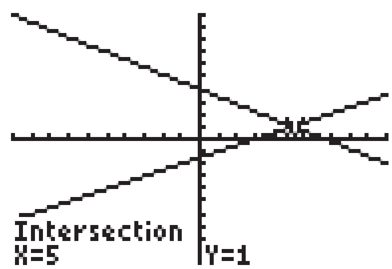
$3x + 5y = 20$

$5y = -3x + 20$

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

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

Applying the intersection of graphs method



[–10, 10] by [–10, 10]

The solution is $(5,1)$.

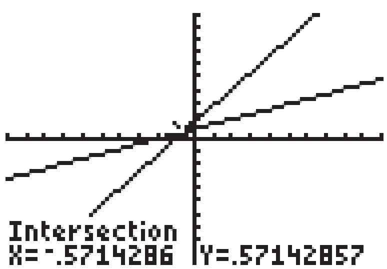
7. Solving the equations for y

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

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

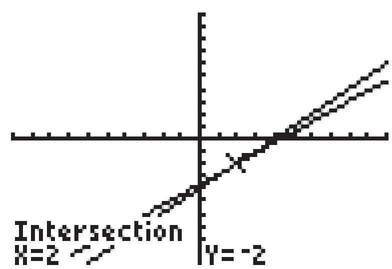
8. Solving the equations for y

$$5x-6y=22$$
$$-6y=-5x+22$$
$$y=\frac{-5x+22}{-6}$$
$$y=\frac{5}{6}x-\frac{11}{3}$$

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 $(2,-2)$.

9. $\begin{cases} 2x+5y=6 & (Eq\,1) \\ x+2.5y=3 & (Eq\,2) \end{cases}$

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

$0=0$

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

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

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

$0=-3$

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

11.

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

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 $(2,-2)$.

12.

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

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 $(4,2)$.

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

Solving the first equation for x

$2x-3y=5$

$2x=3y+5$

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

Substituting into the second equation

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

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

$15y+25+8y=2$

$23y+25=2$

$23y=-23$

$y=-1$

Substituting to find x

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

$2x+3=5$

$2x=2$

$x=1$

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

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

Solving the first equation for x

$4x-5y=-17$

$4x=5y-17$

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

Substituting into the second equation

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

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

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

$23y-51=-28$

$23y=23$

$y=1$

Substituting to find x

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

$4x-5=-17$

$4x=-12$

$x=-3$

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

15.

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

$\begin{cases} -2x-6y=-10 & -2\times(Eq\ 1) \\ 2x+4y=8 & (Eq2) \end{cases}$

$-2y=-2$

$y=1$

Substituting to find x

$x+3(1)=5$

$x+3=5$

$x=2$

The solution is $(2,1)$.

16.

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

$$\begin{cases} 8x-6y=-26 & 2(Eq\ 1) \\ 5x+6y=13 & (Eq2) \end{cases}$$

$13x=-13$

$x=-1$

Substituting to find x

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

$-4-3y=-13$

$-3y=-9$

$y=3$

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

17.

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

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

$14y=24$

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

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

18.

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

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

$-6x=4$

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

Substituting to find y

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

$-2+3y=5$

$3y=7$

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

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

19.

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

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

$29x=116$

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

Substituting to find y

$5(4)-3y=11$

$20-3y=11$

$-3y=-9$

$y=3$

The solution is $(4,3)$.

20.

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

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

$44x = 88$

$x = 2$

Substituting to find y

$8(2) - 4y = 0$

$16 - 4y = 0$

$-4y = -16$

$y = 4$

The solution is $(2,4)$.

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

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

$$\begin{cases} -6x - 12y = -24 & -2\times(Eq\ 1) \\ 6x + 12y = 24 & 3\times(Eq\ 2) \end{cases}$$

$0 = 0$

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

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

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

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

$0 = 0$

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

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

$$\begin{cases} 6x - 9y = 12 & (Eq\ 1) \\ -6x + 9y = 12 & -2\times(Eq\ 2) \end{cases}$$

$0 = 24$

No solution. Lines are parallel. This is an inconsistent system.

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

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

$0 = -5$

No solution. Lines are parallel. This is an inconsistent system.

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

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 $(2,4)$.

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

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 $(1, 2)$.

27.

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

Substituting the second equation into the first equation

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

$16y + 32 + 6y = 4$

$22y + 32 = 4$

$22y = -28$

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

Substituting to find x

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

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

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

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

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 $(1, -1)$.

29.

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

$\begin{cases} -6x + 15y = -48 & -3 \times (Eq\ 1) \\ 6x - 8y = 34 & (Eq\ 2) \end{cases}$

$7y = -14$

$y = -2$

Substituting to find x

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

$2x + 10 = 16$

$2x = 6$

$x = 3$

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

30.

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

$$\begin{cases} 12x - 3y = 12 & 3\times(Eq\ 1) \\ 6x + 3y = 15 & (Eq\ 2) \end{cases}$$

$$18x = 27$$

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

Substituting to find y

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

$$6 - y = 4$$

$$-y = -2$$

$$y = 2$$

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

31.

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

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

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

$$37y = 37$$

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

Substituting to find x

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

$$3x - 7 = -1$$

$$3x = 6$$

$$x = 2$$

The solution is $(2,1)$.

32.

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

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

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

$$-16y = 4$$

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

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

33.

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

$$\begin{cases} -8x + 6y = -18 & -2\times(Eq\ 1) \\ 8x - 6y = 16 & (Eq\ 2) \end{cases}$$

$$0 = -2$$

No solution. Lines are parallel.

34.

$$\begin{cases} 5x - 4y = 8 & (Eq\ 1) \\ -15x + 12y = -12 & (Eq\ 2) \end{cases}$$

$$\begin{cases} 15x - 12y = 24 & 3\times(Eq\ 1) \\ -15x + 12y = -12 & (Eq\ 2) \end{cases}$$

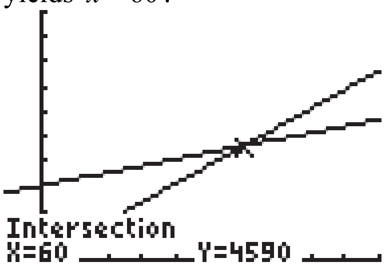
$$0 = 12$$

No solution. Lines are parallel.

Section 2.3 Exercises

35.
$$R = C$$
$$76.50x = 2970 + 27x$$
$$49.50x = 2970$$
$$x = \frac{2970}{49.50}$$
$$x = 60$$

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

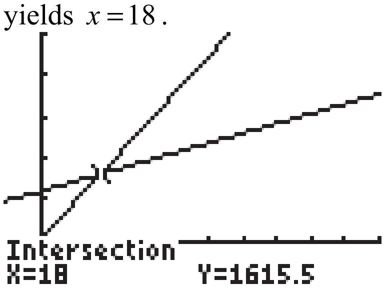


[–10, 100] by [–10, 10,000]

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

36.
$$R = C$$
$$89.75x = 23.50x + 1192.50$$
$$66.25x = 1192.50$$
$$x = \frac{1192.50}{66.25}$$
$$x = 18$$

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



[–10, 100] by [–1000, 5000]

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

37.
$$R = C$$
$$15.80x = 8593.20 + 3.20x$$
$$12.60x = 8593.20$$
$$x = \frac{8593.20}{12.60}$$
$$x = 682$$

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

38.
$$R = C$$
$$136.50x = 9661.60 + 43.60x$$
$$92.90x = 9661.60$$
$$x = \frac{9661.60}{92.90}$$
$$x = 104$$

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

39. a.
$$\begin{cases} p + 2q = 320 & (Eq1) \\ p - 8q = 20 & (Eq2) \end{cases}$$
$$\begin{cases} 4p + 8q = 1280 & 4\times(Eq\ 1) \\ p - 8q = 20 & (Eq\ 2) \end{cases}$$
$$5p = 1300$$
$$p = \frac{1300}{5} = 260$$
The equilibrium price is $260.

b. Substituting to find q
$$260 - 8q = 20$$
$$-8q = -240$$
$$q = \frac{-240}{-8} = 30$$
The equilibrium quantity occurs when 30 units are demanded and supplied.

40. 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 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.

41. a. For the drug Concerta, let

$x_1 = 0, y_1 = 2.4,$ and $x_2 = 11, y_2 = 10.$

Then, $\frac{y_2 - y_1}{x_2 - x_1} = \frac{10 - 2.4}{11 - 0} = 0.69$

Since $x_1 = 0, y_1$ is the y-intercept.

Thus the equation is $y = 0.69x + 2.4,$

representing the market share for

Concerta as a linear function of time.

b. For the drug Ritalin, let

$x_1 = 0, y_1 = 7.7,$ and $x_2 = 11, y_2 = 6.9.$

Then, $\frac{y_2 - y_1}{x_2 - x_1} = \frac{6.9 - 7.7}{11 - 0} = -0.073$

Since $x_1 = 0, y_1$ is the y-intercept.

