Chapter 2

Equations, Inequalities, and Problem Solving

Exercise Set 2.1

1. The equations $x + 3 = 7$ and $6x = 24$ are equivalent equations.

3. A solution is a replacement that makes an equation true.

5. The multiplication principle is used to solve $\frac{2}{3} \cdot x = -4$.

7. For $6x = 30$, the next step is (d) divide both sides by 6.

9. For $\frac{1}{6}x = 30$, the next step is (c) multiply both sides by 6.

11.
$$x + 10 = 21$$
$$x + 10 - 10 = 21 - 10$$
$$x = 11$$

Check:
$$\begin{array}{r|l} x + 10 = 21 \\ \hline 11 + 10 & 21 \end{array}$$
$$21 \stackrel{?}{=} 21 \quad \text{TRUE}$$

The solution is 11.

13.
$$y + 7 = -18$$
$$y + 7 - 7 = -18 - 7$$
$$y = -25$$

Check:
$$\begin{array}{r|l} y + 7 = -18 \\ \hline -25 + 7 & 18 \end{array}$$
$$-18 \stackrel{?}{=} -18 \quad \text{TRUE}$$

The solution is -25.

15.
$$-6 = y + 25$$
$$-6 - 25 = y + 25 - 25$$
$$-31 = y$$

Check:
$$\begin{array}{r|l} -6 = y + 25 \\ \hline -6 & -31 + 25 \end{array}$$
$$-6 \stackrel{?}{=} -6 \quad \text{TRUE}$$

The solution is -31.

17.
$$x - 18 = 23$$
$$x - 18 + 18 = 23 + 18$$
$$x = 41$$

Check:
$$\begin{array}{r|l} x - 18 = 23 \\ \hline 41 - 18 & 23 \end{array}$$
$$23 \stackrel{?}{=} 23 \quad \text{TRUE}$$

The solution is 41.

19.
$$12 = -7 + y$$
$$7 + 12 = 7 + (-7) + y$$
$$19 = y$$

Check:
$$\begin{array}{r|l} 12 = -7 + y \\ \hline 12 & -7 + 19 \end{array}$$
$$12 \stackrel{?}{=} 12 \quad \text{TRUE}$$

The solution is 19.

21.
$$-5 + t = -11$$
$$5 + (-5) + t = 5 + (-11)$$
$$t = -6$$

Check:
$$\begin{array}{r|l} -5 + t = -11 \\ \hline -5 + (-6) & -11 \end{array}$$
$$-11 \stackrel{?}{=} -11 \quad \text{TRUE}$$

The solution is -6.

23.
$$r + \frac{1}{3} = \frac{8}{3}$$
$$r + \frac{1}{3} - \frac{1}{3} = \frac{8}{3} - \frac{1}{3}$$
$$r = \frac{7}{3}$$

Check:
$$\begin{array}{r|l} r + \frac{1}{3} = \frac{8}{3} \\ \hline \frac{7}{3} + \frac{1}{3} & \frac{8}{3} \end{array}$$
$$\frac{8}{3} \stackrel{?}{=} \frac{8}{3} \quad \text{TRUE}$$

The solution is $\frac{7}{3}$.

25.
$$x - \frac{3}{5} = -\frac{7}{10}$$
$$x - \frac{3}{5} + \frac{3}{5} = -\frac{7}{10} + \frac{3}{5}$$
$$x = -\frac{7}{10} + \frac{3}{5} \cdot \frac{2}{2}$$
$$x = -\frac{7}{10} + \frac{6}{10}$$
$$x = -\frac{1}{10}$$

Check:
$$\begin{array}{r|l} x - \frac{3}{5} = -\frac{7}{10} \\ \hline -\frac{1}{10} - \frac{3}{5} & -\frac{7}{10} \\ -\frac{1}{10} - \frac{6}{10} & \\ \hline \end{array}$$
$$-\frac{7}{10} \stackrel{?}{=} -\frac{7}{10} \quad \text{TRUE}$$

The solution is $-\frac{1}{10}$.

27.
$$x - \frac{5}{6} = \frac{7}{8}$$
$$x - \frac{5}{6} + \frac{5}{6} = \frac{7}{8} + \frac{5}{6}$$
$$x = \frac{7}{8}\cdot\frac{3}{3} + \frac{5}{6}\cdot\frac{4}{4}$$
$$x = \frac{21}{24} + \frac{20}{24}$$
$$x = \frac{41}{24}$$

Check:
$$\begin{array}{r|l} x - \frac{5}{6} = \frac{7}{8} & \\ \hline \frac{41}{24} - \frac{5}{6} & \frac{7}{8} \\ \frac{41}{24} - \frac{20}{24} & \frac{21}{24} \\ \frac{21}{24} \stackrel{?}{=} \frac{21}{24} & \text{TRUE} \end{array}$$

The solution is $\frac{41}{24}$.

29.
$$-\frac{1}{5} + z = -\frac{1}{4}$$
$$\frac{1}{5} - \frac{1}{5} + z = \frac{1}{5} - \frac{1}{4}$$
$$z = \frac{1}{5}\cdot\frac{4}{4} - \frac{1}{4}\cdot\frac{5}{5}$$
$$z = \frac{4}{20} - \frac{5}{20}$$
$$z = -\frac{1}{20}$$

Check:
$$\begin{array}{r|l} -\frac{1}{5} + z = -\frac{1}{4} & \\ \hline -\frac{1}{5} + \left(-\frac{1}{20}\right) & -\frac{1}{4} \\ -\frac{4}{20} + \left(-\frac{1}{20}\right) & -\frac{5}{20} \\ -\frac{5}{20} \stackrel{?}{=} -\frac{5}{20} & \text{TRUE} \end{array}$$

The solution is $-\frac{1}{20}$.

31.
$$m - 2.8 = 6.3$$
$$m - 2.8 + 2.8 = 6.3 + 2.8$$
$$m = 9.1$$

Check:
$$\begin{array}{r|l} m - 2.8 = 6.3 & \\ \hline 9.1 - 2.8 & 6.3 \\ 6.3 \stackrel{?}{=} 6.3 & \text{TRUE} \end{array}$$

The solution is 9.1.

33.
$$-9.7 = -4.7 + y$$
$$4.7 + (-9.7) = 4.7 + (-4.7) + y$$
$$-5 = y$$

Check:
$$\begin{array}{r|l} -9.7 = -4.7 + y & \\ \hline -9.7 & -4.7 + (-5) \\ -9.7 \stackrel{?}{=} -9.7 & \text{TRUE} \end{array}$$

35.
$$8a = 56$$
$$\frac{8a}{8} = \frac{56}{8} \quad \text{Dividing both sides by 8}$$
$$1 \cdot a = 7 \quad \text{Simplifying}$$
$$a = 7 \quad \text{Identity property of 1}$$

Check:
$$\begin{array}{r|l} 8a = 56 & \\ \hline 8 \cdot 7 & 56 \\ 56 \stackrel{?}{=} 56 & \text{TRUE} \end{array}$$

The solution is 7.

37.
$$84 = 7x$$
$$\frac{84}{7} = \frac{7x}{7} \quad \text{Dividing both sides by 7}$$
$$12 = 1 \cdot x$$
$$12 = x$$

Check:
$$\begin{array}{r|l} 84 = 7x & \\ \hline 84 & 7 \cdot 12 \\ 84 \stackrel{?}{=} 84 & \text{TRUE} \end{array}$$

The solution is 12.

39.
$$-x = 38$$
$$-1 \cdot x = 38$$
$$-1 \cdot (-1 \cdot x) = -1 \cdot 38$$
$$1 \cdot x = -38$$
$$x = -38$$

Check:
$$\begin{array}{r|l} -x = 38 & \\ \hline -(-38) & 38 \\ 38 \stackrel{?}{=} 38 & \text{TRUE} \end{array}$$

The solution is -38.

41. $-t = -8$

The equation states that the opposite of t is the opposite of 8. Thus, $t = 8$. We could also do this exercise as follows.

$$-t = -8$$
$$-1(-t) = -1(-8) \quad \text{Multiplying both sides by } -1$$
$$t = 8$$

Check:
$$\begin{array}{r|l} -t = -8 & \\ \hline -(8) & -8 \\ -8 \stackrel{?}{=} -8 & \text{TRUE} \end{array}$$

The solution is 8.

43.
$$-7x = 49$$
$$\frac{-7x}{-7} = \frac{49}{-7}$$
$$1 \cdot x = -7$$
$$x = -7$$

Check:
$$\begin{array}{r|l} -7x = 49 & \\ \hline -7(-7) & 49 \\ 49 \stackrel{?}{=} 49 & \text{TRUE} \end{array}$$

The solution is -7.

45. $-1.3a = -10.4$

$$\frac{-1.3a}{-1.3} = \frac{-10.4}{-1.3}$$

$$a = 8$$

Check:

$$\begin{array}{r|l} -1.3a = -10.4 & \\ \hline -1.3(8) & -10.4 \\ -10.4 \stackrel{?}{=} -10.4 & \text{TRUE} \end{array}$$

The solution is 8.

47. $\frac{y}{8} = 11$

$$\frac{1}{8} \cdot y = 11$$

$$8\left(\frac{1}{8}\right) \cdot y = 8 \cdot 11$$

$$y = 88$$

Check:

$$\begin{array}{r|l} \frac{y}{8} = 11 & \\ \hline \frac{88}{8} & 11 \\ 11 \stackrel{?}{=} 11 & \text{TRUE} \end{array}$$

The solution is 88.

49. $\frac{4}{5}x = 16$

$$\frac{5}{4} \cdot \frac{4}{5}x = \frac{5}{4} \cdot 16$$

$$x = \frac{5 \cdot \cancel{4} \cdot 4}{\cancel{4} \cdot 1}$$

$$x = 20$$

Check:

$$\begin{array}{r|l} \frac{4}{5}x = 16 & \\ \hline \frac{4}{5} \cdot 20 & 16 \\ 16 \stackrel{?}{=} 16 & \text{TRUE} \end{array}$$

The solution is 20.

51. $\frac{-x}{6} = 9$

$$-\frac{1}{6} \cdot x = 9$$

$$-6\left(-\frac{1}{6}\right) \cdot x = -6 \cdot 9$$

$$x = -54$$

Check:

$$\begin{array}{r|l} \frac{-x}{6} = 9 & \\ \hline \frac{-(-54)}{6} & 9 \\ \frac{54}{6} & \\ 9 \stackrel{?}{=} 9 & \text{TRUE} \end{array}$$

The solution is -54.

53. $\frac{1}{9} = \frac{z}{-5}$

$$\frac{1}{9} = -\frac{1}{5} \cdot z$$

$$-5 \cdot \frac{1}{9} = -5 \cdot \left(-\frac{1}{5} \cdot z\right)$$

$$-\frac{5}{9} = z$$

Check:

$$\begin{array}{r|l} \frac{1}{9} = \frac{z}{-5} & \\ \hline \frac{1}{9} & \frac{-5/9}{-5} \\ & -\frac{5}{9} \cdot \frac{1}{-5} \\ \frac{1}{9} \stackrel{?}{=} \frac{1}{9} & \text{TRUE} \end{array}$$

The solution is $\frac{-5}{9}$.

55. $-\frac{3}{5}r = -\frac{3}{5}$

The solution of the equation is the number that is multiplied by $-\frac{3}{5}$ to get $-\frac{3}{5}$. That number is 1. We could also do this exercise as follows:

$$-\frac{3}{5}r = -\frac{3}{5}$$

$$-\frac{5}{3} \cdot \left(-\frac{3}{5}r\right) = -\frac{5}{3}\left(-\frac{3}{5}\right)$$

$$r = 1$$

Check:

$$\begin{array}{r|l} -\frac{3}{5}r = -\frac{3}{5} & \\ \hline -\frac{3}{5} \cdot 1 & -\frac{3}{5} \\ -\frac{3}{5} \stackrel{?}{=} -\frac{3}{5} & \text{TRUE} \end{array}$$

The solution is 1.

57. $\frac{-3r}{2} = -\frac{27}{4}$

$$-\frac{3}{2}r = -\frac{27}{4}$$

$$-\frac{2}{3} \cdot \left(-\frac{3}{2}r\right) = -\frac{2}{3} \cdot \left(-\frac{27}{4}\right)$$

$$r = \frac{\cancel{2} \cdot \cancel{3} \cdot 3 \cdot 3}{\cancel{3} \cdot \cancel{2} \cdot 2}$$

$$r = \frac{9}{2}$$

Check:

$$\begin{array}{r|l} \frac{-3r}{2} = -\frac{27}{4} & \\ \hline -\frac{3}{2} \cdot \frac{9}{2} & -\frac{27}{4} \\ -\frac{27}{4} \stackrel{?}{=} -\frac{27}{4} & \text{TRUE} \end{array}$$

The solution is $\frac{9}{2}$.

59.
$$\begin{aligned} 4.5 + t &= -3.1 \\ 4.5 + t - 4.5 &= -3.1 - 4.5 \\ t &= -7.6 \end{aligned}$$
The solution is -7.6.

61.
$$\begin{aligned} -8.2x &= 20.5 \\ \frac{-8.2x}{-8.2} &= \frac{20.5}{-8.2} \\ x &= -2.5 \end{aligned}$$
The solution is -2.5.

63.
$$\begin{aligned} x - 4 &= -19 \\ x - 4 + 4 &= -19 + 4 \\ x &= -15 \end{aligned}$$
The solution is -15.

65.
$$\begin{aligned} t - 3 &= 8 \\ t - 3 + 3 &= -8 + 3 \\ t &= -5 \end{aligned}$$
The solution is -5.

67.
$$\begin{aligned} -12x &= 14 \\ \frac{-12x}{-12} &= \frac{14}{-12} \\ 1 \cdot x &= -\frac{7}{6} \\ x &= -\frac{7}{6} \end{aligned}$$
The solution is $-\frac{7}{6}$.

69.
$$\begin{aligned} 48 &= -\frac{3}{8}y \\ -\frac{8}{3} \cdot 48 &= -\frac{8}{3}\left(-\frac{3}{8}y\right) \\ -\frac{8 \cdot \cancel{3} \cdot 16}{\cancel{3}} &= y \\ -128 &= y \end{aligned}$$
The solution is -128.

71.
$$\begin{aligned} a - \frac{1}{6} &= -\frac{2}{3} \\ a - \frac{1}{6} + \frac{1}{6} &= -\frac{2}{3} + \frac{1}{6} \\ a &= -\frac{4}{6} + \frac{1}{6} \\ a &= -\frac{3}{6} \\ a &= -\frac{1}{2} \end{aligned}$$
The solution is $-\frac{1}{2}$.

73.
$$\begin{aligned} -24 &= \frac{8x}{5} \\ -24 &= \frac{8}{5}x \\ \frac{5}{8}(-24) &= \frac{5}{8} \cdot \frac{8}{5}x \\ -\frac{5 \cdot \cancel{8} \cdot 3}{\cancel{8} \cdot 1} &= x \\ -15 &= x \end{aligned}$$
The solution is -15.

75.
$$\begin{aligned} -\frac{4}{3}t &= -12 \\ -\frac{3}{4}\left(-\frac{4}{3}t\right) &= -\frac{3}{4}(-12) \\ t &= \frac{3 \cdot \cancel{4} \cdot 3}{\cancel{4}} \\ t &= 9 \end{aligned}$$
The solution is 9.

77.
$$\begin{aligned} -483.297 &= -794.053 + t \\ -483.297 + 794.053 &= -794.053 + t + 794.053 \\ 310.756 &= t \qquad \text{Using a calculator} \end{aligned}$$
The solution is 310.756.

79. Writing Exercise. For an equation $x + a = b$, add the opposite of a (or subtract a) on both sides of the equation. For an equation $ax = b$, multiply by $1/a$ (or divide by a) on both sides of the equation.

81.
$$\begin{aligned} & 3 \cdot 4 - 18 \\ &= 12 - 18 && \text{Multiplying} \\ &= -6 && \text{Subtracting} \end{aligned}$$

83.
$$\begin{aligned} & 16 \div (2 - 3 \cdot 2) + 5 \\ &= 16 \div (2 - 6) + 5 && \text{Simplifying inside} \\ &= 16 \div (-4) + 5 && \text{the parentheses} \\ &= -4 + 5 && \text{Dividing} \\ &= 1 && \text{Adding} \end{aligned}$$

85. Writing Exercise. Yes, it will form an equivalent equation by the addition principle. It will not help to solve the equation, however. The multiplication principle should be used to solve the equation.

87.
$$\begin{aligned} mx &= 11.6m \\ \frac{mx}{m} &= \frac{11.6m}{m} \\ x &= 11.6 \end{aligned}$$
The solution is 11.6.

89.
$$\begin{aligned} cx + 5c &= 7c \\ cx + 5c - 5c &= 7c - 5c \\ cx &= 2c \\ \frac{cx}{c} &= \frac{2c}{c} \\ x &= 2 \end{aligned}$$

91. $7 + |x| = 30$

$-7 + 7 + |x| = -7 + 30$

$|x| = 23$

x represents a number whose distance from 0 is 23. Thus $x = -23$ or $x = 23$.

93. $t - 3590 = 1820$

$t - 3590 + 3590 = 1820 + 3590$

$t = 5410$

$t + 3590 = 5410 + 3590$

$t + 3590 = 9000$

95. To "undo" the last step, divide 22.5 by 0.3.

$22.5 \div 0.3 = 75$

Now divide 75 by 0.3.

$75 \div 0.3 = 250$

The answer should be 250 not 22.5.

Exercise Set 2.2

1. $3x - 1 = 7$

$3x - 1 + 1 = 7 + 1$ Adding 1 to both sides

$3x = 7 + 1$

Choice (c) is correct.

3. $6(x - 1) = 2$

$6x - 6 = 2$ Using the distributive law

Choice (a) is correct.

5. $4x = 3 - 2x$

$4x + 2x = 3 - 2x + 2x$ Adding $2x$ to both sides

$4x + 2x = 3$

Choice (b) is correct.

7. $2x + 9 = 25$

$2x + 9 - 9 = 25 - 9$ Subtracting 9 from both sides

$2x = 16$ Simplifying

$\frac{2x}{2} = \frac{16}{2}$ Dividing both sides by 2

$x = 8$ Simplifying

Check:

$2x + 9 = 25$	
$2 \cdot 8 + 9$	25
$16 + 9$	
$25 \stackrel{?}{=} 25$	TRUE

The solution is 8.

9. $6z + 5 = 47$

$6z + 5 - 5 = 47 - 5$ Subtracting 5 from both sides

$6z = 42$ Simplifying

$\frac{6z}{6} = \frac{42}{6}$ Dividing both sides by 6

Check:

$6z + 5 = 47$	
$6 \cdot 7 + 5$	47
$42 + 5$	
$47 \stackrel{?}{=} 47$	TRUE

The solution is 7.

11. $7t - 8 = 27$

$7t - 8 + 8 = 27 + 8$ Adding 8 to both sides

$7t = 35$

$\frac{7t}{7} = \frac{35}{7}$ Dividing both sides by 7

$t = 5$

Check:

$7t - 8 = 27$	
$7 \cdot 5 - 8$	27
$35 - 8$	
$27 \stackrel{?}{=} 27$	TRUE

The solution is 5.

13. $3x - 9 = 1$

$3x - 9 + 9 = 1 + 9$

$3x = 10$

$\frac{3x}{3} = \frac{10}{3}$

$x = \frac{10}{3}$

Check:

$3x - 9 = 1$	
$3 \cdot \frac{10}{3} - 9$	1
$10 - 9$	
$1 \stackrel{?}{=} 1$	TRUE

The solution is $\frac{10}{3}$.

15. $8z + 2 = -54$

$8z + 2 - 2 = -54 - 2$

$8z = -56$

$\frac{8z}{8} = \frac{-56}{8}$

$z = -7$

Check:

$8z + 2 = -54$	
$8(-7) + 2$	-54
$-56 + 2$	
$-54 \stackrel{?}{=} -54$	TRUE

The solution is -7.

17. $-37 = 9t + 8$

$-37 - 8 = 9t + 8 - 8$

$-45 = 9t$

$\frac{-45}{9} = \frac{9t}{9}$

$-5 = t$

Check:

$-37 = 9t + 8$	
-37	$9 \cdot (-5) + 8$
	$-45 + 8$
$-37 \stackrel{?}{=} -37$	TRUE

19. $12 - t = 16$

$-12 + 12 - t = -12 + 16$

$-t = 4$

$\frac{-t}{-1} = \frac{4}{-1}$

$t = -4$

Check:

$12 - t = 16$	
$12 - (-4)$	16
$12 + 4$	

$16 \stackrel{?}{=} 16$ TRUE

The solution is -4.

21. $-6z - 18 = -132$

$-6z - 18 + 18 = -132 + 18$

$-6z = -114$

$\frac{-6z}{-6} = \frac{-114}{-6}$

$z = 19$

Check:

$-6z - 18 = -132$	
$-6 \cdot 19 - 18$	-132
$-114 - 18$	

$-132 \stackrel{?}{=} -132$ TRUE

The solution is 19.

23. $5.3 + 1.2n = 1.94$

$1.2n = -3.36$

$\frac{1.2n}{1.2} = \frac{-3.36}{1.2}$

$n = -2.8$

Check:

$5.31 + 1.2n = 1.94$	
$5.3 + 1.2(-2.8)$	1.94
$5.3 + (-3.36)$	

$1.94 \stackrel{?}{=} 1.94$ TRUE

The solution is -2.8.

25. $32 - 7x = 11$

$-32 + 32 - 7x = -32 + 11$

$-7x = -21$

$\frac{-7x}{-7} = \frac{-21}{-7}$

$x = 3$

Check:

$32 - 7x = 11$	
$32 - 7 \cdot 3$	11
$32 - 21$	

$11 \stackrel{?}{=} 11$ TRUE

The solution is 3.

27. $\frac{3}{5}t - 1 = 8$

$\frac{3}{5}t - 1 + 1 = 8 + 1$

$\frac{3}{5}t = 9$

$\frac{5}{3} \cdot \frac{3}{5}t = \frac{5}{3} \cdot 9$

$t = \frac{5 \cdot \cancel{3} \cdot 3}{\cancel{3} \cdot 1}$

$t = 15$

Check:

$\frac{3}{5}t - 1 = 8$	
$\frac{3}{5} \cdot 15 - 1$	8
$9 - 1$	

$8 \stackrel{?}{=} 8$ TRUE

The solution is 15.

29. $6 + \frac{7}{2}x = -15$

$-6 + 6 + \frac{7}{2}x = -6 - 15$

$\frac{7}{2}x = -21$

$\frac{2}{7} \cdot \frac{7}{2}x = \frac{2}{7}(-21)$

$x = -\frac{2 \cdot 3 \cdot \cancel{7}}{\cancel{7} \cdot 1}$

$x = -6$

Check:

$6 + \frac{7}{2}x = -15$	
$6 + \frac{7}{2}(-6)$	-15
$6 + (-21)$	

$-15 \stackrel{?}{=} -15$ TRUE

The solution is -6.

31. $-\frac{4a}{5} - 8 = 2$

$-\frac{4a}{5} - 8 + 8 = 2 + 8$

$-\frac{4a}{5} = 10$

$-\frac{5}{4}\left(-\frac{4a}{5}\right) = -\frac{5}{4} \cdot 10$

$a = -\frac{5 \cdot 5 \cdot \cancel{2}}{2 \cdot \cancel{2}}$

$a = -\frac{25}{2}$

Check:

$-\frac{4a}{5} - 8 = 2$	
$-\frac{4}{5}\left(-\frac{25}{2}\right) - 8$	2
$10 - 8$	

$2 \stackrel{?}{=} 2$ TRUE

The solution is $-\frac{25}{2}$.

33. $4x = x + 3x$
$4x = 4x$

All real numbers are solutions and the equation is an identity.

35. $4x - 6 = 6x$

$-6 = 6x - 4x$ Subtracting $4x$ from both sides

$-6 = 2x$ Simplifying

$\frac{-6}{2} = \frac{2x}{2}$ Dividing both sides by 2

$-3 = x$

Check:

$4x - 6 = 6x$	
$4(-3) - 6$	$6(-3)$
$-12 - 6$	-18
$-18 \stackrel{?}{=} -18$	TRUE

The solution is -3.

37. $2 - 5y = 26 - y$

$2 - 5y + y = 26 - y + y$ Adding y to both sides

$2 - 4y = 26$ Simplifying

$-2 + 2 - 4y = -2 + 26$ Adding -2 to both sides

$-4y = 24$ Simplifying

$\frac{-4y}{-4} = \frac{24}{-4}$ Dividing both sides by -4

$y = -6$

Check:

$2 - 5y = 26 - y$	
$2 - 5(-6)$	$26 - (-6)$
$2 + 30$	$26 + 6$
$32 \stackrel{?}{=} 32$	TRUE

The solution is -6.

39. $7(2a - 1) = 21$

$14a - 7 = 21$ Using the distributive law

$14a = 21 + 7$ Adding 7

$14a = 28$

$a = 2$ Dividing by 14

Check:

$7(2a - 1) = 21$	
$7(2 \cdot 2 - 1)$	21
$7(4 - 1)$	
$7 \cdot 3$	
$21 \stackrel{?}{=} 21$	TRUE

The solution is 2.

41. We can write $11 = 11(x + 1)$ as $11 \cdot 1 = 11(x + 1)$. Then $1 = x + 1$, or $x = 0$. The solution is 0.

43. $2(3 + 4m) - 6 = 48$
$6 + 8m - 6 = 48$
$8m = 48$ Combining like terms
$m = 6$

Check:

$2(3 + 4m) - 6 = 48$	
$2(3 + 4 \cdot 6) - 6$	48
$2(3 + 24) - 6$	
$2 \cdot 27 - 6$	
$54 - 6$	
$48 \stackrel{?}{=} 48$	TRUE

The solution is 6.

45. $3(x + 4) = 3(x - 1)$

$3x + 12 = 3x - 3$ Using the distributive law

$12 = -3$ Subtracting $3x$ from both sides

Since $12 \neq -3$, there is no solution and the equation is a contradiction.

47. $2r + 8 = 6r + 10$
$2r + 8 - 10 = 6r + 10 - 10$
$2r - 2 = 6r$ Combining like terms
$-2r + 2r - 2 = -2r + 6r$
$-2 = 4r$
$\frac{-2}{4} = \frac{4r}{4}$

$-\frac{1}{2} = r$

Check:

$2r + 8 = 6r + 10$	
$2\left(-\frac{1}{2}\right) + 8$	$6\left(-\frac{1}{2}\right) + 10$
$-1 + 8$	$-3 + 10$
$7 \stackrel{?}{=} 7$	TRUE

The solution is $-\frac{1}{2}$.

49. $6x + 3 = 2x + 3$
$6x - 2x = 3 - 3$
$4x = 0$
$\frac{4x}{4} = \frac{0}{4}$
$x = 0$

Check:

$6x + 3 = 2x + 3$	
$6 \cdot 0 + 3$	$2 \cdot 0 + 3$
$0 + 3$	$0 + 3$
$3 \stackrel{?}{=} 3$	TRUE

The solution is 0.

51. $5 - 2x = 3x - 7x + 25$
$5 - 2x = -4x + 25$
$4x - 2x = 25 - 5$
$2x = 20$
$\frac{2x}{2} = \frac{20}{2}$
$x = 10$

Check:

$5 - 2x = 3x - 7x + 25$	
$5 - 2 \cdot 10$	$3 \cdot 10 - 7 \cdot 10 + 25$
$5 - 20$	$30 - 70 + 25$
-15	$-40 + 25$

The solution is 10.

53. $7+3x-6=3x+5-x$

$3x+1=2x+5$ Combining like terms on each side

$3x-2x=5-1$

$x=4$

Check:

$7+3x-6=3x+5-x$	
$7+3\cdot 4-6$	$3\cdot 4+5-4$
$7+12-6$	$12+5-4$
$19-6$	$17-4$
$13 \stackrel{?}{=} 13$	TRUE

The solution is 4.

55. $4y-4+y+24=6y+20-4y$

$5y+20=2y+20$

$5y-2y=20-20$

$3y=0$

$y=0$

Check:

$4y-4+y+24=6y+20-4y$	
$4\cdot 0-4+0+24$	$6\cdot 0+20-4\cdot 0$
$0-4+0+24$	$0+20-0$
$20 \stackrel{?}{=} 20$	TRUE

The solution is 0.

57. $4+7x=7(x+1)$

$4+7x=7x+7$

$4=7$

Since $4 \neq 7$, there is no solution and the equation is a contradiction.

59. $19-3(2x-1)=7$

$19-6x+3=7$

$22-6x=7$

$-6x=7-22$

$-6x=-15$

$x=\dfrac{15}{6}$

$x=\dfrac{5}{2}$

Check:

$19-3(2x-1)=7$	
$19-3(2\cdot\frac{5}{2}-1)$	7
$19-3(5-1)$	
$19-3(4)$	
$19-12$	
$7 \stackrel{?}{=} 7$	TRUE

The solution is $\frac{5}{2}$.

61. $7(5x-2)=6(6x-1)$

$35x-14=36x-6$

$-14+6=36x-35x$

$-8=x$

Check:

$7(5x-2)=6(6x-1)$	
$7(5(-8)-2)$	$6(6(-8)-1)$
$7(-40-2)$	$6(-48-1)$
$7(-42)$	$6(-49)$

The solution is -8.

63. $2(3t+1)-5=t-(t+2)$

$6t+2-5=t-t-2$

$6t-3=-2$

$6t=-2+3$

$6t=1$

$t=\dfrac{1}{6}$

Check:

$2(3t+1)-5=t-(t+2)$	
$2\left(3\cdot\frac{1}{6}+1\right)-5$	$\frac{1}{6}-\left(\frac{1}{6}+2\right)$
$2\left(\frac{1}{2}+1\right)-5$	$\frac{1}{6}-2\frac{1}{6}$
$2\cdot\frac{3}{2}-5$	-2
$-2 \stackrel{?}{=} -2$	TRUE

The solution is $\dfrac{1}{6}$.