Thus the equation is $y = -0.073x + 7.7,$

representing the market share for

Ritalin as a linear function of time.

c. To determine the number of weeks past the release date when the two market shares are equal, set the two linear equations equal, and solve for x. Thus,

$0.69x + 2.4 = -0.073x + 7.7$

$0.763x = 5.3$

$x = 6.946 \approx 7$ weeks

42. Equilibrium occurs when the demand equals the supply,

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

$1.50q = 349.50$

$q = 233$

Substituting to calculate p

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

When the price is \$236.90, 233 units are produced and sold. This level of production and price represents equilibrium.

43. The populations will be equal when the two equations are equal,

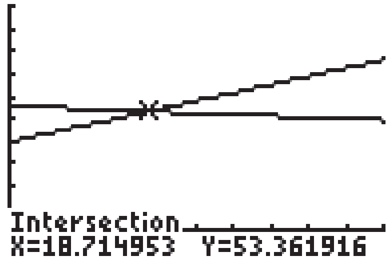
$0.293x + 157.8454 = 1.73x + 54.094$

$103.7514 = 1.437x$

$x = 72$

In the year 2072 (2000 + 72) is when the White, non-Hispanic population is projected to be the same as the remainder of the population.

44. Applying the intersection of graphs method



[0, 50] by [–10, 100]

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

45. $y_H = 0.224x + 9.0$ (the % of Hispanics)

$y_B = 0.057x + 12.3$ (the % of blacks)

Setting the first equation equal to the second equation, solve for *x*:

$0.224x + 9.0 = 0.057x + 12.3$

$.167x = 3.3$

$x = \dfrac{3.3}{.167} = 19.76 \approx 20$

Thus, 20 years after 1990, in the year 2010, the percent of Hispanics in the U.S. civilian non-institutional population equaled the percent of blacks.

46. a.

For the first birth, let

$x_1 = 1970, y_1 = 22.1,$ and $x_2 = 2010, y_2 = 25.5.$

Then, $\dfrac{y_2 - y_1}{x_2 - x_1} = \dfrac{25.5 - 22.1}{2010 - 1970} = 0.085$

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

$y - 22.1 = 0.085(x - 1970)$

$y - 22.1 = 0.085x - 167.45$

$y = 0.085x - 145.35$

representing the median age at giving first birth as a function of year.

b.

For the first marriage, let

$x_1 = 1970, y_1 = 20.9,$ and $x_2 = 2010, y_2 = 26.1.$

Then, $\dfrac{y_2 - y_1}{x_2 - x_1} = \dfrac{26.1 - 20.9}{2010 - 1970} = 0.13$

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

$y - 20.9 = 0.13(x - 1970)$

$y - 20.9 = 0.13x - 256.1$

$y = 0.13x - 235.2$

representing the median age for women at first marriage as a function of year.

c. To determine the crossover point, set the two linear equations found in the two previous parts equal, and solve for *x*. Thus,

$$0.085x - 145.35 = 0.13x - 235.2$$
$$89.85 = 0.045x$$
$$x = 1996.7 \approx 1997$$

No; the approximation is not the same point as when the actual crossover occurred.

47.

Let h = the 2016 revenue, and
let l = the 2013 revenue.

$$\begin{cases} h+2l=2144.9 & (Eq1) \\ h-l=135.5 & (Eq2) \end{cases}$$

$$\begin{cases} h+2l=2144.9 & (Eq\ 1) \\ 2h-2l=271 & 2\times(Eq\ 2) \end{cases}$$

$3h=2415.9$

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

Substituting to calculate l

$805.3-l=135.5$

$-l=-669.8$

$l=669.8$

The 2013 revenue is \$669.8 million, while the 2016 revenue is \$805.3 million.

48.

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

$$\begin{cases} h+l=83.5 & (Eq\ 1) \\ h-l=21.88 & (Eq\ 2) \end{cases}$$

$2h=105.38$

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

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.

49. a. $x+y=2400$

b. $30x$

c. $45y$

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

e.

$$\begin{cases} x+y=2400 & (Eq\ 1) \\ 30x+45y=84,000 & (Eq\ 2) \end{cases}$$

$$\begin{cases} -30x-30y=-72,000 & -30\times(Eq\ 1) \\ 30x+45y=84,000 & (Eq\ 2) \end{cases}$$

$15y=12,000$

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

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.

50. a. $x+y=500,000$

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

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

d. $0.10x+0.12y=53,000$

e.

$$\begin{cases} x+y=500,000 & (Eq\ 1) \\ 0.10x+0.12y=53,000 & (Eq\ 2) \end{cases}$$

$$\begin{cases} -0.10x-0.10y=-50,000 & -0.10\times(Eq\ 1) \\ 0.10x+0.12y=53,000 & (Eq\ 2) \end{cases}$$

$0.02y=3000$

$y=\dfrac{3000}{0.02}=150,000$

Substituting to calculate x

$x+150,000=500,000$

$x=350,000$

\$350,000 is invested in the 10% property, and \$150,000 is invested in the 12% property.

51. a.

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

$$\begin{cases} x + y = 100{,}000 & (Eq\ 1) \\ 0.08x + 0.12y = 9{,}000 & (Eq\ 2) \end{cases}$$

$$\begin{cases} -0.08x - 0.08y = -8{,}000 & -0.08 \times (Eq\ 1) \\ 0.08x + 0.12y = 9{,}000 & (Eq\ 2) \end{cases}$$

$0.04y = 1000$

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

Substituting to calculate x

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

$x = 75{,}000$

b. \$75,000 is invested in the 8% account, and \$25,000 is invested in the 12% account. Using two accounts minimizes investment risk.

52. a.

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

$$\begin{cases} x + y = 52{,}000 & (Eq\ 1) \\ 0.10x + 0.14y = 5{,}720 & (Eq\ 2) \end{cases}$$

$$\begin{cases} -0.10x - 0.10y = -5{,}200 & -0.10 \times (Eq\ 1) \\ 0.10x + 0.14y = 5{,}720 & (Eq\ 2) \end{cases}$$

$0.04y = 520$

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

Substituting to calculate x

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

$x = 39{,}000$

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

53.

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

$$\begin{cases} x + y = 250{,}000 & (Eq\ 1) \\ 0.066x + 0.086y = .07(x + y) & (Eq\ 2) \end{cases}$$

$66x + 86y = 70x + 70y \qquad 1000 \times (Eq\ 2)$

$16y = 4x$

$4y = x$

Then substituting $4y$ for x in Eq 1, 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.

54.

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

$$\begin{cases} x+y=300{,}000 & (Eq\ 1) \\ 0.062x+0.092y=.076(x+y) & (Eq\ 2) \end{cases}$$

$$62x+92y=76x+76y \qquad 1000\times(Eq\ 2)$$

$$16y=14x$$

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

Then substituting $\frac{7}{8}x$ for y in Eq 1, 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.

55.

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

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

$$\begin{cases} 10x+5y=800 \\ -5x-5y=-500 \end{cases}$$

Then using the elimination method

$$5x=300$$

$x=60$ cc's of the 10% solution

Substituting to calculate y

$y=40$ cc's of the 5% solution

Thus, 60 cc’s of the 10% solution should be mixed with 40 cc’s of the 5% solution to get 100 cc’s of the 8% solution.

56.

Let x = the amount (cc's) of the 16% solution,

and let y = the amount (cc's) of the 6% solution.

$$\begin{cases} x+y=200 \text{ (cc's of the final solution)} & (Eq\ 1) \\ 0.16x+0.06y=0.12(200) & (Eq\ 2) \end{cases}$$

$$\begin{cases} 16x+6y=2400 & 100\times(Eq\ 2) \\ -6x-6y=-1200 & -6\times(Eq\ 1) \end{cases}$$

Then using the elimination method

$10x=1200$

$x=120$ cc's of the 16% solution

Substituting to calculate y

$y=80$ cc's of the 6% solution

Thus, 120 cc's of the 16% solution should be mixed with 80 cc's of the 6% solution to get 200 cc's of the 12% solution.

57.

Let x = the number of glasses of milk,

and let y = the number of 1/4-pound

servings of meat.

Then the protein equation is:

$8.5x+22y=69.5 \qquad (Eq\ 1)$

and the iron equation is:

$0.1x+3.4y=7.1 \qquad (Eq\ 2)$

$$\begin{cases} 85x+220y=695 & 10\times(Eq\ 1) \\ 1x+34y=71 & 10\times(Eq\ 2) \end{cases}$$

$-85x-2890y=-6035 \qquad -85\times(Eq\ 2)$

$-2670y=-5340$

$$y=\frac{-5340}{-2670}=2$$

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 provide the desired quantities for the diet.

58.

Let x = the amount of substance A, and

let y = the amount of substance B.

Nutrient equation:

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

$$\begin{cases} x + y = 14 & (Eq1) \\ 0.06x + 0.10y = 1 & (Eq2) \end{cases}$$

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

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

$0.04y = 0.16$

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

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%.

59. To find when the percent of those enrolled equals that of those not enrolled, set the equations equal to each other and solve for x. Then find the percent by substituting into either one of the original equations.