65. $2(7-x)-20=7x-3(2+3x)$

$14-2x-20=7x-6-9x$

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

All real numbers are solutions and the equation is an identity.

67. $19-(2x+3)=2(x+3)+x$

$19-2x-3=2x+6+x$

$16-2x=3x+6$

$16-6=3x+2x$

$10=5x$

$2=x$

Check:

$19-(2x+3)=2(x+3)+x$	
$19-(2\cdot 2+3)$	$2(2+3)+2$
$19-(4+3)$	$2\cdot 5+2$
$19-7$	$10+2$
$12 \stackrel{?}{=} 12$	TRUE

The solution is 2.

69. $\dfrac{2}{3}+\dfrac{1}{4}t=2$

The number 12 is the least common denominator, so we multiply by 12 on both sides.

$12\left(\dfrac{2}{3}+\dfrac{1}{4}t\right)=12\cdot 2$

$12\cdot\dfrac{2}{3}+12\cdot\dfrac{1}{4}t=24$

$8+3t=24$

$3t=24-8$

$3t=16$

$t=\dfrac{16}{3}$

Check:

$\frac{2}{3}+\frac{1}{4}t=2$	
$\frac{2}{3}+\frac{1}{4}\left(\frac{16}{3}\right)$	2
$\frac{2}{3}+\frac{4}{3}$	
$2 \stackrel{?}{=} 2$	TRUE

71. $\frac{2}{3}+4t=6t-\frac{2}{15}$

The number 15 is the least common denominator, so we multiply by 15 on both sides.

$$15\Big(\frac{2}{3}+4t\Big)=15\Big(6t-\frac{2}{15}\Big)$$
$$15\cdot\frac{2}{3}+15\cdot 4t=15\cdot 6t-15\cdot\frac{2}{15}$$
$$10+60t=90t-2$$
$$10+2=90t-60t$$
$$12=30t$$
$$\frac{12}{30}=t$$
$$\frac{2}{5}=t$$

Check:

$$\frac{2}{3}+4t=6t-\frac{2}{15}$$

$\frac{2}{3}+4\cdot\frac{2}{5}$	$6\cdot\frac{2}{5}-\frac{2}{15}$
$\frac{2}{3}+\frac{8}{5}$	$\frac{12}{5}-\frac{2}{15}$
$\frac{10}{15}+\frac{24}{15}$	$\frac{36}{15}-\frac{2}{15}$
$\frac{34}{15}\stackrel{?}{=}\frac{34}{15}$	TRUE

The solution is $\frac{2}{5}$.

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

The number 15 is the least common denominator, so we multiply by 15 on both sides.

$$15\Big(\frac{1}{3}x+\frac{2}{5}\Big)=15\Big(\frac{4}{5}+\frac{3}{5}x-\frac{2}{3}\Big)$$
$$15\cdot\frac{1}{3}x+15\cdot\frac{2}{5}=15\cdot\frac{4}{5}+15\cdot\frac{3}{5}x-15\cdot\frac{2}{3}$$
$$5x+6=12+9x-10$$
$$5x+6=2+9x$$
$$5x-9x=2-6$$
$$-4x=-4$$
$$\frac{-4x}{-4}=\frac{-4}{-4}$$
$$x=1$$

Check:

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

$\frac{1}{3}\cdot 1+\frac{2}{5}$	$\frac{4}{5}+\frac{3}{5}\cdot 1-\frac{2}{3}$
$\frac{1}{3}+\frac{2}{5}$	$\frac{4}{5}+\frac{3}{5}-\frac{2}{3}$
$\frac{5}{15}+\frac{6}{15}$	$\frac{12}{15}+\frac{9}{15}-\frac{10}{15}$
$\frac{11}{15}$	$\frac{11}{15}$
$\frac{11}{15}\stackrel{?}{=}\frac{11}{15}$	TRUE

75. $2.1x+45.2=3.2-8.4x$

Greatest number of decimal places is 1

$$10(2.1x+45.2)=10(3.2-8.4x)$$

Multiplying by 10 to clear decimals

$$10(2.1x)+10(45.2)=10(3.2)-10(8.4x)$$
$$21x+452=32-84x$$
$$21x+84x=32-452$$
$$105x=-420$$
$$x=\frac{-420}{105}$$
$$x=-4$$

Check:

$$2.1x+45.2=3.2-8.4x$$

$2.1(-4)+45.2$	$3.2-8.4(-4)$
$-8.4+45.2$	$3.2+33.6$
$36.8\stackrel{?}{=}36.8$	TRUE

The solution is -4.

77. $0.76+0.21t=0.96t-0.49$

Greatest number of decimal places is 2

$$100(0.76+0.21t)=100(0.96t-0.49)$$

Multiplying by 100 to clear decimals

$$100(0.76)+100(0.21t)=100(0.96t)-100(0.49)$$
$$76+21t=96t-49$$
$$76+49=96t-21t$$
$$125=75t$$
$$\frac{125}{75}=t$$
$$\frac{5}{3}=t, \text{ or}$$
$$1.\overline{6}=t$$

The answer checks. The solution is $\frac{5}{3}$, or $1.\overline{6}$.

79. $\frac{2}{5}x-\frac{3}{2}x=\frac{3}{4}x+3$

The least common denominator is 20.

$$20\Big(\frac{2}{5}x-\frac{3}{2}x\Big)=20\Big(\frac{3}{4}x+3\Big)$$
$$20\cdot\frac{2}{5}x-20\cdot\frac{3}{2}x=20\cdot\frac{3}{4}x+20\cdot 3$$
$$8x-30x=15x+60$$
$$-22x=15x+60$$
$$-22x-15x=60$$
$$-37x=60$$
$$x=-\frac{60}{37}$$

Check:

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

$\frac{2}{5}\Big(-\frac{60}{37}\Big)-\frac{3}{2}\Big(-\frac{60}{37}\Big)$	$\frac{3}{4}\Big(-\frac{60}{37}\Big)+3$
$-\frac{24}{37}+\frac{90}{37}$	$-\frac{45}{37}+\frac{111}{37}$
$\frac{66}{37}\stackrel{?}{=}\frac{66}{37}$	

The solution is $-\frac{60}{37}$.

81.
$$\frac{1}{3}(2x-1)=7$$
$$3\cdot\frac{1}{3}(2x-1)=3\cdot 7$$
$$2x-1=21$$
$$2x=22$$
$$x=11$$

Check:
$$\frac{1}{3}(2x-1)=7$$
$$\frac{1}{3}(2\cdot 11-1) \mid 7$$
$$\frac{1}{3}\cdot 21$$
$$7\stackrel{?}{=}7 \quad \text{TRUE}$$

The solution is 11.

83.
$$\frac{3}{4}(3t-4)=15$$
$$\frac{4}{3}\cdot\frac{3}{4}(3t-4)=\frac{4}{3}\cdot 15$$
$$3t-4=20$$
$$3t=24$$
$$t=8$$

Check:
$$\frac{3}{4}(3t-4)=15$$
$$\frac{3}{4}(3\cdot 8-4) \mid 15$$
$$\frac{3}{4}\cdot(24-4)$$
$$\frac{3}{4}\cdot 20$$
$$15\stackrel{?}{=}15 \quad \text{TRUE}$$

The solution is 8.

85.
$$\frac{1}{6}\left(\frac{3}{4}x-2\right)=-\frac{1}{5}$$
$$30\cdot\frac{1}{6}\left(\frac{3}{4}x-2\right)=30\left(-\frac{1}{5}\right)$$
$$5\left(\frac{3}{4}x-2\right)=-6$$
$$\frac{15}{4}x-10=-6$$
$$\frac{15}{4}x=4$$
$$4\cdot\frac{15}{4}x=4\cdot 4$$
$$15x=16$$
$$x=\frac{16}{15}$$

Check:
$$\frac{1}{6}\left(\frac{3}{4}x-2\right)=-\frac{1}{5}$$
$$\frac{1}{6}\left(\frac{3}{4}\cdot\frac{16}{15}-2\right) \mid -\frac{1}{5}$$
$$\frac{1}{6}\left(\frac{4}{5}-2\right)$$
$$\frac{1}{6}\left(-\frac{6}{5}\right)$$
$$-\frac{1}{5}\stackrel{?}{=}-\frac{1}{5} \quad \text{TRUE}$$

The solution is $\frac{16}{15}$.

87.
$$0.7(3x+6)=1.1-(x-3)$$
$$2.1x+4.2=1.1-x+3$$
$$2.1x+4.2=-x+4.1$$
$$10(2.1x+4.2)=10(-x+4.1) \quad \text{Clearing decimals}$$
$$21x+42=-10x+41$$
$$21x=-10x+41-42$$
$$21x=-10x-1$$
$$31x=-1$$
$$x=-\frac{1}{31}$$

The check is left to the student. The solution is $-\frac{1}{31}$.

89.
$$a+(a-3)=(a+2)-(a+1)$$
$$a+a-3=a+2-a-1$$
$$2a-3=1$$
$$2a=1+3$$
$$2a=4$$
$$a=2$$

Check:
$$a+(a-3)=(a+2)-(a+1)$$
$$2+(2-3) \mid (2+2)-(2+1)$$
$$2-1 \mid 4-3$$
$$1\stackrel{?}{=}1 \quad \text{TRUE}$$

The solution is 2.

91. Writing Exercise. By adding $t-13$ to both sides of $45-t=13$ we have $32=t$. This approach is preferable since we found the solution in just one step.

93. $3-5a=3-5\cdot 2=3-10=-7$

95. $7x-2x=7(-3)-2(-3)=-21+6=-15$

97. Writing Exercise. Multiply by 100 to clear decimals. Next multiply by 12 to clear fractions. (These steps could be reversed.) Then proceed as usual. The procedure could be streamlined by multiplying by 1200 to clear decimals and fractions in one step.

99.
$$8.43x-2.5(3.2-0.7x)=-3.455x+9.04$$
$$8.43x-8+1.75x=-3.455x+9.04$$
$$10.18x-8=-3.455x+9.04$$
$$10.18x+3.455x=9.04+8$$
$$13.635x=17.04$$

The solution is $1.\overline{2497}$, or $\frac{1136}{909}$.

101.
$$\begin{aligned} -2[3(x-2)+4] &= 4(5-x)-2x \\ -2[3x-6+4] &= 20-4x-2x \\ -2[3x-2] &= 20-6x \\ -6x+4 &= 20-6x \\ 4 &= 20 \end{aligned}$$
Adding $6x$ to both sides

This is a contradiction.

103.
$$\begin{aligned} 2x(x+5)-3(x^2+2x-1) &= 9-5x-x^2 \\ 2x^2+10x-3x^2-6x+3 &= 9-5x-x^2 \\ -x^2+4x+3 &= 9-5x-x^2 \\ 4x+3 &= 9-5x \quad \text{Adding } x^2 \\ 4x+5x &= 9-3 \\ 9x &= 6 \\ x &= \frac{2}{3} \end{aligned}$$

The solution is $\frac{2}{3}$.

105.
$$\begin{aligned} 9-3x &= 2(5-2x)-(1-5x) \\ 9-3x &= 10-4x-1+5x \\ 9-3x &= 9+x \\ 9-9 &= x+3x \\ 0 &= 4x \\ 0 &= x \end{aligned}$$

The solution is 0.

107.
$$\begin{aligned} \frac{x}{14}-\frac{5x+2}{49} &= \frac{3x-4}{7} \\ 98\left(\frac{x}{14}-\frac{5x+2}{49}\right) &= 98\left(\frac{3x-4}{7}\right) \\ 98\cdot\frac{x}{14}-98\left(\frac{5x+2}{49}\right) &= 42x-56 \\ 7x-10x-4 &= 42x-56 \\ -3x-4 &= 42x-56 \\ -4+56 &= 42x+3x \\ 52 &= 45x \\ \frac{52}{45} &= x \end{aligned}$$

109.
$$\begin{aligned} 2\{9-3[-2x-4]\} &= 12x+42 \\ 2\{9+6x+12\} &= 12x+42 \\ 2\{6x+21\} &= 12x+42 \\ 12x+42 &= 12x+42 \end{aligned}$$

All real numbers are solutions and the equation is an identity.

Exercise Set 2.3

1. We substitute 0.9 for t and calculate d.

$$d = 344t = 344\cdot 0.9 = 309.6$$

The fans were 309.6m from the stage.

3. We substitute 21,345 for n and calculate f.

$$f = \frac{n}{15} = \frac{21,345}{15} = 1423$$

There are 1423 full-time equivalent students.

5. We substitute 0.025 for I and 0.044 for U and calculate f.
$$\begin{aligned} f &= 8.5+1.4(I-U) \\ &= 8.5+1.4(0.025-0.044) \\ &= 8.5+1.4(-0.019) \\ &= 8.5-0.0266 \\ &= 8.4734 \end{aligned}$$

The federal funds rate should be 8.4734.

7. Substitute 1 for t and calculate n.
$$\begin{aligned} n &= 0.5t^4+3.45t^3-96.65t^2+347.7t \\ &= 0.5(1)^4+3.45(1)^3-96.65(1)^2+347.7(1) \\ &= 0.5+3.45-96.65+347.7 \\ &= 255 \end{aligned}$$

255 mg of ibuprofen remains in the bloodstream.

9.
$$\begin{aligned} A &= bh \\ \frac{A}{h} &= \frac{bh}{h} \quad \text{Dividing both sides by } h \\ \frac{A}{h} &= b \end{aligned}$$

11.
$$\begin{aligned} d &= rt \\ \frac{d}{t} &= \frac{rt}{t} \quad \text{Dividing both sides by } t \\ \frac{d}{t} &= r \end{aligned}$$

13.
$$\begin{aligned} I &= Prt \\ \frac{I}{rt} &= \frac{Prt}{rt} \quad \text{Dividing both sides by } rt \\ \frac{I}{rt} &= P \end{aligned}$$

15.
$$\begin{aligned} H &= 65-m \\ H+m &= 65 \quad \text{Adding } m \text{ to both sides} \\ m &= 65-H \quad \text{Subtracting } H \text{ from both sides} \end{aligned}$$

17.
$$\begin{aligned} P &= 2l+2w \\ P-2w &= 2l+2w-2w \quad \text{Subtracting } 2w \text{ from both sides} \\ P-2w &= 2l \\ \frac{P-2w}{2} &= \frac{2l}{2} \quad \text{Dividing both sides by 2} \\ \frac{P-2w}{2} &= l, \text{ or} \\ \frac{P}{2}-w &= l \end{aligned}$$

19.
$$\begin{aligned} A &= \pi r^2 \\ \frac{A}{r^2} &= \frac{\pi r^2}{r^2} \\ \frac{A}{r^2} &= \pi \end{aligned}$$

21. $A = \frac{1}{2}bh$

$2A = 2 \cdot \frac{1}{2}bh$ Multiplying both sides by 2

$2A = bh$

$\frac{2A}{b} = \frac{bh}{b}$ Dividing both sides by h

$\frac{2A}{b} = h$

23. $E = mc^2$

$\frac{E}{m} = \frac{mc^2}{m}$ Dividing both sides by m

$\frac{E}{m} = c^2$

25. $Q = \frac{c+d}{2}$

$2Q = 2 \cdot \frac{c+d}{2}$ Multiplying both sides by 2

$2Q = c + d$

$2Q - c = c + d - c$ Subtracting c from both sides

$2Q - c = d$

27. $A = \frac{a+b+c}{3}$

$3A = 3 \cdot \frac{a+b+c}{3}$ Multiplying both sides by 3

$3A = a + b + c$

$3A - a - c = a + b + c - a - c$ Subtracting a and c from both sides

$3A - a - c = b$

29. $w = \frac{r}{f}$

$f \cdot w = f \cdot \frac{r}{f}$ Multiplying both sides by f

$fw = r$

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

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

$\frac{5}{9}(F - 32) = \frac{5}{9} \cdot \frac{9}{5}C$

$\frac{5}{9}(F - 32) = C$

33. $2x - y = 1$

$2x - y + y - 1 = 1 + y - 1$ Adding $y - 1$ to both sides

$2x - 1 = y$

35. $2x + 5y = 10$

$5y = -2x + 10$

$y = \frac{-2x + 10}{5}$

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

37. $4x - 3y = 6$

$-3y = -4x + 6$

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

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

39. $9x + 8y = 4$

$8y = -9x + 4$

$y = \frac{-9x + 4}{8}$

$y = -\frac{9}{8}x + \frac{1}{2}$

41. $3x - 5y = 8$

$-5y = -3x + 8$

$y = \frac{-3x + 8}{-5}$

$y = \frac{3}{5}x - \frac{8}{5}$

43. $z = 13 + 2(x + y)$

$z - 13 = 2(x + y)$

$z - 13 = 2x + 2y$

$z - 13 - 2y = 2x$

$\frac{z - 13 - 2y}{2} = x$

$\frac{1}{2}z - \frac{13}{2} - y = x$

45. $t = 27 - \frac{1}{4}(w - l)$

$t - 27 = -\frac{1}{4}(w - l)$

$-4(t - 27) = w - l$ Multiplying by -4

$-4t + 108 = w - l$

$-4t + 108 - w = -l$

$4t - 108 + w = l$ Multiplying by -1

47. $A = at + bt$

$A = t(a + b)$ Factoring

$\frac{A}{a+b} = t$ Dividing both sides by $a+b$

49. $A = \frac{1}{2}ah + \frac{1}{2}bh$

$2A = 2\left(\frac{1}{2}ah + \frac{1}{2}bh\right)$

$2A = ah + bh$

$2A = h(a + b)$

$\frac{2A}{a+b} = h$

51.
$$R = r + \frac{400(W-L)}{N}$$
$$N \cdot R = N\left(r + \frac{400(W-L)}{N}\right)$$
Multiplying both sides by N
$$NR = Nr + 400(W-L)$$
$$NR = Nr + 400W - 400L$$
$$NR + 400L = Nr + 400W$$ Adding $400L$ to both sides
$$400L = Nr + 400W - NR$$ Adding $-NR$ to both sides
$$L = \frac{Nr + 400W - NR}{400}$$

53. Writing Exercise. Given the formula for converting Celsius temperature C to Fahrenheit temperature F, solve for C. This yields a formula for converting Fahrenheit temperature to Celsius temperature.

55.
$$\begin{aligned} &-2 + 5 - (-4) - 17 \\ &= -2 + 5 + 4 - 17 \\ &= 3 + 4 - 17 \\ &= 7 - 17 \\ &= -10 \end{aligned}$$

57. $4.2(-11.75)(0) = 0$

59.
$$\begin{aligned} &20 \div (-4) \cdot 2 - 3 \\ &= -5 \cdot 2 - 3 && \text{Dividing and} \\ &= -10 - 3 && \text{multiplying from left to right} \\ &= -13 && \text{Subtracting} \end{aligned}$$

61. Writing Exercise. Answers may vary. A decorator wants to have a carpet cut for a bedroom. The perimeter of the room is 54 ft and its length is 15 ft. How wide should the carpet be?

63.
$$K = 21.235w + 7.75h - 10.54a + 102.3$$
$$2852 = 21.235(80) + 7.75(190) - 10.54a + 102.3$$
$$2852 = 1698.8 + 1472.5 - 10.54a + 102.3$$
$$2852 = 3273.6 - 10.54a$$
$$-421.6 = -10.54a$$
$$40 = a$$

The man is 40 years old.

65. First we substitute 54 for A and solve for s to find the length of a side of the cube.
$$A = 6s^2$$
$$54 = 6s^2$$
$$9 = s^2$$
$$3 = s$$ Taking the positive square root

Now we substitute 3 for s in the formula for the volume of a cube and compute the volume.

$$V = s^3 = 3^3 = 27$$

The volume of the cube is 27 in^3.

67.
$$c = \frac{w}{a} \cdot d$$
$$ac = a \cdot \frac{w}{a} \cdot d$$
$$ac = wd$$
$$a = \frac{wd}{c}$$

69.
$$ac = bc + d$$
$$ac - bc = d$$
$$c(a-b) = d$$
$$c = \frac{d}{a-b}$$

71.
$$3a = c - a(b+d)$$
$$3a = c - ab - ad$$
$$3a + ab + ad = c$$
$$a(3 + b + d) = c$$
$$a = \frac{c}{3+b+d}$$

73.
$$K = 21.235w + 7.75h - 10.54a + 102.3$$
$$K = 21.235\left(\frac{w}{2.2046}\right) + 7.75\left(\frac{h}{0.3937}\right) - 10.54a + 102.3$$
$$K = 9.632w + 19.685h - 10.54a + 102.3$$

Exercise Set 2.4

1. "What percent of 57 is 23?" can be translated as $n \cdot 57 = 23$, so choice (d) is correct.

3. "23 is 57% of what number?" can be translated as $23 = 0.57y$, so choice (e) is correct.

5. "57 is what percent of 23?" can be translated as $n \cdot 23 = 57$, so choice (c) is correct.

7. "What is 23% of 57?" can be translated as $a = (0.23)57$, so choice (f) is correct.

9. "23% of what number is 57?" can be translated as $57 = 0.23y$, so choice (b) is correct.

11. $49\% = 49.0\%$

49% 0.49.0

Move the decimal point 2 places to the left.

$49\% = 0.49$

13. $1\% = 1.0\%$

1% 0.01.0

Move the decimal point 2 places to the left.

$1\% = 0.01$

15. $4.1\% = 4.10\%$

4.1% 0.04.10

Move the decimal point 2 places to the left.

17. $20\% = 20.0\%$

20% $0.20.0$

Move the decimal point 2 places to the left.

$20\% = 0.20$, or 0.2

19. 62.5% $0.62.5$

Move the decimal point 2 places to the left.

$62.5\% = 0.625$

21. 0.2% $0.00.2$

Move the decimal point 2 places to the left.

$0.2\% = 0.002$

23. $175\%=175.0\%$ $1.75.0$

Move the decimal point 2 places to the left.

$175\% = 1.75$

25. 0.38

First move the decimal point two places to the right; then write a % symbol: 0.38. → 38%

27. 0.039

First move the decimal point two places to the right; then write a % symbol: 0.03.9 → 3.9%

29. 0.45

First move the decimal point two places to the right; then write a % symbol: 0.45. → 45%

31. 0.7

First move the decimal point two places to the right; then write a % symbol: 0.70. → 70%

33. 0.0009

First move the decimal point two places to the right; then write a % symbol: 0.00. 09 → 0.09%

35. 1.06

First move the decimal point two places to the right; then write a % symbol: 1.06. → 106%

37. 1.8

First move the decimal point two places to the right; then write a % symbol: 1.80. → 180%

39. $\frac{3}{5}$ $\left(\text{Note: } \frac{3}{5} = 0.6\right)$

Move the decimal point two places to the right; then write a % symbol: 0.60. → 60%

41. $\frac{8}{25}$ $\left(\text{Note: } \frac{8}{25} = 0.32\right)$

First move the decimal point two places to the right; then write a % symbol: 0.32. → 32%

43. Translate.

What percent of 76 is 19?

$y \cdot 76 = 19$

$y = \frac{19}{76}$

$y = 0.25 = 25\%$

The answer is 25%.

45. Translate.

What percent of 150 is 39?

$y \cdot 150 = 39$

$y = \frac{39}{150}$

$y = 0.26 = 26\%$

The answer is 26%.

47. Translate.

14 is 30% of what number?

$14 = 30\% \cdot y$

We solve the equation.

$14 = 0.3y \quad (30\% = 0.3)$

$\frac{14}{0.3} = y$

$46.\overline{6} = y$

The answer is $46.\overline{6}$, or $46\frac{2}{3}$, or $\frac{140}{3}$.

49. Translate.

0.3 is 12% of what number?

$0.3 = 12\% \cdot y$

We solve the equation.

$0.3 = 0.12y \quad (12\% = 0.12)$

$\frac{0.3}{0.12} = y$

$2.5 = y$

The answer is 2.5.

51. Translate.

$$\underbrace{\text{What number}}_{\downarrow\ y} \text{ is } \underset{\downarrow}{1\%} \text{ of } \underset{\downarrow}{\text{one million}}?$$
$$y = 1\% \cdot 1{,}000{,}000$$

We solve the equation.

$y = 0.01 \cdot 1{,}000{,}000$ $(1\% = 0.01)$
$y = 10{,}000$ Multiplying

The answer is 10,000.

53. Translate.

$$\underbrace{\text{What percent}}_{\downarrow\ y} \text{ of } 60 \text{ is } 75?$$
$$y \cdot 60 = 75$$

We solve the equation and then convert to percent notation.

$$y \cdot 60 = 75$$
$$y = \frac{75}{60}$$
$$y = 1.25 = 125\%$$

The answer is 125%.

55. Translate.

$$\text{What is } 2\% \text{ of } 40?$$
$$x = 2\% \cdot 40$$

We solve the equation.

$x = 0.02 \cdot 40$ $(2\% = 0.02)$
$x = 0.8$ Multiplying

The answer is 0.8.

57. Observe that 25 is half of 50. Thus, the answer is 0.5, or 50%. We could also do this exercise by translating to an equation.

Translate.

$$25 \text{ is } \underbrace{\text{what percent}}_{\downarrow\ y} \text{ of } 50?$$
$$25 = y \cdot 50$$

We solve the equation and convert to percent notation.

$$25 = y \cdot 50$$
$$\frac{25}{50} = y$$
$$0.5 = y, \text{ or } 50\% = y$$

The answer is 50%.

59. Translate.

$$\text{What percent of } 69 \text{ is } \$23?$$
$$y \cdot 69 = 23$$

We solve the equation and convert to percent notation.

$$y \cdot 69 = 23 y = \frac{23}{69} y = 0.33\overline{3} = 33.\overline{3}\% \text{ or } 33\frac{1}{3}\%$$

The answer is $33.\overline{3}\%$ or 33 1/3%.

61. First we reword and translate, letting c represent Americans who commute to work, in millions.

$$\text{What is } 5\% \text{ of } 57?$$
$$c = 0.05 \cdot 57$$
$$c = 0.05 \cdot 57 = 2.85$$

There are 2.85 million Americans who bicycle to commute to school or work.

63. First we reword and translate, letting h represent Americans who bicycle to exercise for health.

$$\text{What is } 41\% \text{ of } 57\%$$
$$h = 0.41 \cdot 57$$
$$h = 0.41 \cdot 57 = 23.37$$

There are 23.37 million Americans who bicycle to exercise for health.

65. First we reword and translate, letting c represent the number of credits Cody has completed.

$$\text{What is } 60\% \text{ of } 125?$$
$$c = 0.6 \cdot 125$$
$$c = 0.6 \cdot 125 = 75$$

Cody has completed 75 credits.

67. First we reword and translate, letting b represent the number of at-bats.

$$216 \text{ is } 36.3\% \text{ of } \underbrace{\text{what number}}_{\downarrow\ b}?$$
$$216 = 0.363 \cdot b$$
$$\frac{216}{0.363} = b$$
$$595 \approx b$$

Magglio Ordonez had 595 at-bats.

69. a) First we reword and translate, letting p represent the unknown percent.

$$\underbrace{\text{What percent}}_{\downarrow\ p} \text{ of } \$25 \text{ is } \$4?$$
$$p \cdot 25 = 4$$
$$\frac{p \cdot 25}{25} = \frac{4}{25}$$
$$p = 0.16 = 16\%$$

The tip was 16% of the cost of the meal.

b) We add to find the total cost of the meal, including tip:

$$\$25 + \$4 = \$29$$

71. To find the percent of crude oil came from Canada and Mexico, we first reword and translate, letting p represent the unknown percent.

$$\underbrace{3.4 \text{ million}}_{\downarrow\ 3.4} \text{ is } \underbrace{\text{what percent}}_{\downarrow\ p} \text{ of } \underbrace{10.2 \text{ million}}_{\downarrow\ 10.2}?$$
$$3.4 = p \cdot 10.2$$
$$\frac{3.4}{10.2} = p$$
$$0.33\overline{3} = p$$

About $33.\overline{3}\%$ or 33 1/3% of crude oil came from Canada and Mexico.

To find the percent of crude oil that came from the rest of the world, we subtract:

$$100\% - 33\ 1/3\% = 66\ 2/3\% \text{ or } 66.\overline{6}\%.$$

About 66 2/3% or $66.\overline{6}\%$ of crude oil came from the rest of the world.

73. Let I = the amount of interest Glenn will pay. Then we have:

$$\begin{array}{l} I \text{ is } 7\% \text{ of } \$2400. \\ \downarrow\downarrow\ \ \downarrow\ \ \downarrow\ \ \downarrow \\ I = 0.07 \cdot \$2400 \\ I = \$168 \end{array}$$

Glenn will pay \$168 interest.

75. If n = the number of women who had babies in good or excellent health, we have:

$$\begin{array}{l} n \text{ is } 95\% \text{ of } 300. \\ \downarrow\downarrow\ \ \downarrow\ \ \downarrow\ \ \downarrow \\ n = 0.95 \cdot 300 \\ n = 285 \end{array}$$

285 women had babies in good or excellent health.

77. A self-employed person must earn 120% as much as a non-self-employed person. Let a = the amount Tia would need to earn, in dollars per hour, on her own for a comparable income.

$$\begin{array}{l} a \text{ is } 120\% \text{ of } \$16. \\ \downarrow\downarrow\ \ \downarrow\ \ \downarrow\ \ \downarrow \\ a = 1.2 \cdot 16 \\ a = 19.20 \end{array}$$

Tia would need to earn \$19.20 per hour on her own.