$-0.282x + 19.553 = -0.086x + 13.643$

$-0.196x = -5.91$

$x = 30.153,$ the number of years after the year 2000, during the year 2031.

Substituting to calculate y:

$y = -0.282(30.153) + 19.553$

$y = 11\%$

It is estimated that in the year 2031, the percent of young adults aged 18 to 22 who use alcohol will be the same for those enrolled in college as for those not enrolled in college. That percent will be 11%.

60.

Let x = the amount of the 30% solution, and

let y = the amount of the 15% solution.

$x + y = 45$

Medicine concentration:

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

$$\begin{cases} x + y = 45 & (Eq1) \\ 0.30x + 0.15y = 9 & (Eq2) \end{cases}$$

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

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

$-0.15y = -4.5$

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

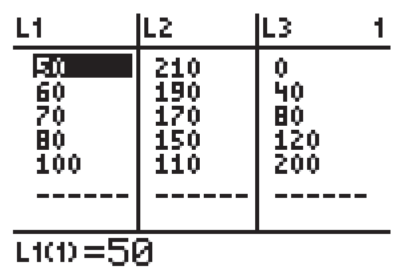
Substituting to calculate x

$x + 30 = 45$

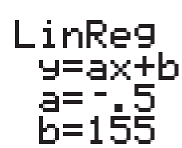
$x = 15$

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

61.



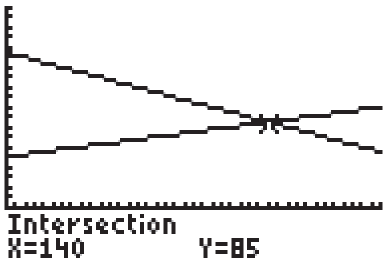
a. Demand function: Finding a linear model using L_2 as input and L_1 as output yields $p = -\frac{1}{2}q + 155$.



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

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.

62.

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

L1(1)=200

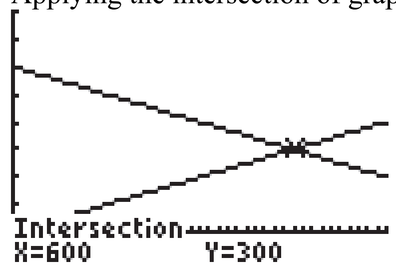
Demand function: Finding a linear model using L_3 as input and L_2 as output yields $p = -\frac{1}{2}q + 600$.

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

Supply function: Finding a linear model using L_3 as input and L_1 as output yields $p = \frac{1}{2}q + 0$ or $p = \frac{1}{2}q$.

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

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.

63. Let x = the number of years after 62.

$750x = 1000(x-4)$

$750x = 1000x - 4000$

$-250x = -4000$

$x = 16$

When the person is 78 (62 +16) is the age when the social security benefits paid would be the same.

64. $20\%x + 5\%y = 15.5\%(x + y)$

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

$0.045x = 0.105y$

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

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

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

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

The 5% concentration must be increased by 3 cc.

65. 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.

66. 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 demand equation:

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

$y - 350 = \frac{-1}{8}(x - 800)$

$y - 350 = \frac{-1}{8}x + 100$

$y = \frac{-1}{8}x + 450$ 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 supply equation:

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

$y - 280 = \frac{3}{20}(x - 700)$

$y - 280 = \frac{3}{20}x - 105$

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

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

To find the quantity, q, that produces market equilibrium, set the equations equal.

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

$\text{LCD}: 40$

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

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

$-11q = -11{,}000$

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

To find the price, p, at market equilibrium, solve for p.

$p = \frac{-1}{8}(1000) + 450 = 325$

Thus, the market equilibrium point is (1000, 325). If the price per unit is \$325, both supply and demand will be 1000 units.

67. 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 demand equation:

$$y - y_1 = m(x - x_1)$$
$$y - 10 = \frac{-1}{10}(x - 900)$$
$$y - 10 = \frac{-1}{10}x + 90$$
$$y = \frac{-1}{10}x + 100 \text{ or}$$
$$p = \frac{-1}{10}q + 100$$

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 supply equation:

$$y - y_1 = m(x - x_1)$$
$$y - 30 = \frac{2}{70}(x - 700)$$
$$y - 30 = \frac{2}{70}x - 20$$
$$y = \frac{2}{70}x + 10 \text{ or}$$
$$p = \frac{2}{70}q + 10$$

To find the quantity, q, that produces market equilibrium, set the equations equal.

$$\frac{-1}{10}q + 100 = \frac{2}{70}q + 10$$
$$70\left(\frac{-1}{10}q + 100\right) = 70\left(\frac{2}{70}q + 10\right)$$
$$-7q + 7000 = 2q + 700$$
$$-9q = -6300$$
$$q = \frac{-6300}{-9} = 700$$

To find the price, p, at market equilibrium, solve for p.

$$p = \frac{2}{70}(700) + 10$$
$$p = 2(10) + 10$$
$$p = 30$$

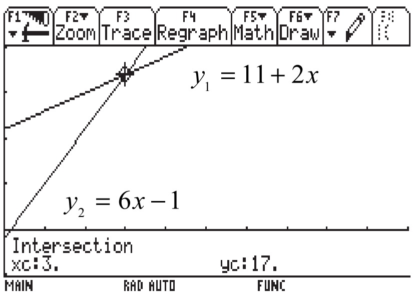
700 units priced at $30 represents the market equilibrium.

Section 2.4 Skills Check

1. Algebraically:

$$6x-1\le 11+2x$$
$$4x-1\le 11$$
$$4x\le 12$$
$$x\le \frac{12}{4}$$
$$x\le 3$$

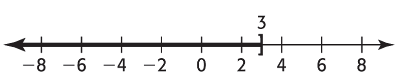
Graphically:



[0, 10] by [–5, 20]

$6x-1\le 11+2x$ implies that the solution region is $x\le 3$.
The interval notation is $(-\infty,3]$.

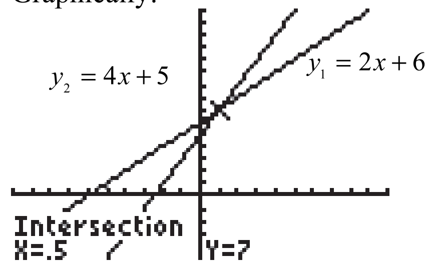
The graph of the solution is:



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:

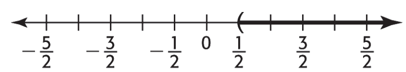


[–5, 5] by [–5, 15]

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

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

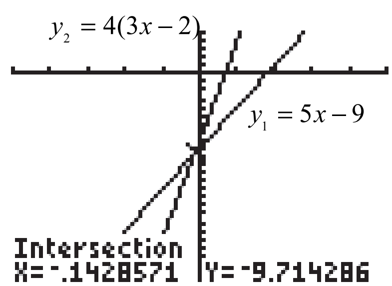
The graph of the solution is:



3. Algebraically:

$$4(3x-2)\le 5x-9$$
$$12x-8\le 5x-9$$
$$7x\le -1$$
$$\frac{7x}{7}\le\frac{-1}{7}$$
$$x\le -\frac{1}{7}$$

Graphically:

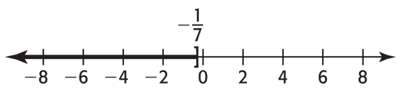


[–5, 5] by [–25, 5]

$4(3x-2) \le 5x-9$ implies that the solution region is $x \le -\dfrac{1}{7}$.

The interval notation is $\left(-\infty, -\dfrac{1}{7}\right]$.

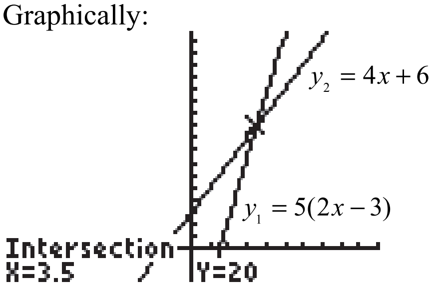
The graph of the solution is:



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:

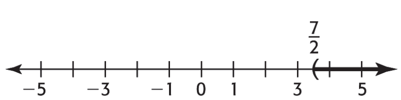


[–10, 10] by [–5, 35]

$5(2x-3) > 4x+6$ implies that the solution region is $x > \dfrac{7}{2}$.

The interval notation is $\left(\dfrac{7}{2}, \infty\right)$.

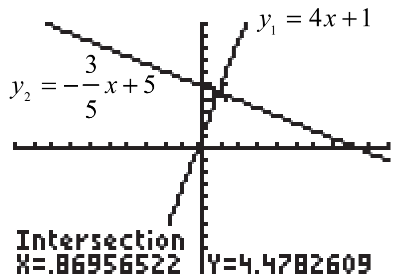
The graph of the solution is:



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:

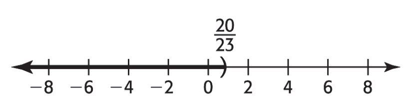


[–10, 10] by [–10, 10]

$4x+1 < -\dfrac{3}{5}x+5$ implies that the solution region is $x < \dfrac{20}{23}$.