79. We reword and translate.

$$\begin{array}{l} \underbrace{\text{What percent}} \text{ of } 103 \text{ is } 45? \\ \ \ \downarrow\ \ \ \ \ \ \downarrow\ \downarrow\ \downarrow\ \downarrow \\ \ \ p\ \ \ \ \ \ \cdot\ 103 = 45 \end{array}$$

$$p \cdot 103 = 45$$

$$p \approx 0.437 = 43.7\%$$

The actual cost exceeds initial estimate by about 43.7%.

81. When the sales tax is 6%, the total amount paid is 106% of the cost of the merchandise. Let c = the cost of the merchandise. Then we have:

$$\begin{array}{l} \$47.70 \text{ is } 106\% \text{ of } c. \\ \ \ \downarrow\ \ \ \downarrow\ \ \ \downarrow\ \ \ \downarrow\downarrow \\ 47.70 = 1.06 \cdot c \end{array}$$

$$\frac{47.70}{1.06} = c$$

$$45 = c$$

The price of the merchandise was \$45.

83. When the sales tax is 6%, the total amount paid is 106% of the cost of the merchandise. Let c = the amount the school group owes, or the cost of the software without tax. Then we have:

$$\begin{array}{l} \$157.41 \text{ is } 106\% \text{ of } c. \\ \ \ \downarrow\ \ \ \downarrow\ \ \ \downarrow\ \ \ \downarrow\downarrow \\ 157.41 = 1.06 \cdot c \end{array}$$

$$\frac{157.41}{1.06} = c$$

$$148.5 = c$$

The school group owes \$148.50.

85. First we reword and translate.

$$\begin{array}{l} \text{What is } 16.5\% \text{ of } 191? \\ \ \ \downarrow\ \ \ \downarrow\ \ \ \downarrow\ \ \ \downarrow\ \ \ \downarrow \\ \ \ a\ \ = 0.165 \cdot 191 \end{array}$$

Solve. We convert 16.5% to decimal notation and multiply.

$$a = 0.165 \cdot 191$$

$$a = 31.515 \approx 31.5$$

About 31.5 lb of the author's body weight is fat.

87. Let m = the number of mailed ads that led to a sale or response from customers. Then we have:

$$\begin{array}{l} m \text{ is } 2.15\% \text{ of } 114. \\ \downarrow\downarrow\ \ \downarrow\ \ \downarrow\ \ \downarrow \\ m = 0.0215 \cdot 114 \\ m \approx 2.45 \end{array}$$

About 2.45 billion pieces of mail led to a response.

89. The number of calories in a serving of Light Style Bread is 85% of the number of calories in a serving of regular bread. Let c = the number of calories in a serving of regular bread. Then we have:

$$\begin{array}{l} \underbrace{140 \text{ calories}} \text{ is } 85\% \text{ of } c. \\ \ \ \downarrow\ \ \ \ \ \ \downarrow\ \downarrow\ \downarrow\ \downarrow \\ \ \ 140\ \ \ \ = 0.85 \cdot c \end{array}$$

$$\frac{140}{0.85} = c$$

$$165 \approx c$$

There are about 165 calories in a serving of regular bread.

91. Writing Exercise. The book is marked up \$30. Since Campus Bookbuyers paid \$30 for the book, this is a 100% markup.

93. Let l represent represent the length and w the width. Then twice the length plus twice the width is $2l + 2w$.

95. Let p represent the number of points Tino scored. Then $p - 5$ is five fewer than p.

97. Half of a is $\frac{1}{2}a$. So the product of 10 and half of a is $10\left(\frac{1}{2}a\right)$.

99. Let l represent the length and w the width. Then, the width is 2 in. less than the length which is $w = l - 2$.

101. (a) In the survey report, 40% of all sick days on Monday or Friday sounds excessive. However, for a traditional 5-day business week, 40% is the same as $\frac{2}{5}$. That is, just 2 days

(b)In the FBI statistics, 26% of home burglaries occurring between Memorial Day and Labor Day sounds excessive. However, 26% of a 365-day year is 73 days, For the months of June, July, and August there are at least 90 days. So 26% is less than one home burglary per day.

103. Let p = the population of Bardville. Then we have:

$$\begin{array}{l} 1332 \text{ is } 15\% \text{ of } 48\% \text{ of } \underbrace{\text{the population.}} \\ \downarrow\ \downarrow\ \downarrow\ \downarrow\ \downarrow\ \downarrow\ \quad\downarrow \\ 1332 = 0.15 \cdot 0.48 \cdot \quad p \end{array}$$

$$\frac{1332}{0.15(0.48)} = p$$

$$18,500 = p$$

The population of Bardville is 18,500.

105. Since 6 ft $= 6 \times 1$ ft $= 6 \times 12$ in. $= 72$ in., we can express 6 ft 4 in. as 72 in.+4 in., or 76 in. We reword and translate. Let a = Jaraan's final adult height.

$$\begin{array}{l} \underbrace{\text{76in.}} \text{ is } 96.1\% \text{ of } \underbrace{\text{adult height}} \\ \downarrow\ \downarrow\ \downarrow\ \downarrow\ \quad\downarrow \\ 76 = 0.961 \cdot \quad a \end{array}$$

$$\frac{76}{0.961} = a$$

$$79 \approx a$$

Note that 79 in. $= 72$ in. $+ 7$ in. $= 6$ ft 7 in.

Jaraan's final adult height will be about 6 ft 7 in.

107. Using the formula for the area A of a rectangle with length l and width w, $A = l \cdot w$, we first find the area of the photo.

$$A = 8 \text{ in.} \times 6 \text{ in.} = 48 \text{ in}^2$$

Next we find the area of the photo that will be visible using a mat intended for a 5-in. by 7-in. photo.

$$A = 7 \text{ in.} \times 5 \text{ in.} = 35 \text{ in}^2$$

Then the area of the photo that will be hidden by the mat is 48 in^2 − 35 in^2, or 13 in^2.

We find what percentage of the area of the photo this represents.

$$\begin{array}{l} \underbrace{\text{What percent}} \text{ of } \underbrace{48 \text{ in}^2} \text{ is } \underbrace{13 \text{ in}^2}? \\ \quad\downarrow\quad\ \downarrow\ \downarrow\ \downarrow\ \downarrow \\ \quad p\quad\ \cdot\ 48\ =\ 13 \end{array}$$

$$\frac{p \cdot 48}{48} = \frac{13}{48}$$

$$p \approx 0.27$$

$$p \approx 27\%$$

The mat will hide about 27% of the photo.

109. Writing Exercise. Suppose Jorge has x dollars of taxable income. If he makes a \$50 tax-deductible contribution, then he pays tax of $0.3(x - \$50)$, or $0.3x - \$15$ and his assets are reduced by $0.3x - \$15 + \$50$, or $0.3x + \$35$. If he makes a \$40 non-tax-deductible contribution, he pays tax of $0.3x$ and his assets are reduced by $0.3x + \$40$. Thus, it costs him less to make a \$50 tax-deductible contribution.

Exercise Set 2.5

1. Familiarize. Let n = the number. Then three less than two times the number is $2n - 3$.

Translate.

$$\begin{array}{l} \underbrace{\text{Three less than twice a number}} \text{ is } 19. \\ \quad\downarrow\quad\quad\quad\quad\quad\quad\ \downarrow\ \downarrow \\ \quad 2n - 3\quad\quad\quad\quad\quad\ =\ 19 \end{array}$$

Carry out. We solve the equation.

$$\begin{aligned} 2n - 3 &= 19 \\ 2n &= 22 \quad \text{Adding 3} \\ n &= 11 \quad \text{Dividing by 2} \end{aligned}$$

Check. Twice 11 is 22 and three fewer than 19. The answer checks.

State. The number is 11.

3. Familiarize. Let a = the number. Then "five times the sum of 3 and twice some number" translates to $5(2a + 3)$.

Translate.

$$\begin{array}{l} \underbrace{\text{Five times the sum of 3 and twice some number}} \text{ is } 70. \\ \quad\downarrow\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\ \downarrow\ \downarrow \\ \quad 5(2a + 3)\quad\quad\quad\quad\quad\quad\quad\quad\ =\ 70 \end{array}$$

Carry out. We solve the equation.

$$\begin{aligned} 5(2a + 3) &= 70 \\ 10a + 15 &= 70 \quad \text{Using the distributive law} \\ 10a &= 55 \quad \text{Subtracting 15} \\ a &= \tfrac{11}{2} \quad \text{Dividing by 10} \end{aligned}$$

Check. The sum of $2 \cdot \frac{11}{2}$ and 3 is 14, and $5 \cdot 14 = 70$. The answer checks.

State. The number is $\frac{11}{2}$.

5. Familiarize. Let p = the regular price of the iPod. At 20% off, Kyle paid $(100 - 20)\%$, or 80% of the regular price.

Translate.

$$\begin{array}{l} \$120 \text{ is } 80\% \text{ of } \underbrace{\text{the regular price.}} \\ \downarrow\ \downarrow\ \downarrow\ \downarrow\ \quad\downarrow \\ 120\ =\ 0.80\ \cdot\ \quad p \end{array}$$

Carry out. We solve the equation.

$$120 = 0.80p$$

$$150 = p$$

Check. 80% of \$150, or 0.80(\$150), is \$120. The answer checks.

State. The regular price was \$150.

7. Familiarize. Let c = the price of the graphing calculator itself. When the sales tax rate is 6%, the tax paid on the calculator is 6% of c, or $0.06c$.

Translate.

$$\begin{array}{l} \underbrace{\text{Price of calculator}} \text{ plus } \underbrace{\text{sales tax}} \text{ is } \$137.80. \\ \quad\downarrow\quad\quad\quad\quad\ \downarrow\ \quad\downarrow\ \downarrow\ \downarrow \\ \quad c\quad\quad\quad\ +\ \ 0.06c\ =\ 137.80 \end{array}$$

$$c + 0.06c = 137.80$$
$$1.06c = 137.80$$
$$c = 130$$

Check. 6% of \$130, or 0.06(\$130), is \$7.80 and \$7.80 + \$130 is \$137.80, the total cost. The answer checks.

State. The graphing calculator itself cost \$130.

9. **Familiarize**. Let d = Looi's distance, in miles, from the start after 8 hr. Then the distance from the finish line is $2d$.

Translate.

$$\underbrace{\text{Distance from start}}_{\downarrow\ d} \quad \underset{\downarrow\ +}{\text{plus}} \quad \underbrace{\text{distance from finish}}_{\downarrow\ 2d} \quad \underset{\downarrow\ =}{\text{is}} \quad \underset{\downarrow\ 235.3}{\text{235.3 mi.}}$$

Carry out. We solve the equation.

$$d + 2d = 235.3$$
$$3d = 235.3$$
$$d \approx 78.4$$

Check. If Looi is 78.4 mi from the start, then he is $2 \cdot (78.4)$, or 156.8 mi from the finish. Since $78.4 + 156.8$ is approximately 235.3, the total distance, the answer checks.

State. Looi had traveled approximately 78.4 mi.

11. **Familiarize**.Let d = the distance, in miles, that Danica had traveled to the given point after the start. Then the distance from the finish line was $300d$ miles.

Translate.

$$\underbrace{\text{Distance to finish}}_{\downarrow\ 300-d} \quad \underset{\downarrow\ +}{\text{plus}} \quad \underbrace{\text{20 mi more}}_{\downarrow\ 20} \quad \underset{\downarrow\ =}{\text{was}} \quad \underbrace{\text{distance to start.}}_{\downarrow\ d}$$

Carry out. We solve the equation.

$$300 - d + 20 = d$$
$$320 - d = d$$
$$320 = 2d$$
$$160 = d$$

Check. If Danica was 160 mi from the start, she was 300160, or 140 mi from the finish. Since 160 is 20 more than 140, the answer checks.

State. Danica had traveled 160 mi at the given point.

13. **Familiarize**. Let n = the number of Erica's apartment. Then $n+1$ = the number of her next-door neighbor's apartment.

Translate.

$$\underbrace{\text{Erica's number}}_{\downarrow\ n} \quad \underset{\downarrow\ +}{\text{plus}} \quad \underbrace{\text{neighbor's number}}_{\downarrow\ (n+1)} \quad \underset{\downarrow\ =}{\text{is}} \quad \underset{\downarrow\ 2409}{\text{2409.}}$$

Carry out. We solve the equation.

$$n + (n + 1) = 2409$$
$$2n + 1 = 2409$$
$$2n = 2408$$

If Erica's apartment number is 1204, then her next-door neighbor's number is $1204 + 1$, or 1205.

Check. 1204 and 1205 are consecutive numbers whose sum is 2409. The answer checks.

State. The apartment numbers are 1204 and 1205.

15. **Familiarize**. Let n = the smaller house number. Then $n + 2$ = the larger number.

Translate.

$$\underbrace{\text{Smaller number}}_{\downarrow\ n} \quad \underset{\downarrow\ +}{\text{plus}} \quad \underbrace{\text{larger number}}_{\downarrow\ (n+2)} \quad \underset{\downarrow\ =}{\text{is}} \quad \underset{\downarrow\ 572}{\text{572.}}$$

Carry out. We solve the equation.

$$n + (n + 2) = 572$$
$$2n + 2 = 572$$
$$2n = 570$$
$$n = 285$$

If the smaller number is 285, then the larger number is $285 + 2$, or 287.

Check. 285 and 287 are consecutive odd numbers and $285 + 287 = 572$. The answer checks.

State. The house numbers are 285 and 287.

17. **Familiarize**. Let x = the first page number. Then $x + 1$ = the second page number, and $x + 2$ = the third page number.

Translate.

$$\underbrace{\text{The sum of three consecutive page numbers}}_{\downarrow\ x+(x+1)+(x+2)} \quad \underset{\downarrow\ =}{\text{is}} \quad \underset{\downarrow\ 99}{\text{99.}}$$

Carry out. We solve the equation.

$$x + (x + 1) + (x + 2) = 99$$
$$3x + 3 = 99$$
$$3x = 96$$
$$x = 32$$

If x is 32, then $x + 1$ is 33 and $x + 2 = 34$.

Check. 32, 33, and 34 are consecutive integers, and $32 + 33 + 34 = 99$. The result checks.

State. The page numbers are 32, 33, and 34.

19. **Familiarize**. Let m = the man's age. Then $m - 2$ = the woman's age.

Translate.

$$\underbrace{\text{Man's age}}_{\downarrow\ m} \quad \underset{\downarrow\ +}{\text{plus}} \quad \underbrace{\text{Woman's age}}_{\downarrow\ (m-2)} \quad \underset{\downarrow\ =}{\text{is}} \quad \underset{\downarrow\ 204}{\text{204.}}$$

Carry out. We solve the equation.

$$m + (m - 2) = 204$$
$$2m - 2 = 204$$
$$2m = 206$$

If m is 103, then $m - 2$ is 101.

Check. 103 is 2 more than 101, and $103 + 101 = 204$. The answer checks.

State. The man was 103 yr old, and the woman was 101 yr old.

21. **Familiarize**. Familiarize. Let m = the number non-spam messages, in billions. Then $4m$ is the number of spam messages.