The interval notation is $\left(-\infty, \dfrac{20}{23}\right)$.

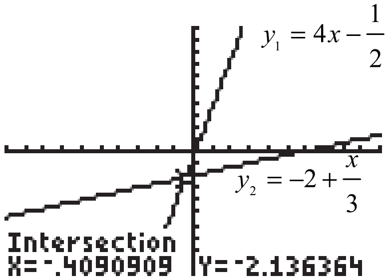
The graph of the solution is:



6. Algebraically:

$$4x-\frac{1}{2}\le -2+\frac{x}{3}$$
$$6\left(4x-\frac{1}{2}\right)\le 6\left(-2+\frac{x}{3}\right)$$
$$24x-3\le -12+2x$$
$$22x-3\le -12$$
$$22x\le -9$$
$$x\le -\frac{9}{22}$$

Graphically:

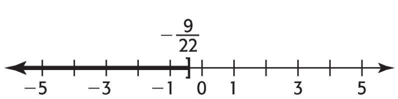


[–10, 10] by [–10, 10]

$4x-\frac{1}{2}\le -2+\frac{x}{3}$ implies that the solution region is $x\le -\frac{9}{22}$.

The interval notation is $\left(-\infty,-\frac{9}{22}\right]$.

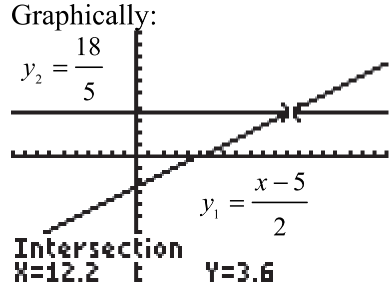
The graph of the solution is:



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 $x<\frac{61}{5}$.

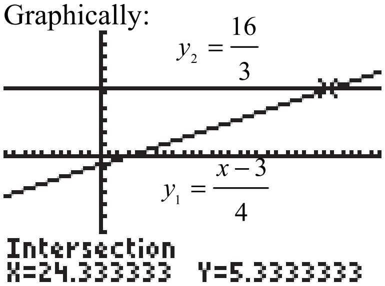
The interval notation is $\left(-\infty,\frac{61}{5}\right)$.

The graph of the solution is

8. Algebraically:

$$\frac{x-3}{4} < \frac{16}{3}$$
$$12\left(\frac{x-3}{4}\right) < 12\left(\frac{16}{3}\right)$$
$$3(x-3) < 64$$
$$3x-9 < 64$$
$$3x < 73$$
$$x < \frac{73}{3}$$

Graphically:



[–10, 30] by [–10, 10]

$\frac{x-3}{4} < \frac{16}{3}$ implies that the solution region is $x < \frac{73}{3}$.

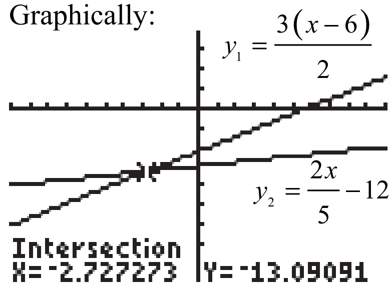
The interval notation is $\left(-\infty, \frac{73}{3}\right)$.

The graph of the solution is:

9. Algebraically:

$$\frac{3(x-6)}{2} \geq \frac{2x}{5} - 12$$
$$10\left(\frac{3(x-6)}{2}\right) \geq 10\left(\frac{2x}{5} - 12\right)$$
$$5(3(x-6)) \geq 2(2x) - 120$$
$$15(x-6) \geq 4x - 120$$
$$15x - 90 \geq 4x - 120$$
$$11x - 90 \geq -120$$
$$11x \geq -30$$
$$x \geq -\frac{30}{11}$$

Graphically:

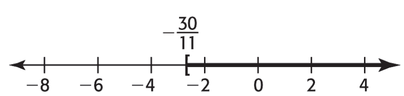


[–10, 10] by [–35, 15]

$\frac{3(x-6)}{2} \geq \frac{2x}{5} - 12$ implies that the solution region is $x \geq -\frac{30}{11}$.

The interval notation is $\left[-\frac{30}{11}, \infty\right)$.

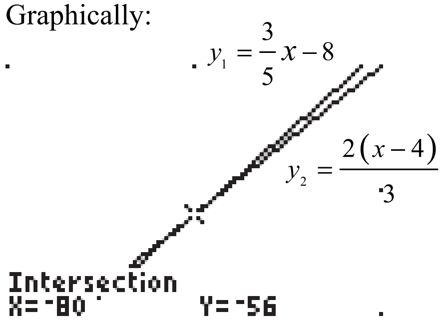
The graph of the solution is:



10. Algebraically:

$$\frac{2(x-4)}{3} \geq \frac{3x}{5} - 8$$
$$15\left[\frac{2(x-4)}{3}\right] \geq 15\left[\frac{3x}{5} - 8\right]$$
$$10x - 40 \geq 9x - 120$$
$$x \geq -80$$

Graphically:

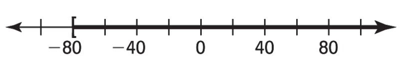


[–90, –70] by [–60, –50]

$\frac{2(x-4)}{3} \geq \frac{3x}{5} - 8$ implies that the solution region is $x \geq -80$.

The interval notation is $[-80, \infty)$.

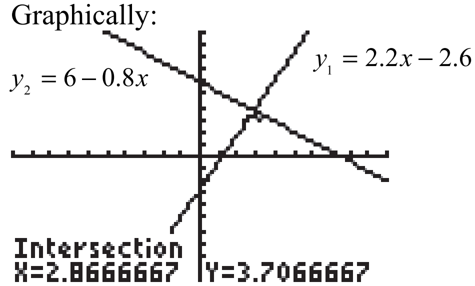
The graph of the solution is:



11. Algebraically:

$$2.2x - 2.6 \geq 6 - 0.8x$$
$$3.0x - 2.6 \geq 6$$
$$3.0x \geq 8.6$$
$$x \geq \frac{8.6}{3.0}$$
$$x \geq 2.8\overline{6}$$

Graphically:

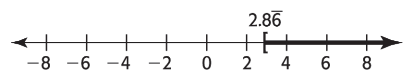


[–10, 10] by [–10, 10]

$2.2x - 2.6 \geq 6 - 0.8x$ implies that the solution region is $x \geq 2.8\overline{6}$.

The interval notation is $[2.8\overline{6}, \infty)$.

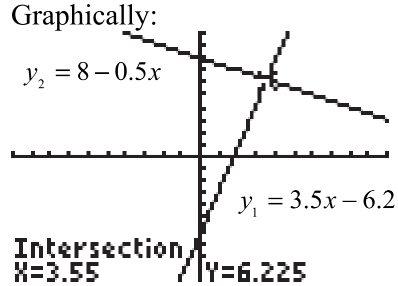
The graph of the solution is:



12. Algebraically:

$$3.5x - 6.2 \leq 8 - 0.5x$$
$$4x \leq 14.2$$
$$x \leq \frac{14.2}{4}$$
$$x \leq 3.55$$

Graphically:



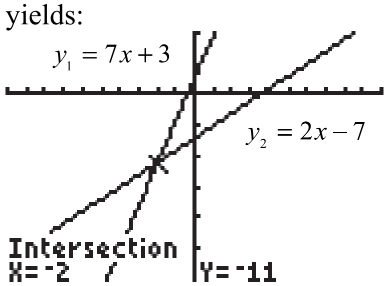
[–10, 10] by [–10, 10]

$3.5x - 6.2 \leq 8 - 0.5x$ 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:

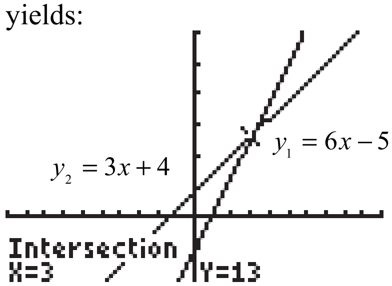


[–10, 10] by [–30, 10]

$7x + 3 < 2x - 7$ 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]

$3x + 4 \le 6x - 5$ implies that the solution region is $x \ge 3$.

The interval notation is $[3, \infty)$.

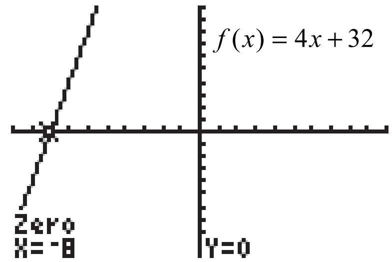
15. To apply the x-intercept method, first rewrite the inequality so that zero is on one side of the inequality.

$5(2x + 4) \ge 6(x - 2)$

$10x + 20 \ge 6x - 12$

$4x + 32 \ge 0$

Let $f(x) = 4x + 32$, and determine graphically where $f(x) \ge 0$.



[–10, 10] by [–10, 10]

$f(x) \ge 0$ implies that the solution region is $x \ge -8$.

The interval notation is $[-8, \infty)$.

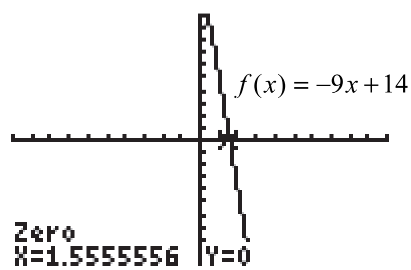
16. To apply the x-intercept method, first rewrite the inequality so that zero is on one side of the inequality.

$-3(x - 4) < 2(3x - 1)$

$-3x + 12 < 6x - 2$

$-9x + 14 < 0$

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 $x > 1.\overline{5}$.

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.

$$17 \le 3x-5 < 31$$
$$17+5 \le 3x-5+5 < 31+5$$
$$22 \le 3x < 36$$
$$\frac{22}{3} \le \frac{3x}{3} < \frac{36}{3}$$
$$\frac{22}{3} \le x < 12$$

The interval notation is $\left[\frac{22}{3},12\right)$.

20.

$$120 < 20x-40 \le 160$$
$$120+40 < 20x-40+40 \le 160+40$$
$$160 < 20x \le 200$$
$$8 < x \le 10$$

The interval notation is $(8,10]$.

21. $2x+1 \ge 6$ and $2x+1 \le 21$

$$6 \le 2x+1 \le 21$$
$$5 \le 2x \le 20$$
$$\frac{5}{2} \le x \le 10$$
$$x \ge \frac{5}{2} \text{ and } x \le 10$$

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

$2x-5>6$

$2x>11$

$x>\frac{11}{2}$

$x<-\frac{8}{3}$ and $x>\frac{11}{2}$

Since "and" implies that these two inequalities must both be true at the same time, and there is no set of numbers where this occurs, there is no solution to this system of inequalities.

24. $6x-2\le -5$ or $3x+4>9$

Inequality 1

$6x-2\le -5$

$6x\le -3$

$x\le -\frac{1}{2}$

Inequality 2

$3x+4>9$

$3x>5$

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

$x\le -\frac{1}{2}$ or $x>\frac{5}{3}$

Since "or" implies that one or the other of these inequalities is true, the solution for this system, in interval notation, is

$\left(-\infty,-\frac{1}{2}\right]\cup\left(\frac{5}{3},\infty\right)$

25. $\frac{3}{4}x-2\ge 6-2x$ or $\frac{2}{3}x-1\ge 2x-2$

Inequality 1

$4\left(\frac{3}{4}x-2\right)\ge 4(6-2x)$

$3x-8\ge 24-8x$

$11x\ge 32$

$x\ge \frac{32}{11}$

Inequality 2

$3\left(\frac{2}{3}x-1\right)\ge 3(2x-2)$

$2x-3\ge 6x-6$

$-4x\ge -3$

$x\le \frac{3}{4}$

$x\ge \frac{32}{11}$ or $x\le \frac{3}{4}$

Since "or" implies that one or the other of these inequalities is true, the solution for this system, in interval notation, is

$\left(-\infty,\frac{3}{4}\right]\cup\left[\frac{32}{11},\infty\right)$

26. $\frac{1}{2}x-3<5x$ 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

$5\left(\frac{2}{5}x-5\right)>5(6x)$

$2x-25>30x$

$-28x>25$

$x<-\frac{25}{28}$

$x>-\frac{2}{3}$ or $x<-\frac{25}{28}$

$\left(-\infty,-\frac{25}{28}\right)\cup\left(-\frac{2}{3},\infty\right)$

27.

$$37.002 \le 0.554x - 2.886 \le 77.998$$
$$37.002 + 2.886 \le 0.554x - 2.886 + 2.886 \le 77.998 + 2.886$$
$$39.888 \le 0.554x \le 80.884$$
$$\frac{39.888}{0.554} \le \frac{0.554x}{0.554} \le \frac{80.884}{0.554}$$
$$72 \le x \le 146$$

The interval notation is $[72,146]$.

28.

$$70 \le \frac{60+88+73+65+x}{5} < 80$$
$$70 \le \frac{286+x}{5} < 80$$
$$5(70) \le 5\left(\frac{286+x}{5}\right) \le 5(80)$$
$$350 \le 286 + x \le 400$$
$$350 - 286 \le 286 - 286 + x \le 400 - 286$$
$$64 \le x < 114$$

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.

$$\begin{aligned} F &\leq 32 \\ \frac{9}{5}C + 32 &\leq 32 \\ \frac{9}{5}C &\leq 0 \\ C &\leq 0 \end{aligned}$$

A Celsius temperature at or below zero degrees is "freezing."

32.

$$\begin{aligned} C &\geq 100 \\ \frac{5}{9}(F - 32) &\geq 100 \\ 9\left[\frac{5}{9}(F - 32)\right] &\geq 9[100] \\ 5F - 160 &\geq 900 \\ 5F &\geq 1060 \\ F &\geq 212 \end{aligned}$$

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.

The income from the second position will exceed the income from the first position when

$$\begin{aligned} &2000 + 0.05x > 3100 \\ &0.05x > 1100 \\ &x > \frac{1100}{0.05} \\ &x > 22{,}000 \end{aligned}$$

When monthly sales exceed \$22,000, the second position is more profitable than the first position.

34. Original value $= (1000)(22) = \$22{,}000$

$$\begin{aligned} \text{Adjusted value} &= 22{,}000 - (22{,}000)(20\%) \\ &= 22{,}000 - 4400 \\ &= 17{,}600 \end{aligned}$$

Let $x =$ percentage increase

$$\begin{aligned} &17{,}600 + 17{,}600x > 22{,}000 \\ &17{,}600x > 4400 \\ &x > \frac{4400}{17{,}600} \\ &x > 0.25 \\ &x > 25\% \end{aligned}$$

The percent increase must be greater than 25% in order to ensure a profit.

35.

Let $x =$ Stan's final exam grade.

$$80 \le \frac{78+69+92+81+2x}{6} \le 89$$
$$6(80) \le 6\left(\frac{78+69+92+81+2x}{6}\right) \le 6(89)$$
$$480 \le 320 + 2x \le 534$$
$$480 - 320 \le 320 - 320 + 2x \le 534 - 320$$
$$160 \le 2x \le 214$$
$$\frac{160}{2} \le \frac{2x}{2} \le \frac{214}{2}$$
$$80 \le x \le 107$$

If the final exam does not contain any bonus points, Stan needs to score between 80 and 100 to earn a grade of B for the course.

36. Let $x =$ John's final exam grade.

$$70 \le \frac{78+62+82+2x}{5} \le 79$$
$$5(70) \le 5\left(\frac{78+62+82+2x}{5}\right) \le 5(79)$$
$$350 \le 222 + 2x \le 395$$
$$128 \le 2x \le 173$$
$$\frac{128}{2} \le \frac{2x}{2} \le \frac{173}{2}$$
$$64 \le x \le 86.5$$

John needs to score between 64 and 86.5 to earn a grade of C for the course.

37.

$$p < 27$$
$$-1.873t + 60.643 < 27$$
$$1.873t < 33.643$$
$$t < 18$$

From the year 2018 (2000 +18) is when the percent of 12th graders who have ever used cigarettes is projected to be below 27 %.

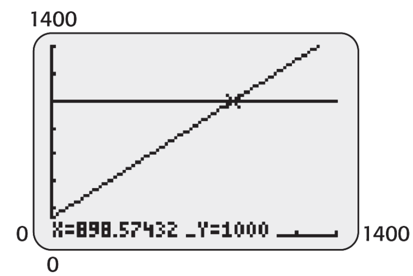
38. a. $y \ge 1000$

$$0.97x + 128.3829 \ge 1000$$
$$0.97x \ge 871.6171$$
$$x \ge \frac{871.6171}{0.97}$$

$x \ge 898.57$ or approximately $x \ge 899$

Old scores greater than or equal to 899 are equivalent to new scores greater than or equal to 1000.

b.



39. Let $x =$ age after 70.

$$2000(x+4) < 2640x$$
$$2000x + 8000 < 2640x$$
$$8000 < 640x$$
$$12.5 < x$$

From age 82.5 (70 + 12.5) is when the social security benefits would be more for a person that delayed their benefits until age 70.

40. If x is the number of years after 2000, and if $y = 1.36x + 68.8$, then the percent of households in the U.S. with Internet access greater than 89 is given by:

$$1.36x + 68.8 \ge 89$$
$$1.36x \ge 20.2$$
$$x \ge 14.85 \approx 15 \text{ years after 2000}$$

Therefore, 15 years from 2000 is 2015 and after.

41. Let x represent the actual life of the HID headlights.

$1500 - 10\%(1500) \le x \le 1500 + 10\%(1500)$

$1500 - 150 \le x \le 1500 + 150$

$1350 \le x \le 1650$

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, $92 < x < 135$

Thus, the prison sentence should be between 92 months and 135 months.