Translate.

$$\underbrace{\text{spam}}_{\downarrow\ 4m}\ \text{plus}\ \underbrace{\text{non-spam}}_{\downarrow\ m}\ \text{is}\ \underbrace{125}_{\downarrow\ = 125}$$

Carry out. We solve the equation.

$$\begin{aligned} 4m + m &= 125 \\ 5m &= 125 \\ m &= 25 \end{aligned}$$

If m is 25, then $4m$ is 100.

Check. 100 is four times 25, and $25 + 100 = 125$. The answer checks.

State.There were 100 billion spam messages and 25 billion non-spam messages sent each day in 2006.

23. **Familiarize**. The page numbers are consecutive integers. If we let x = the smaller number, then $x + 1$ = the larger number.

Translate. We reword the problem.

$$\underbrace{\text{First integer}}_{\downarrow\ x}\ +\ \underbrace{\text{Second integer}}_{\downarrow\ (x+1)}\ = 281$$

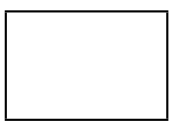
Carry out. We solve the equation.

$$\begin{aligned} x + (x + 1) &= 281 \\ 2x + 1 &= 281 \quad \text{Combining like terms} \\ 2x &= 280 \quad \text{Adding } -1 \text{ on both sides} \\ x &= 140 \quad \text{Dividing on both sides by 2} \end{aligned}$$

Check. If $x = 140$, then $x + 1 = 141$. These are consecutive integers, and $140 + 141 = 281$. The answer checks.

State. The page numbers are 140 and 141.

25. **Familiarize**. We draw a picture. Let w = the width of the rectangle, in feet. Then $w + 60$ = the length.



The perimeter is twice the length plus twice the width, and the area is the product of the length and the width.

Translate.

$$\underbrace{\text{Twice the length}}_{\downarrow\ 2(w+60)}\ \text{plus}\ \underbrace{\text{twice the width}}_{\downarrow\ 2w}\ \text{is}\ \underbrace{520\text{ ft}}_{\downarrow\ 520}.$$

Carry out. We solve the equation.

$$\begin{aligned} 2(w + 60) + 2w &= 520 \\ 2w + 120 + 2w &= 520 \\ 4w + 120 &= 520 \\ 4w &= 400 \\ w &= 100 \end{aligned}$$

Then $w + 60 = 100 + 60 = 160$, and the area is $160 \text{ ft} \cdot 100 \text{ ft} = 16,000 \text{ ft}^2$.

Check. The length, 160 ft, is 60 ft more than the width, 100 ft. The perimeter is $2 \cdot 160 \text{ ft} + 2 \cdot 100 \text{ ft}$, or $320 \text{ ft} + 200 \text{ ft}$, or 520 ft. We can check the area by doing the calculation again. The answer checks.

State. The length is 160 ft, the width is 100 ft, and the area is 16,000 ft^2.

27. **Familiarize**. Let w = the width, in meters. Then $w + 4$ is the length. The perimeter is twice the length plus twice the width.

Translate.

$$\underbrace{\text{Twice the width}}_{\downarrow\ 2w}\ \text{plus}\ \underbrace{\text{twice the length}}_{\downarrow\ 2(w+4)}\ \text{is } 92.$$

Carry out. We solve the equation.

$$\begin{aligned} 2w + 2(w + 4) &= 92 \\ 2w + 2w + 8 &= 92 \\ 4w &= 84 \\ w &= 21 \end{aligned}$$

Then $w + 4 = 21 + 4 = 25$.

Check. The length, 25 m is 4 more than the width, 21 m. The perimeter is $2 \cdot 21 \text{ m} + 2 \cdot 25 \text{ m} = 42 \text{ m} + 50 \text{ m} = 92 \text{ m}$. The answer checks.

State. The length of the garden is 25 m and the width is 21 m.

29. **Familiarize**. Let w = the width, in inches. Then $2w$ = the length. The perimeter is twice the length plus twice the width. We express $10\frac{1}{2}$ as 10.5.

Translate.

$$\underbrace{\text{Twice the length}}_{\downarrow\ 2 \cdot 2w}\ \text{plus}\ \underbrace{\text{twice the width}}_{\downarrow\ 2w}\ \text{is}\ \underbrace{10.5\text{ in.}}_{\downarrow\ 10.5}$$

Carry out. We solve the equation.

$$\begin{aligned} 2 \cdot 2w + 2w &= 10.5 \\ 4w + 2w &= 10.5 \\ 6w &= 10.5 \\ w &= 1.75, \text{ or } 1\frac{3}{4} \end{aligned}$$

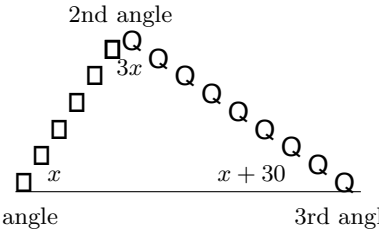
Then $2w = 2(1.75) = 3.5$, or $3\frac{1}{2}$.

Check. The length, $3\frac{1}{2}$ in., is twice the width, $1\frac{3}{4}$ in.

$7 \text{ in.} + 3\frac{1}{2} \text{ in.} = 10\frac{1}{2} \text{ in.}$ The answer checks.

State. The actual dimensions are $3\frac{1}{2}$ in. by $1\frac{3}{4}$ in.

31. **Familiarize.** We draw a picture. We let $x =$ the measure of the first angle. Then $3x =$ the measure of the second angle, and $x + 30 =$ the measure of the third angle.



Recall that the measures of the angles of any triangle add up to $180^\square$.

Translate.

$$\underbrace{\text{Measure of first angle}}_{x} + \underbrace{\text{measure of second angle}}_{3x} + \underbrace{\text{measure of third angle}}_{x+30} \text{ is } \underbrace{180^\square}_{180}.$$

$$x + 3x + (x + 30) = 180$$

Carry out. We solve the equation.

$$\begin{aligned} x + 3x + (x + 30) &= 180 \\ 5x + 30 &= 180 \\ 5x &= 150 \\ x &= 30 \end{aligned}$$

Possible answers for the angle measures are as follows:

First angle: $x = 30^\square$

Second angle: $3x = 3(30)^\square = 90^\square$

Third angle: $x + 30^\square = 30^\square + 30^\square = 60^\square$

Check. Consider $30^\square$, $90^\square$, and $60^\square$. The second angle is three times the first, and the third is $30^\square$ more than the first. The sum of the measures of the angles is $180^\square$. These numbers check.

State. The measure of the first angle is $30^\square$, the measure of the second angle is $90^\square$, and the measure of the third angle is $60^\square$.

33. **Familiarize.** Let $x =$ the measure of the first angle. Then $4x =$ the measure of the second angle, and $x + 4x + 5 = 5x + 5$ is the measure of the third angle.

Translate.

$$\underbrace{\text{Measure of first angle}}_{x} + \underbrace{\text{measure of second angle}}_{4x} + \underbrace{\text{measure of third angle}}_{5x+5} \text{ is } \underbrace{180^\square}_{180}.$$

$$x + 4x + (5x + 5) = 180$$

Carry out. We solve the equation.

$$\begin{aligned} x + 4x + (5x + 5) &= 180 \\ 10x + 5 &= 180 \\ 10x &= 175 \\ x &= 17.5 \end{aligned}$$

If $x = 17.5$, then $4x = 4(17.5) = 70$, and $5x+5 = 5(17.5)+5 = 87.5 + 5 = 92.5$.

Check. Consider $17.5^\square$, $70^\square$, and $92.5^\square$. The second is four times the first, and the third is $5^\square$more than the sum of the other two. The sum of the measures of the angles is $180^\square$. These numbers check.

State. The measure of the second angle is $70^\square$.

35. **Familiarize.** Let $b =$ the length of the bottom section of the rocket, in feet. Then $\frac{1}{6}b =$ the length of the top section, and $\frac{1}{2}b =$ the length of the middle section.

Translate.

$$\underbrace{\text{Length of top section}}_{\frac{1}{6}b} + \underbrace{\text{length of middle section}}_{\frac{1}{2}b} + \underbrace{\text{length of bottom section}}_{b} \text{ is } \underbrace{240 \text{ ft}}_{240}.$$

$$\frac{1}{6}b + \frac{1}{2}b + b = 240$$

Carry out. We solve the equation. First we multiply by 6 on both sides to clear the fractions.

$$\begin{aligned} \frac{1}{6}b + \frac{1}{2}b + b &= 240 \\ 6\left(\frac{1}{6}b + \frac{1}{2}b + b\right) &= 6 \cdot 240 \\ 6 \cdot \frac{1}{6}b + 6 \cdot \frac{1}{2}b + 6 \cdot b &= 1440 \\ b + 3b + 6b &= 1440 \\ 10b &= 1440 \\ b &= 144 \end{aligned}$$

Then $\frac{1}{6}b = \frac{1}{6} \cdot 144 = 24$ and $\frac{1}{2}b = \frac{1}{2} \cdot 144 = 72$.

Check. 24 ft is $\frac{1}{6}$ of 144 ft, and 72 ft is $\frac{1}{2}$ of 144 ft. The sum of the lengths of the sections is
$24 \text{ ft} + 72 \text{ ft} + 144 \text{ ft} = 240 \text{ ft}$. The answer checks.

State. The length of the top section is 24 ft, the length of the middle section is 72 ft, and the length of the bottom section is 144 ft.

37. **Familiarize.** Let $m =$ the number of miles that can be traveled on a \$18 budget. Then the total cost of the taxi ride, in dollars, is $2.250 + 1.80m$, or $2.25 + 1.8m$.

Translate.

$$\underbrace{\text{Cost of taxi ride}}_{2.25 + 1.8m} \text{ is } \$18.$$

$$2.25 + 1.8m = 18$$

Carry out. We solve the equation.

$$\begin{aligned} 2.25 + 1.8m &= 18 \\ 1.8m &= 15.75 \end{aligned}$$

Check. The mileage charge is \$1.80(8.75), or \$15.75, and the total cost of the ride is \$2.25 + \$15.75 = \$18. The answer checks.

State. Debbie can travel 8.75 mi on her budget.

39. **Familiarize**. The total cost is the daily charge plus the mileage charge. Let d = the distance that can be traveled, in miles, in one day for \$100. The mileage charge is the cost per mile times the number of miles traveled, or $0.39d$.

Translate.

$$\underbrace{\text{Daily rate}}_{\downarrow\ 49.95}\ \text{plus}\ \underbrace{\text{mileage charge}}_{\downarrow\ 0.39d}\ \text{is}\ \$100.$$

$$49.95 + 0.39d = 100$$

Carry out. We solve the equation.

$$\begin{aligned} 49.95 + 0.39d &= 100 \\ 0.39d &= 50.05 \\ d &= 128.\overline{3}, \text{or} 128\frac{1}{3} \end{aligned}$$

Check. For a trip of $128\frac{1}{3}$ mi, the mileage charge is $\$0.39\left(128\frac{1}{3}\right)$, or \$50.05, and \$49.95 + \$50.05 = \$100. The answer checks.

State. Concert Productions can travel $128\frac{1}{3}$ mi in one day and stay within their budget.

41. **Familiarize**. Let x = the measure of one angle. Then $90 - x$ = the measure of its complement.

Translate.

$$\underbrace{\text{Measure of one angle}}_{\downarrow\ x}\ \text{is}\ 15^\square\ \underbrace{\text{more than}}_{\downarrow\ +}\ \underbrace{\text{twice the measure of its complement.}}_{\downarrow\ 2(90-x)}$$

$$x = 15 + 2(90 - x)$$

Carry out. We solve the equation.

$$\begin{aligned} x &= 15 + 2(90 - x) \\ x &= 15 + 180 - 2x \\ x &= 195 - 2x \\ 3x &= 195 \\ x &= 65 \end{aligned}$$

If x is 65, then $90 - x$ is 25.

Check. The sum of the angle measures is $90^\square$. Also, $65^\square$ is $15^\square$ more than twice its complement, $25^\square$. The answer checks.

State. The angle measures are $65^\square$ and $25^\square$.

43. Familiarize. Let x = the measure of one angle. Then $180 - x$ = the measure of its supplement.

Translate.

$$\underbrace{\text{Measure of one angle}}_{\downarrow\ x}\ \text{is}\ 3\tfrac{1}{2}\ \text{times}\ \underbrace{\text{measure of second angle.}}_{\downarrow\ (180-x)}$$

Carry out. We solve the equation.

$$\begin{aligned} x &= 3\tfrac{1}{2}(180 - x) \\ x &= 630 - 3.5x \\ 4.5x &= 630 \\ x &= 140 \end{aligned}$$

If $x = 140$, then $180 - 140 = 40^\square$.

Check. The sum of the angles is $180^\square$. Also $140^\square$is three and a half times $40^\square$. The answer checks.

State. The angles are $40^\square$and $140^\square$.

45. **Familiarize**. Let l = the length of the paper, in cm. Then $l - 6.3$ = the width. The perimeter is twice the length plus twice the width.

Translate.

$$\underbrace{\text{Twice the length}}_{\downarrow\ 2l}\ \text{plus}\ \underbrace{\text{twice the width}}_{\downarrow\ 2(l-6.3)}\ \text{is}\ \underbrace{99\ \text{cm}}_{\downarrow\ 99}.$$

$$2l + 2(l - 6.3) = 99$$

Carry out. We solve the equation.

$$\begin{aligned} 2l + 2(l - 6.3) &= 99 \\ 2l + 2l - 12.6 &= 99 \\ 4l - 12.6 &= 99 \\ 4l &= 111.6 \\ l &= 27.9 \end{aligned}$$

Then $l - 6.3 = 27.9 - 6.3 = 21.6$.

Check. The width, 21.6 cm, is 6.3 cm less than the length, 27.9 cm. The perimeter is 2(27.9 cm) + 2(21.6 cm) = 55.8 cm + 43.2 cm = 99 cm. The answer checks.

State. The length of the paper is 27.9 cm, and the width is 21.6 cm.

47. **Familiarize**. Let a = the amount Janeka invested. Then the simple interest for one year is $6\% \cdot a$, or $0.06a$.

Translate.

$$\underbrace{\text{Amount invested}}_{\downarrow\ a}\ \text{plus interest is}\ \$6996.$$

$$a + 0.06a = 6996$$

Carry out. We solve the equation.

$$\begin{aligned} a + 0.06a &= 6996 \\ 1.06a &= 6996 \\ a &= 6600 \end{aligned}$$

Check. An investment of \$6600 at 6% simple interest earns 0.06(\$6600), or \$396, in one year. Since \$6600 + \$396 = \$6996, the answer checks.

State. Janeka invested \$6600.

49. **Familiarize**. Let w = the winning score. Then $w - 340$ = the losing score.

Translate.

$$\underbrace{\text{Winning score}}_{\downarrow\ w}\ \text{plus}\ \underbrace{\text{losing score}}_{\downarrow\ w-340}\ \text{was}\ \underbrace{1320\ \text{points}}_{\downarrow\ 1320}.$$

Carry out. We solve the equation.

$$\begin{aligned} w + (w - 340) &= 1320 \\ 2w - 340 &= 1320 \\ 2w &= 1660 \\ w &= 830 \end{aligned}$$

Then $w - 340 = 830 - 340 = 490$.