43. If x is the number of years after 2010, and if $y = 2375x + 39{,}630$, then the average annual wage of U.S. workers will be at least $68,130 is given by:

$2375x + 39{,}630 \ge 68{,}130$

$2375x \ge 28{,}500$

$x \ge 12$ years after 2010

Therefore, 12 years from 2010 is 2022 and after.

44. a.

$y = 250$

$28.5x + 50.5 = 250$

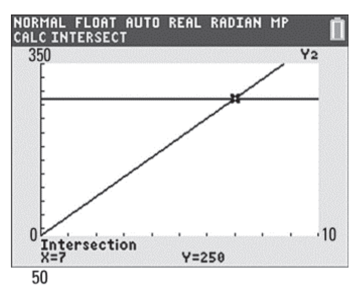
$28.5x = 199.5$

$$x = \frac{199.5}{28.5}$$

$x = 7$

Thus, the number of doctorates employed was 250 seven years after the year 2000, in the year 2007.

b.



c. Prior to 2007, the number of doctorates employed was below 250.

45. **a.** Since the rate of increase is constant, the equation modeling the value of the home is linear.

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$
$$= \frac{270,000 - 190,000}{4 - 0}$$
$$= \frac{80,000}{4}$$
$$= 20,000$$

Solving for the equation:

$$y - y_1 = m(x - x_1)$$
$$y - 190,000 = 20,000(x - 0)$$
$$y - 190,000 = 20,000x$$
$$y = 20,000x + 190,000$$

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, $11 \le x \le 14.$

Or, $y > 400,000$

between 2007 and 2010, inclusive.

The value of the home will be greater than $400,000 between 2007 and 2010.

c. Since the housing market took such a down turn in the last year or so, it does not seem reasonable that this model remained accurate until the end of 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.

$$(5.5\%)(357,500) + x \ge (6\%)(390,000)$$
$$19,662.50 + x \ge 23,400$$
$$x \ge 3737.50$$

The price of the 12th car needs to be at least $32,500 + 3737.50 = 36,237.50$ 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 produced and sold should exceed 12,715.

49.

$$P(x) \ge 0$$
$$6.45x - 9675 \ge 0$$
$$6.45x \ge 9675$$
$$x \ge \frac{9675}{6.45}$$
$$x \ge 1500$$

Sales of 1500 feet or more of PVC pipe will avoid a loss for the hardware store.

50. Generating a loss implies that

$P(x) < 0$

$-40,255 + 9.80x < 0$

$9.80x < 40,255$

$x < \frac{40,255}{9.80}$

$x < 4107.653061$

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. $T \le 85$

$0.43m + 76.8 \le 85$

$0.43m \le 8.2$

$m \le \frac{8.2}{0.43}$

$m \le 19.06976744$ or approximately,

$m \le 19$

The temperature will be at most 85°F for the first 19 minutes.

53. Since at least implies greater than or equal to, $H(x) \ge 14.6.$ Thus,

$0.224x + 9.0 \ge 14.6$

$0.224x \ge 5.6$

$x \ge \frac{5.6}{0.224}$

$x \ge 25$

Thus, the Hispanic population is at least 14.6%, 25 years after 1990, on or after the year 2015

54.

$$245 < y < 248$$

$$245 < 0.155x + 244.37 < 248$$

$$245 - 244.37 < 0.155x + 244.37 - 244.37 < 248 - 244.37$$

$$0.63 < 0.155x < 3.63$$

$$\frac{0.63}{0.155} < \frac{0.155}{0.155}x < \frac{3.63}{0.155}$$

$$4.06 < x < 23.42$$

Considering x as a discrete variable yields $4 < x < 23$.

From 1974 (1970 + 4) until 1993 (1970 + 23), the reading scores were between 245 and 248.

55. If x is the number of years after 1990, and if $y = 138.2x + 97.87$, then the expenditures for health care will exceed \$4658.5 billion is given by:

$$138.2x + 97.87 > 4658.5$$
$$138.2x > 4560.63$$
$$x > 33.0002 \approx 33 \text{ years after 1990}$$

Therefore, 33 years from 1990 is after 2023.

56. Since "at least" implies greater than or equal to, $B(x) \geq 13.44$. Thus,

$$0.057x + 12.3 \geq 13.44$$
$$0.057x \geq 1.14$$
$$x \geq \frac{1.14}{0.057}$$
$$x \geq 20$$

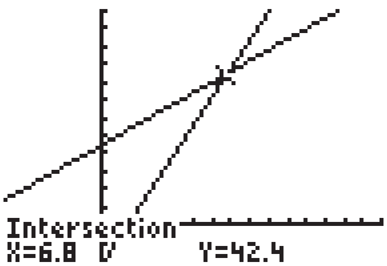
Thus, the percent of blacks is at least 13.44%, 20 years after 1990, on or after the year 2010.

Chapter 2 Skills Check

1. a.

$$\begin{aligned}3x+22&=8x-12\\3x-8x+22&=8x-8x-12\\-5x+22&=-12\\-5x+22-22&=-12-22\\-5x&=-34\\\frac{-5x}{-5}&=\frac{-34}{-5}\\x&=\frac{34}{5}=6.8\end{aligned}$$

b. Applying the intersection of graphs method yields $x = 6.8$.

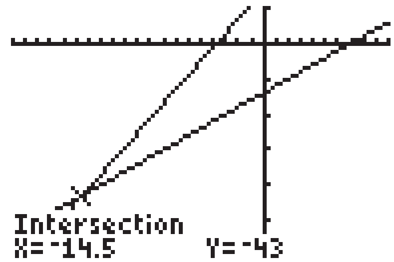


[–5, 15] by [–10, 60]

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]

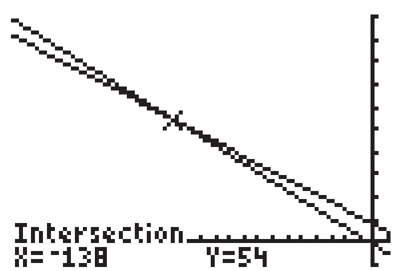
3. a.

$$\frac{3(x-2)}{5}-x=8-\frac{x}{3}$$

LCD: 15

$$\begin{aligned}15\left(\frac{3(x-2)}{5}-x\right)&=15\left(8-\frac{x}{3}\right)\\3\big(3(x-2)\big)-15x&=120-5x\\3\big(3x-6\big)-15x&=120-5x\\9x-18-15x&=120-5x\\-6x-18&=120-5x\\-1x-18&=120\\-1x&=138\\x&=-138\end{aligned}$$

b. Applying the intersection of graphs method yields $x = -138$.

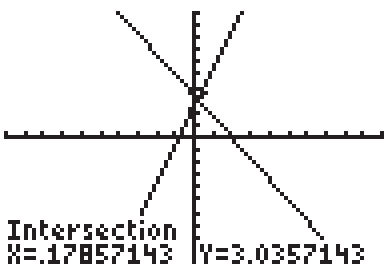


[–250, 10] by [–10, 100]

4. a.

$$\begin{aligned}
\frac{6x+5}{2} &= \frac{5(2-x)}{3}\\
\frac{6x+5}{2} &= \frac{10-5x}{3}\\
\text{LCD: } 6&\\
6\left(\frac{6x+5}{2}\right) &= 6\left(\frac{10-5x}{3}\right)\\
3(6x+5) &= 2(10-5x)\\
18x+15 &= 20-10x\\
18x+15+10x &= 20-10x+10x\\
28x+15 &= 20\\
28x+15-15 &= 20-15\\
28x &= 5\\
x &= \frac{5}{28} \approx 0.179
\end{aligned}$$

b. Applying the intersection of graphs method yields $x = 5/28 \approx 0.179$.

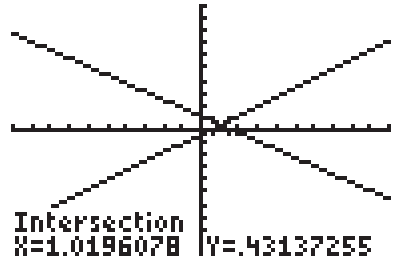


[–10,10] by [–10, –10]

5. a.

$$\begin{aligned}
\frac{3x}{4}-\frac{1}{3} &= 1-\frac{2}{3}\left(x-\frac{1}{6}\right)\\
\frac{3x}{4}-\frac{1}{3} &= 1-\frac{2}{3}x+\frac{1}{9}\\
\text{LCD: } 36&\\
36\left(\frac{3x}{4}-\frac{1}{3}\right) &= 36\left(1-\frac{2}{3}x+\frac{1}{9}\right)\\
27x-12 &= 36-24x+4\\
51x &= 52\\
x &= \frac{52}{51} \approx 1.0196
\end{aligned}$$

b. Applying the intersection of graphs method yields $x = 52/51 \approx 1.0196$.

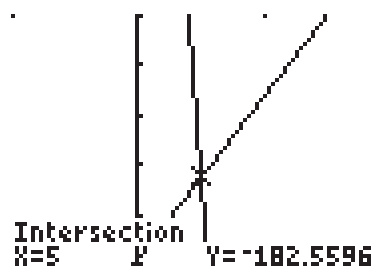


[–10,10] by [–10, –10]

6. a.

$$\begin{aligned}
3.259x-198.8546 &= -3.8(8.625x+4.917)\\
3.259x-198.8546 &= -32.775x-18.6846\\
36.034x &= 180.17\\
x &= 5
\end{aligned}$$

b. Applying the intersection of graphs method yields $x = 5$.



[–10, 20] by [–200, –150]

7. a. $f(x) = 7x-105$

$$\begin{aligned}
7x-105 &= 0\\
7x &= 105\\
x &= 15
\end{aligned}$$

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:

$$P(a-y)=1+\frac{m}{3}$$

$$Pa-Py=1+\frac{m}{3}$$

$$-Py=1+\frac{m}{3}-Pa$$

$$-Py=\left(\frac{3+m-3Pa}{3}\right)$$

$$y=\left(\frac{3+m-3Pa}{-3P}\right)$$

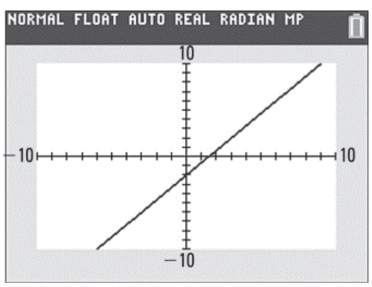
9. Solve for y:

$$4x-3y=6$$

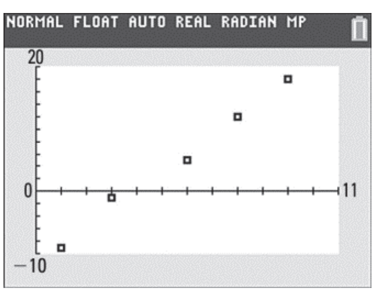
$$-3y=-4x+6$$

$$y=\frac{-4x+6}{-3}=\frac{4x-6}{3}$$

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

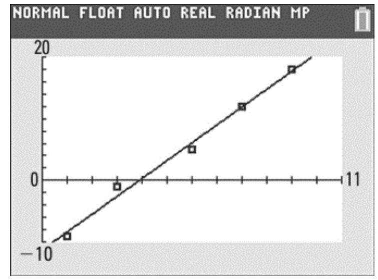


10.



11. $y=2.8947x-11.211$

12.



13. No. The data points in the table do not fit the linear model exactly.

14.

$$\begin{cases}3x+2y=0 & (Eq1)\\ 2x-y=7 & (Eq2)\end{cases}$$

$$\begin{cases}3x+2y=0 & (Eq1)\\ 4x-2y=14 & 2\times(Eq2)\end{cases}$$

$$7x=14$$

$$x=2$$

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. $\begin{cases} -6x+4y=10 & (Eq1) \\ 3x-2y=5 & (Eq2) \end{cases}$

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

$0=20$

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

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

$1+y=-3$

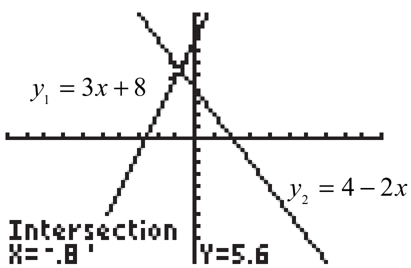
$y=-4$

The solution is $\left(\frac{1}{2},-4\right)$.

20. Algebraically:

$$3x+8<4-2x$$
$$5x+8<4$$
$$5x<-4$$
$$x<-\frac{4}{5}=-0.8$$

Graphically:



[–10, 10] by [–10, 10]

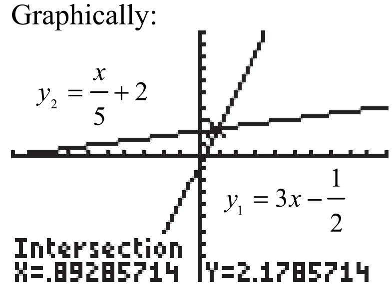
$3x+8<4-2x$ implies that the solution is $x<-\frac{4}{5}$.

The interval notation is $\left(-\infty,-\frac{4}{5}\right)$.

21. Algebraically:

$$3x-\frac{1}{2}\le\frac{x}{5}+2$$
$$10\left(3x-\frac{1}{2}\right)\le10\left(\frac{x}{5}+2\right)$$
$$30x-5\le2x+20$$
$$28x-5\le20$$
$$28x\le25$$
$$x\le\frac{25}{28}\approx0.893$$

Graphically:



[–10, 10] by [–10, 10]

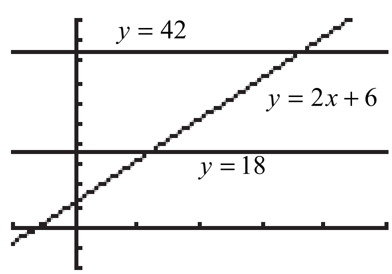
$3x-\frac{1}{2}\le\frac{x}{5}+2$ implies that the solution is $x\le\frac{25}{28}$.

The interval notation is $\left(-\infty,\frac{25}{28}\right]$.

22. Algebraically:

$$18\le2x+6<42$$
$$18-6\le2x+6-6<42-6$$
$$12\le2x<36$$
$$\frac{12}{2}\le\frac{2x}{2}<\frac{36}{2}$$
$$6\le x<18$$

Graphically:



[–5, 25] by [–10, 50]

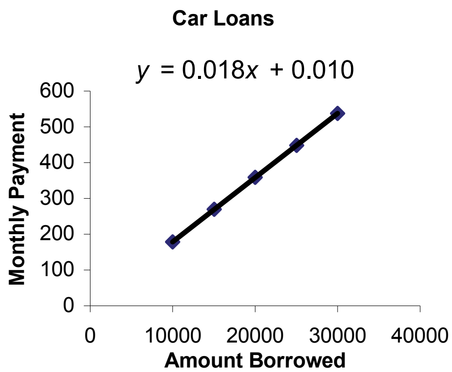
$18\le2x+6<42$ implies that the solution is $6\le x<18$.
The interval notation is $[6,18)$.

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.

c.



Rounded model:

$P = f(A) = 0.018A + 0.010$

Unrounded model:

$f(A) = 0.017924A + 0.010$

24. a. Using the linear model from part c) in problem 23:

$$f(28{,}000) = 0.018(28{,}000) + 0.010$$
$$= 504.01$$

The predicted monthly payment on a car loan of $28,000 is $504.01.

b. Yes. Any input could be used for A.

c.

$$f(A) \le 500$$
$$0.017924A + 0.010 \le 500$$
$$0.017924A \le 499.99$$
$$A \le \frac{499.99}{0.017924}$$
$$A \le 27{,}895.00$$

The loan amount should be less than or equal to $27,895.00.

25.

$$2.158 = 0.0154x + 1.85$$
$$0.308 = 0.0154x$$
$$x = 20$$

$x = 20$, and the year is 2030 (2010 + 20).

26. $f(x) = 4500$

27. a. $m = \dfrac{y_2 - y_1}{x_2 - x_1} = \dfrac{895 - 455}{250 - 150} = \dfrac{440}{100} = 4.4$

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 $P(x) > 0$.

$$4.4x - 205 > 0$$
$$4.4x > 205$$
$$x = \frac{205}{4.4} = 46.59\overline{09} \approx 47$$

The company will make a profit when producing and selling at least 47 units.

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 second position will yield a greater salary.

29.

Original Cost $= 24{,}000 \times 12 = 288{,}000$

Desired Profit $= 10\%(288{,}000) = 28{,}800$

Revenue from 8 sold cars, with 12% avg profit

$= 8(24{,}000 + 12\% \times 24{,}000)$

$= 8(24{,}000 + 2{,}880) = 215{,}040$

Solve for x where x is the selling price of the remaining four cars.

The total Revenue will be $215{,}040 + 4x$.

The desired Profit = Revenue − Cost

$28{,}800 = (215{,}040 + 4x) - 288{,}000$

$28{,}800 = 4x - 72{,}960$

$4x = 101{,}760$

$x = \dfrac{101{,}760}{4} = 25{,}440$

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.

$6\%x + 10\%(420{,}000 - x) = 30{,}000$

$0.06x + 42{,}000 - 0.10x = 30{,}000$

$-0.04x = -12{,}000$

$x = \dfrac{-12{,}000}{-0.04}$

$x = 300{,}000$

The couple should invest $300,000 in the safe account and $120,000 in the risky account.

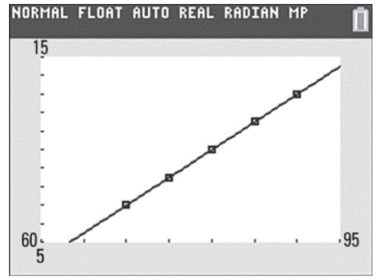
31. a. $m = \dfrac{13-7}{90-70} = \dfrac{6}{20} = 0.3$

$y - 7 = 0.3(x - 70)$

$y - 7 = 0.3x - 21$

$y = 0.3x - 14$

b.



c. Yes; the points do fit exactly.

d. let $x = 78$.