Check. The winning score, 830, is 340 points more than the losing score, 490. The total of the two scores is $830 + 490 = 1320$ points. The answer checks.

State. The winning score was 830 points.

51. **Familiarize**. Let a = the selling price of the house. Then the commission on the selling price is 6% times a, or $0.06a$.

Translate.

$$\underbrace{\text{Selling price}}_{\downarrow\ a} \quad \underset{\downarrow\ -}{\text{minus}} \quad \underbrace{\text{commission}}_{\downarrow\ 0.06a} \quad \underset{\downarrow\ =}{\text{is}} \quad \underset{\downarrow\ 117,500}{\$\ 117{,}500.}$$

Carry out. We solve the equation.

$$\begin{aligned} a - 0.06a &= 117{,}500 \\ 0.94a &= 117{,}500 \\ a &= 125{,}000 \end{aligned}$$

Check. A selling price of \$125,000 gives a commission of \$7500. Since $\$125{,}000 - \$7500 = \$117{,}500$, the answer checks.

State. They must sell the house for \$125,000.

53. **Familiarize**. We will use the equation

$$T = \frac{1}{4}N + 40.$$

Translate. We substitute 80 for T.

$$80 = \frac{1}{4}N + 40$$

Carry out. We solve the equation.

$$\begin{aligned} 80 &= \frac{1}{4}N + 40 \\ 40 &= \frac{1}{4}N \\ 160 &= N \qquad \text{Multiplying by 4 on both sides} \end{aligned}$$

Check. When $N = 160$, we have $T = \frac{1}{4} \cdot 160 + 40 = 40 + 40 = 80$. The answer checks.

State. A cricket chirps 160 times per minute when the temperature is 80°F.

55. **Writing Exercise**. Although many of the problems in this section might be solved by guessing, using the five-step problem-solving process to solve them would give the student practice is using a technique that can be used to solve other problems whose answers are not so readily guessed.

57. Since -8 is to the left of 1, $-8 < 1$.

59. Since $\frac{1}{2}$ is to the right of 0, $\frac{1}{2} > 0$.

63. $y < 5$

65. **Writing Exercise**. Answers may vary.

The sum of three consecutive odd integers is 375. What are the integers?

67. **Familiarize**. Let c = the amount the meal originally cost. The 15% tip is calculated on the original cost of the meal, so the tip is $0.15c$.

Translate.

$$\underbrace{\text{Original cost}}_{\downarrow\ c} \quad \underset{\downarrow\ +}{\text{plus}} \quad \underset{\downarrow\ 0.15c}{\text{tip}} \quad \underset{\downarrow\ -}{\text{less}} \quad \underset{\downarrow\ 10}{\$10} \quad \underset{\downarrow\ =}{\text{is}} \quad \underset{\downarrow\ 32.55}{\$32.55.}$$

Carry out. We solve the equation.

$$\begin{aligned} c + 0.15c - 10 &= 32.55 \\ 1.15c - 10 &= 32.55 \\ 1.15c &= 42.55 \\ c &= 37 \end{aligned}$$

Check. If the meal originally cost \$37, the tip was 15% of \$37, or 0.15(\$37), or \$5.55. Since $\$37 + \$5.55 - \$10 = \$32.55$, the answer checks.

State. The meal originally cost \$37.

69. **Familiarize**. Let s = one score. Then four score = $4s$ and four score and seven = $4s + 7$.

Translate. We reword .

$$\underbrace{1776}_{\downarrow\ 1776} \quad \underset{\downarrow\ +}{\text{plus}} \quad \underbrace{\text{four score and seven}}_{\downarrow\ (4s+7)} \quad \underset{\downarrow\ =}{\text{is}} \quad \underbrace{1863}_{\downarrow\ 1863}$$

Carry out. We solve the equation.

$$\begin{aligned} 1776 + (4s + 7) &= 1863 \\ 4s + 1783 &= 1863 \\ 4s &= 80 \\ s &= 20 \end{aligned}$$

Check. If a score is 20 years, then four score and seven represents 87 years. Adding 87 to 1776 we get 1863. This checks.

State. A score is 20.

71. **Familiarize**. Let n = the number of half dollars. Then the number of quarters is $2n$; the number of dimes is $2 \cdot 2n$, or $4n$; and the number of nickels is $3 \cdot 4n$, or $12n$. The total value of each type of coin, in dollars, is as follows.

Half dollars: $0.5n$

Quarters: $0.25(2n)$, or $0.5n$

Dimes: $0.1(4n)$, or $0.4n$

Nickels: $0.05(12n)$, or $0.6n$

Then the sum of these amounts is $0.5n + 0.5n + 0.4n + 0.6n$, or $2n$.

Translate.

$$\underbrace{\text{Total amount of change}}_{\downarrow\ 2n} \quad \underset{\downarrow\ =}{\text{is}} \quad \underset{\downarrow\ 10}{\$10.}$$

Carry out. We solve the equation.

$$2n = 10$$
$$n = 5$$

Then $2n = 2 \cdot 5 = 10$, $4n = 4 \cdot 5 = 20$, and $12n = 12 \cdot 5 = 60$.

Check. If there are 5 half dollars, 10 quarters, 20 dimes, and 60 nickels, then there are twice as many quarters as half dollars, twice as many dimes as quarters, and 3 times as many nickels as dimes. The total value of the coins is $\$0.5(5) + \$0.25(10) + \$0.1(20) + \$0.05(60) = \$2.50 + \$2.50 + \$2 + \$3 = \$10$. The answer checks.

State. The shopkeeper got 5 half dollars, 10 quarters, 20 dimes, and 60 nickels.

73. Familiarize. Let p = the price before the two discounts. With the first 10% discount, the price becomes 90% of p, or $0.9p$. With the second 10% discount, the final price is 90% of $0.9p$, or $0.9(0.9p)$.

Translate.

10% discount	and	10% discount of price	is	$ 77.75.
↓	↓	↓	↓	↓
0.9	·	$0.9p$	=	77.75

Carry out. We solve the equation.

$$0.9(0.9p) = 77.75$$
$$0.81p = 77.75$$
$$p = 95.99$$

Check. Since 90% of \$95.99 is \$86.39, and 90% of \$86.39 is \$77.75, the answer checks.

State. The original price before discounts was \$95.99.

75. **Familiarize.** Let n = the number of DVDs purchased. Assume that two more DVDs were purchased. Then the first DVD costs \$9.99 and the total cost of the remaining $(n-1)$ DVDs is$\$6.99(n-1)$. The shipping and handling costs are \$3 for the first DVD, \$1.50 for the second (half of \$3), and a total of $\$1(n-2)$ for the remaining $n-2$ DVDs.

Translate.

1st DVD	plus	remaining DVDs	plus	1stS&H charges
↓	↓	↓	↓	↓
9.99	+	$6.99(n-1)$	+	3

... plus	2ndS&H charges	plus	remaining S&Hcharges	is	$45.45.
↓	↓	↓	↓	↓	↓
+	1.50	+	$1(n-2)$	=	45.45

Carry out. We solve the equation.

$$9.99 + 6.99(n-1) + 3 + 1.5 + (n-2) = 45.45$$
$$9.99 + 6.99n - 6.99 + 4.5 + n - 2 = 45.45$$
$$7.99n + 5.5 = 45.45$$
$$7.99n = 39.95$$
$$n = 5$$

Check. If there are 5 DVDs, the cost of the DVDs is \$9.99 + \$6.99(5 − 1), or \$9.99 + \$27.96, or \$37.95. The cost for shipping and handling is \$3 + \$1.50 + \$1(5 − 2) = \$7.50. The total cost is \$37.95 + \$7.50, or \$45.45. The answer checks.

State. There were 5 DVDs in the shipment.

77. **Familiarize.** Let d = the distance, in miles, that Glenda traveled. At \$0.40 per $\frac{1}{5}$ mile, the mileage charge can also be given as 5(\$0.40), or \$2 per mile. Since it took 20 min to complete what is usually a 10-min drive, the taxi was stopped in traffic for $20 - 10$, or 10 min.

Translate.

Initial charge	plus	\$ 2 per mile	plus	stopped in traffic charge	is	$18.50.
↓	↓	↓	↓	↓	↓	↓
2.50	+	$2d$	+	0.40(10)	=	18.50

Carry out. We solve the equation.

$$2.5 + 2d + 0.4(10) = 18.5$$
$$2.5 + 2d + 4 = 18.5$$
$$2d + 6.5 = 18.5$$
$$2d = 12$$
$$d = 6$$

Check. Since \$2(6) = \$12, and \$0.40(10) = \$4, and \$12 + \$4 + \$2.50 = \$18.50, the answer checks.

State. Glenda traveled 6 mi.

79. **Writing Exercise.** If the school can invest the \$2000 so that it earns at least 7.5% and thus grows to at least \$2150 by the end of the year, the second option should be selected. If not, the first option is preferable.

81. **Familiarize.** Let w = the width of the rectangle, in cm. Then $w + 4.25$ = the length.

Translate.

The perimeter	is	101.74 cm.
↓	↓	↓
$2(w + 4.25) + 2w$	=	101.74

Carry out. We solve the equation.

$$2(w + 4.25) + 2w = 101.74$$
$$2w + 8.5 + 2w = 101.74$$
$$4w + 8.5 = 101.74$$
$$4w = 93.24$$
$$w = 23.31$$

Then $w + 4.25 = 23.31 + 4.25 = 27.56$.

Check. The length, 27.56 cm, is 4.25 cm more than the width, 23.31 cm. The perimeter is 2(27.56) cm + 2(23.31 cm) = 55.12 cm + 46.62 cm = 101.74 cm. The

State. The length of the rectangle is 27.56 cm, and the width is 23.31 cm.

Exercise Set 2.6

1. $-5x \leq 30$

$x \geq -6$ Dividing by -5 and reversing the inequality symbol

3. $-2t > -14$

$t < 7$ Dividing by -2 and reversing the inequality symbol

5. $x < -2$ and $-2 > x$ are equivalent.

7. If we add 1 to both sides of $-4x - 1 \leq 15$, we get $-4x \leq 16$. The two given inequalities are equivalent.

9. $x > -4$

a) Since $4 > -4$ is true, 4 is a solution.

b) Since $-6 > -4$ is false, -6 is not a solution.

c) Since $-4 > -4$ is false, -4 is not a solution.

11. $y \leq 19$

a) Since $18.99 \leq 19$ is true, 18.99 is a solution.

b) Since $19.07 \leq 19$ is false, 19.01 is not a solution.

c) Since $19 \leq 19$ is true, 19 is a solution.

13. $c \geq -7$

a) Since $0 \geq -7$ is true, 0 is a solution.

b) Since $-5.4 \geq -7$ is true, -5.4 is a solution.

c) Since $7.1 \geq -7$ is true, 7.1 is a solution.

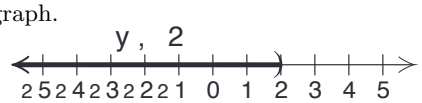
15. $z < -3$

a) Since $0 < -3$ is false, 0 is not a solution.

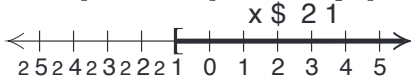
b) Since $-3\frac{1}{3} < -3$ is true, $-3\frac{1}{3}$ is a solution.

c) Since $1 < -3$ is false, 1 is not a solution.

17. The solutions of $y < 2$ are those numbers less than 2. They are shown on the graph by shading all points to the left of 2. The parenthesis at 2 indicates that 2 is not part of the graph.

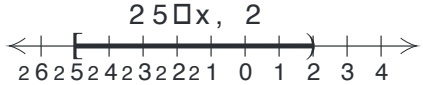


19. The solutions of $x \geq -1$ are those numbers greater than or equal to -1. They are shown on the graph by shading all points to the right of -1. The bracket at -1 indicates that the point -1 is part of the graph.



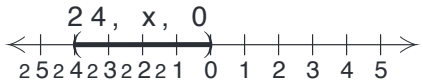
21. The solutions of $0 \leq t$, or $t \geq 0$, are those numbers greater than or equal to zero. They are shown on the graph by shading the point 0 and all points to the right of 0. The bracket at 0 indicates that 0 is part of the graph.

23. In order to be solution of the inequality $-5 \leq x < 2$, a number must be a solution of both $-5 \leq x$ and $x < 2$. The solution set is graphed as follows:



The bracket at -5 means that -5 is part of the graph. The parenthesis at 2 means that 2 is not part of the graph.

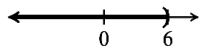
25. In order to be a solution of the inequality $-4 < x < 0$, a number must be a solution of both $-4 < x$ and $x < 0$. The solution set is graphed as follows:



The parenthesis at -4 and 0 mean that -4 and 0 are not part of the graph.

27. $y < 6$

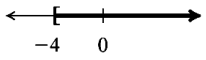
Graph: The solutions consist of all real numbers less than 6, so we shade all numbers to the left of 6 and use a parenthesis at 6 to indicate that it is not a solution.



Set builder notation: $\{y|y < 6\}$
Interval notation: $(-\infty, 6)$

29. $x \geq -4$

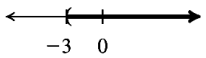
Graph: We shade all numbers to the right of -4 and use a bracket at -4 to indicate that it is also a solution.



Set builder notation: $\{x|x \geq -4\}$
Interval notation: $[-4, \infty)$

31. $t > -3$

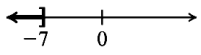
Graph: We shade all numbers to the right of -3 and use a parenthesis at -3 to indicate that it is not a solution.



Set builder notation: $\{t|t > -3\}$
Interval notation: $(-3, \infty)$

33. $x \leq -7$

Graph: We shade all numbers to the left of -7 and use a bracket at -7 to indicate that it is also a solution.



Set builder notation: $\{x|x \leq -7\}$
Interval notation: $(-\infty, -7]$

35. All points to the right of -4 are shaded. The parenthesis at -4 indicates that -4 is not part of the graph. Using set-builder notation we have $\{x|x > -4\}$, or $(-4, \infty)$.

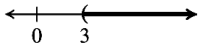
37. The point 2 and all points to the left of 2 are shaded. We have $\{x|x \leq 2\}$, or $(-\infty, 2]$.

39. All points to the left of -1 are shaded. The parenthesis at -1 indicates that -1 is not part of the graph. We have $\{x|x < -1\}$, or $(-\infty, -1)$.

41. The point 0 and all points to the right of 0 are shaded. We have $\{x|x \geq 0\}$, or $[0, \infty)$.

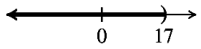
43.
$$\begin{aligned} y + 6 &> 9 \\ y + 6 - 6 &> 9 - 6 \quad \text{Adding } -6 \text{ to both sides} \\ y &> 3 \quad \text{Simplifying} \end{aligned}$$

The solution set is $\{y|y > 3\}$, or $(3, \infty)$.



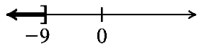
45.
$$\begin{aligned} n - 6 &< 11 \\ n - 6 + 6 &< 11 + 6 \quad \text{Adding 6 to both sides} \\ n &< 17 \quad \text{Simplifying} \end{aligned}$$

The solution set is $\{n|n < 17\}$, or $(-\infty, 17)$.