$y = 0.3(78) - 14$

$y = 23.4 - 14$

$y = 9.4$

The annual rate of return on a donation at age 78 will be 9.4%.

e. let $y = 12.4$.

$12.4 = 0.3x - 14$

$26.4 = 0.3x$

$x = 88$

A person that is 88 years old can expect a 12.4% annual rate of return on a donation.

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. $P(x) = 564x - (40{,}000 + 64x)$

$= 564x - 40{,}000 - 64x$

$= 500x - 40{,}000$

b. $500x - 40{,}000 > 0$

$500x > 40{,}000$

$x > 80$

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. $p = -1.873t + 60.643$

b. let $t = 20\ (2020 - 2000)$.

$p = -1.873(20) + 60.643$

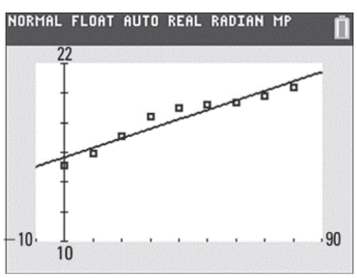
$p = -37.46 + 60.643$

$p = 23.183$

The model predicts that in the year 2020, the percent of 12th graders who have ever used cigarettes will be 23.2%. This is extrapolation because it goes beyond the given data.

36. a. $y = 0.0638x + 15.702$

b.



c. $f(99) = 0.0638(99) + 15.702$

$= 22.018$

In 2049 (1950 + 99), the average woman is expected to live 22 years beyond age 65. Her life expectancy is 87 years.

d. $y > 84 - 65 = 19$

$0.0638x + 15.702 > 19$

$0.0638x > 3.298$

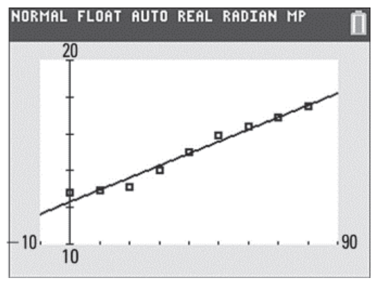
$x > \dfrac{3.298}{0.0638}$

$x > 51.69$

In 2002 (1950 + 52) and beyond, the average woman of age 65 is expected to live more than 84 years.

37. a. $y = 0.0655x + 12.324$

b.



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 $g(x) = 25$.

$0.0655x + 12.324 = 25$

$0.0655x = 25 - 12.324$

$0.0655x = 12.676$

$x = \dfrac{12.676}{0.0655} = 193.527 \approx 194$

In approximately the year 2144 (1950 +194), life expectancy for a 65 year old male will be 90 years.

e. A life expectancy of 81 years translates into $81-65=16$ years beyond age 65.

$g(x)\le 16$

$0.0655x+12.324\le 16$

$0.0655x\le 3.676$

$x\le \dfrac{3.676}{0.0655}$

$x\le 56.1$

Since 1950 + 56 = 2006, the average male could expect to live less than 81 years prior to 2007.

38. a. $m=\dfrac{1320-1000}{70-66}=\dfrac{320}{4}=80$

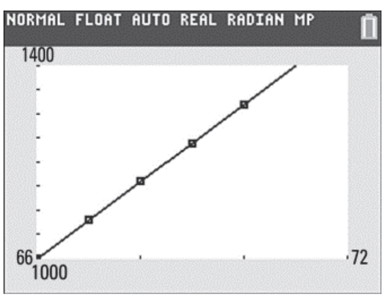
$y-1000=80(x-66)$

$y-1000=80x-5280$

$y=80x-4280$

for $66\le x\le 70$

b.



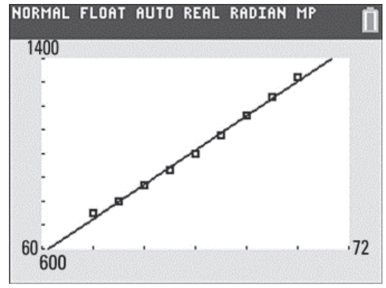
c. This would be an exact model.

39. a. Using a graphing calculator and the linear regression function, the equation of the model will be

$y=72.25x-3751.94$

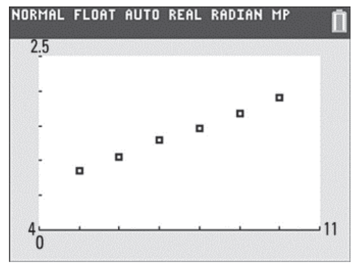
for $62\le x\le 70$

b.



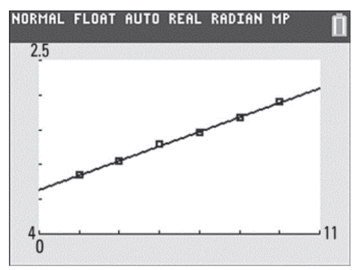
c. This would be an approximate model.

40. a.



b. $y=0.209x-0.195$

c.



The line seems to fit the data points very well.

41. $y > 6.25$

$132x + 1000(6.25) > 9570$

$132x + 6250 > 9570$

$132x > 3320$

$x > 25.15 \approx 25$

$y < 3.63$

$132x + 1000(3.63) < 9570$

$132x + 3630 < 9570$

$132x < 5940$

$x < 45$

The marriage rate with be between 3.63 and 6.25 during the years between 2005 (1980 + 25) and 2025 (1980 + 45).

42. **a.** No; the age and heart rates do not both have constant changes.

b. $y = -0.652x + 142.881$

c. Yes; the age and heart rate both have constant increments. The function will be $y = -0.65x + 143$.

43. Let $3(12) \le x \le 5(12)$ or

$36 \le x \le 60$. Years converted to months.

Then

$0.554(36) - 2.886 \le y \le 0.554(60) - 2.886$.

Therefore, $17.058 \le y \le 30.354$. Or, rounding to the months that include this interval, $17 \le y \le 31$.

The criminal is expected to serve between 17 and 31 months inclusive.

44.

Let x = the amount in the safer fund, and y = the amount in the riskier fund.

$$\begin{cases} x + y = 240,000 & (Eq1) \\ 0.08x + 0.12y = 23,200 & (Eq2) \end{cases}$$

$$\begin{cases} -0.08x - 0.08y = -19,200 & -0.08 \times (Eq1) \\ 0.08x + 0.12y = 23,200 & (Eq2) \end{cases}$$

$0.04y = 4000$

$y = \dfrac{4000}{0.04} = 100,000$

Substituting to calculate x

$x + 100,000 = 240,000$

$x = 140,000$

They should invest \$140,000 in the safer fund, and \$100,000 in the riskier fund.

45.

Let x = number of units.

$R = C$

$565x = 6000 + 325x$

$240x = 6000$

$x = 25$

25 units must be produced and sold to give a break-even point.

46. Let $x =$ dosage of Medication A, and let $y =$ dosage of Medication B.

$$\begin{cases} 6x + 2y = 25.2 & (Eq1) \\ \dfrac{x}{y} = \dfrac{2}{3} & (Eq2) \end{cases}$$

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.

$$\begin{cases} 3q + p = 340 & (Eq1) \\ -4q + p = -220 & (Eq2) \end{cases}$$

$$\begin{cases} -3q - 1p = -340 & -1 \times (Eq1) \\ -4q + 1p = -220 & (Eq2) \end{cases}$$

$-7q = -560$

$q = \frac{-560}{-7} = 80$

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.

$$\begin{cases} p = \dfrac{q}{10} + 8 & (Eq1) \\ 10p + q = 1500 & (Eq2) \end{cases}$$

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 must sell 1800 tickets at \$40 per ticket and 800 tickets at \$60 per ticket to yield \$120,000.

50. a. $x + y = 500,000$

b. $0.12x$

c. $0.15y$

d. $0.12x + 0.15y = 64,500$

e.

$$\begin{cases} x + y = 500,000 & (Eq1) \\ 0.12x + 0.15y = 64,500 & (Eq2) \end{cases}$$

$$\begin{cases} -0.12x - 0.12y = -60,000 & -0.12 \times (Eq1) \\ 0.12x + 0.15y = 64,500 & (Eq2) \end{cases}$$

$0.03y = 4500$

$y = \dfrac{4500}{0.03} = 150,000$

Substituting to calculate x

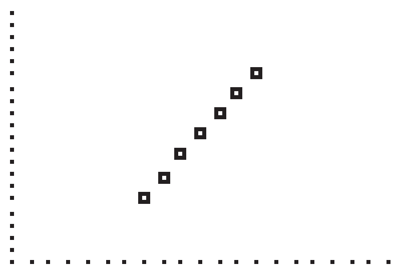
$x + 150,000 = 500,000$

$x = 350,000$

Invest \$350,000 in the 12% property and \$150,000 in the 15% property.

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.