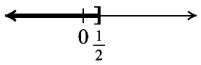
47.
$$\begin{aligned} 2x &\leq x - 9 \\ 2x - x &\leq x - 9 - x \\ x &\leq -9 \end{aligned}$$

The solution set is $\{x|x \leq -9\}$, or $(-\infty, -9]$.



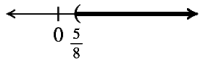
49.
$$\begin{aligned} y + \frac{1}{3} &\leq \frac{5}{6} \\ y + \frac{1}{3} - \frac{1}{3} &\leq \frac{5}{6} - \frac{1}{3} \\ y &\leq \frac{5}{6} - \frac{2}{6} \\ y &\leq \frac{3}{6} \\ y &\leq \frac{1}{2} \end{aligned}$$

The solution set is $\left\{y \middle| y \leq \frac{1}{2}\right\}$, or $(-\infty, \frac{1}{2}]$.



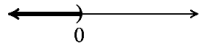
51.
$$\begin{aligned} t - \frac{1}{8} &> \frac{1}{2} \\ t - \frac{1}{8} + \frac{1}{8} &> \frac{1}{2} + \frac{1}{8} \\ t &> \frac{4}{8} + \frac{1}{8} \\ t &> \frac{5}{8} \end{aligned}$$

The solution set is $\left\{t \middle| t > \frac{5}{8}\right\}$, or $(\frac{5}{8}, \infty)$. The graph is as follows:



53.
$$\begin{aligned} -9x + 17 &> 17 - 8x \\ -9x + 17 - 17 &> 17 - 8x - 17 \quad \text{Adding } -17 \\ -9x &> -8x \\ -9x + 9x &> -8x + 9x \quad \text{Adding } 9x \\ 0 &> x \end{aligned}$$

The solution set is $\{x|x < 0\}$, or $(-\infty, 0)$.

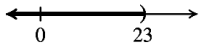


55. $-23 < -t$

The inequality states that the opposite of 23 is less than the opposite of t. Thus, t must be less than 23, so the solution set is $\{t|t < 23\}$. To solve this inequality using the addition principle, we would proceed as follows:

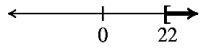
$$\begin{aligned} -23 &< -t \\ t - 23 &< 0 \quad \text{Adding } t \text{ to both sides} \\ t &< 23 \quad \text{Adding 23 to both sides} \end{aligned}$$

The solution set is $\{t|t < 23\}$, or $(-\infty, 23)$.



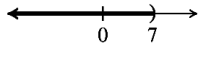
57.
$$\begin{aligned} 10 - y &\leq -12 \\ -10 + 10 - y &\leq -10 - 12 \quad \text{Adding -10} \\ -y &\leq -22 \\ &\downarrow \quad \text{The symbol has to be reversed.} \\ -1(-y) &\geq -1(-22) \\ y &\geq 22 \end{aligned}$$

The solution set is $\{y|y \geq 22\}$, or $[22, \infty)$.

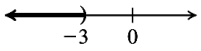


59.
$$\begin{aligned} 4x &< 28 \\ \frac{1}{4} \cdot 4x &< \frac{1}{4} \cdot 28 \quad \text{Multiplying by } \frac{1}{4} \\ x &< 7 \end{aligned}$$

The solution set is $\{x|x < 7\}$, or $(-\infty, 7)$.

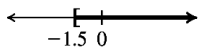


61.
$$\begin{aligned} -24 &> 8t \\ -3 &> t \end{aligned}$$



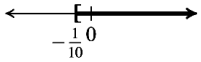
63.
$$1.8 \geq -1.2n$$
$$\frac{-1}{1.2} \cdot 1.8 \leq \frac{-1}{1.2}(-1.2n) \quad \text{Multiplying by } \frac{1}{7}$$
$$\uparrow\_\_\_\_\_ \quad \text{The symbol has to be reversed.}$$
$$-1.5 \leq n$$

The solution set is $\{n|n \geq -1.5\}$, or $[-1.5, \infty)$.



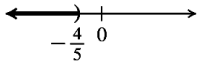
65.
$$-2y \leq \frac{1}{5}$$
$$-\frac{1}{2} \cdot (-2y) \geq -\frac{1}{2} \cdot \frac{1}{5}$$
$$\uparrow\_\_\_\_\_ \quad \text{The symbol has to be reversed.}$$
$$y \geq -\frac{1}{10}$$

The solution set is $\left\{y \middle| y \geq -\frac{1}{10}\right\}$, or $[-\frac{1}{10}, \infty)$.



67.
$$-\frac{8}{5} > 2x$$
$$\frac{1}{2} \cdot -\frac{8}{5} > \frac{1}{2} \cdot 2x$$
$$-\frac{4}{5} > x$$
$$\text{or } x < -\frac{4}{5}$$

The solution set is $\left\{ -\frac{4}{5} > x \right\}$, or $\left\{x < -\frac{4}{5}\right\}$, or $(-\infty, -\frac{4}{5})$.



69.
$$2 + 3x < 20$$
$$2 + 3x - 2 < 20 - 2 \quad \text{Adding } -2 \text{ to both sides}$$
$$3x < 18 \quad \text{Simplifying}$$
$$x < 6 \quad \text{Multiplying both sides by } \frac{1}{3}$$

The solution set is $\{x|x < 6\}$, or $(-\infty, 6)$.

71.
$$4t - 5 \leq 23$$
$$4t - 5 + 5 \leq 23 + 5 \quad \text{Adding 5 to both sides}$$
$$4t \leq 28$$
$$\frac{1}{4} \cdot 4t \leq \frac{1}{4} \cdot 28 \quad \text{Multiplying both sides by } \frac{1}{4}$$
$$t \leq 7$$

73.
$$39 > 3 - 9x$$
$$39 - 3 > 3 - 9x - 3 \quad \text{Adding } -3$$
$$36 > -9x$$
$$-\frac{1}{9} \cdot 36 < -\frac{1}{9} \cdot (-9x) \quad \text{Multiplying by } -\frac{1}{9}$$
$$\uparrow\_\_\_\_ \quad \text{The symbol has to be reversed.}$$
$$-4 < x$$

The solution set is $\{x|-4 < x\}$, or $\{x|x > -4\}$, or $(-4, \infty)$.

75.
$$5 - 6y > 25$$
$$-5 + 5 - 6y > -5 + 25$$
$$-6y > 20$$
$$-\frac{1}{6} \cdot (-6y) < -\frac{1}{6} \cdot 20$$
$$\uparrow\_\_\_\_ \quad \text{The symbol has to be reversed.}$$
$$y < -\frac{20}{6}$$
$$y < -\frac{10}{3}$$

The solution set is $\left\{y \middle| y < -\frac{10}{3}\right\}$, or $(-\infty, -\frac{10}{3})$.

77.
$$-3 < 8x + 7 - 7x$$
$$-3 < x + 7 \quad \text{Collecting like terms}$$
$$-3 - 7 < x + 7 - 7$$
$$-10 < x$$

The solution set is $\{x|x > -10\}$, or $(-10, \infty)$.

79.
$$6 - 4y > 6 - 3y$$
$$6 - 4y + 4y > 6 - 3y + 4y \quad \text{Adding } 4y$$
$$6 > 6 + y$$
$$-6 + 6 > -6 + 6 + y \quad \text{Adding } -6$$
$$0 > y, \text{ or } y < 0$$

The solution set is $\{y|0 > y\}$, or $\{y|y < 0\}$, or $(-\infty, 0)$.

81.
$$7 - 9y \leq 4 - 7y$$
$$7 - 9y + 9y \leq 4 - 7y + 9y$$
$$7 \leq 4 + 2y$$
$$-4 + 7 \leq -4 + 4 + 2y$$
$$3 \leq 2y$$
$$\frac{3}{2} \leq y, \text{or y} \geq \frac{3}{2}$$

The solution set is $\{y|y \geq \frac{3}{2}\}$, or $[\frac{3}{2}, \infty)$.

83.
$$2.1x + 43.2 > 1.2 - 8.4x$$
$$10(2.1x + 43.2) > 10(1.2 - 8.4x) \quad \text{Multiplying by 10 to clear decimals}$$
$$21x + 432 > 12 - 84x$$
$$21x + 84x > 12 - 432 \quad \text{Adding } 84x \text{ and } -432$$
$$105x > -420$$
$$x > -4 \quad \text{Multiplying by } \frac{1}{105}$$

The solution set is $\{x|x > -4\}$, or $(-4, \infty)$.

85.
$$1.7t + 8 - 1.62t < 0.4t - 0.32 + 8$$
$$0.08t + 8 < 0.4t + 7.68 \quad \text{Collecting like}$$
$$100(0.08t + 8) < 100(0.4t + 7.68) \quad \text{Multiplying by}$$
$$8t + 800 < 40t + 768$$
$$-8t - 768 + 8t + 800 < 40t + 768 - 8t - 768$$
$$32 < 32t$$

The solution set is $\{t|t > 1\}$, or $(1, \infty)$.

87.
$$\begin{aligned} \frac{x}{3} + 4 &\le 1 \\ 3\left(\frac{x}{3} + 4\right) &\le 3 \cdot 1 \quad \text{Multiplying by 3 to clear the fraction} \\ x + 12 &\le 3 \\ x &\le -9 \end{aligned}$$

The solution set is $\{x|x \le -9\}$, or $(-\infty, -9]$.

89.
$$\begin{aligned} 3 &< 5 - \frac{t}{7} \\ -2 &< -\frac{t}{7} \\ -7(-2) &> -7\left(-\frac{t}{7}\right) \\ 14 &> t \end{aligned}$$

The solution set is $\{t|t < 14\}$, or $(-\infty, 14)$.

91.
$$\begin{aligned} 4(2y - 3) &\le -44 \\ 8y - 12 &\le -44 \quad \text{Removing parentheses} \\ 8y &\le -32 \quad \text{Adding 12} \\ y &\le -4 \quad \text{Multiplying by } \frac{1}{8} \end{aligned}$$

The solution set is $\{y|y \le -4\}$, or $(-\infty, -4]$.

93.
$$\begin{aligned} 8(2t + 1) &> 4(7t + 7) \\ 16t + 8 &> 28t + 28 \\ -12t + 8 &> 28 \\ -12t &> 20 \\ t &< -\frac{5}{3} \quad \text{Multiplying by } -\tfrac{1}{12} \text{ and reversing the symbol} \end{aligned}$$

The solution set is $\left\{t|t < -\frac{5}{3}\right\}$, or $(-\infty, -\frac{5}{3})$.

95.
$$\begin{aligned} 3(r - 6) + 2 &< 4(r + 2) - 21 \\ 3r - 18 + 2 &< 4r + 8 - 21 \\ 3r - 16 &< 4r - 13 \\ -16 + 13 &< 4r - 3r \\ -3 &< r, \text{ or } r > -3 \end{aligned}$$

The solution set is $\{r|r > -3\}$, or $(-3, \infty)$.

97.
$$\begin{aligned} \frac{4}{5}(3x - 4) &\le 20 \\ \frac{5}{4} \cdot \frac{4}{5}(3x + 4) &\le \frac{5}{4} \cdot 20 \\ 3x + 4 &\le 25 \\ 3x &\le 21 \\ x &\le 7 \end{aligned}$$

The solution set is $\{x|x \le 7\}$, or $(-\infty, 7]$.

99.
$$\begin{aligned} \frac{2}{3}\left(\frac{7}{8} - 4x\right) - \frac{5}{8} &< \frac{3}{8} \\ \frac{2}{3}\left(\frac{7}{8} - 4x\right) &< 1 \quad \text{Adding } \tfrac{5}{8} \\ \frac{7}{12} - \frac{8}{3}x &< 1 \quad \text{Removing parentheses} \\ 12\left(\frac{7}{12} - \frac{8}{3}x\right) &< 12 \cdot 1 \quad \text{Clearing fractions} \\ 7 - 32x &< 12 \\ -32x &< 5 \\ x &> -\frac{5}{32} \end{aligned}$$

The solution is $\left\{x\middle|x > -\frac{5}{32}\right\}$, or $(-\frac{5}{32}, \infty)$.

101. Writing Exercise. The inequalities $x > -3$ and $x \ge -2$ are not equivalent because they do not have the same solution set. For example, -2.5 is a solution of $x > -3$, but it is not a solution of $x \ge -2$.

103. $5x - 2(3 - 6x) = 5x - 6 + 12x = 17x - 6$

105.
$$\begin{aligned} &x - 2\left[4y + 3(8 - x) - 1\right] \\ &= x - 2\left[4y + 24 - 3x - 1\right] \\ &= x - 2\left[4y - 3x + 23\right] \\ &= x - 8y + 6x - 46 \\ &= 7x - 8y - 46 \end{aligned}$$

107.
$$\begin{aligned} &3\left[5(2a - b) + 1\right] - 5\left[4 - (a - b)\right] \\ &= 3\left[10a - 5b + 1\right] - 5\left[4 - a + b\right] \\ &= 30a - 15b + 3 - 20 + 5a - 5b \\ &= 35a - 20b - 17 \end{aligned}$$

109. Writing Exercise. The graph of an inequality of the form $a \le x \le a$ consists of just one number, a.

111. $x < x + 1$

When any real number is increased by 1, the result is greater than the original number. Thus the solution set is $\{x|x \text{ is a real number}\}$, or $(-\infty, \infty)$.

113.
$$\begin{aligned} 27 - 4[2(4x - 3) + 7] &\ge 2[4 - 2(3 - x)] - 3 \\ 27 - 4[8x - 6 + 7] &\ge 2[4 - 6 + 2x] - 3 \\ 27 - 4[8x + 1] &\ge 2[-2 + 2x] - 3 \\ 27 - 32x - 4 &\ge -4 + 4x - 3 \\ 23 - 32x &\ge -7 + 4x \\ 23 + 7 &= 4x + 32x \\ 30 &\ge 36x \\ \frac{5}{6} &\ge x \end{aligned}$$

The solution set is $\left\{x\middle|x \le \frac{5}{6}\right\}$, or $(-\infty, \frac{5}{6}]$.

115.
$$\begin{aligned} -(x + 5) &\ge 4a - 5 \\ -x - 5 &\ge 4a - 5 \\ -x &\ge 4a - 5 + 5 \\ -x &\ge 4a \\ -1(-x) &\le -1 \cdot 4a \\ x &\le -4a \end{aligned}$$

The solution set is $\{x|x \le -4a\}$, or $(-\infty, -4a]$.

117. $y < ax + b$ Assume $a > 0$.
$y - b < ax$
$\frac{y-b}{a} < x$ Since $a > 0$, the inequality symbol stays the same.

The solution set is $\left\{x \middle| x > \frac{y-b}{a}\right\}$, or $(\frac{y-b}{a}, \infty)$.

119. $|x| > -3$

Since absolute value is always nonnegative, the absolute value of any real number will be greater than -3. Thus, the solution set is $\{x|x \text{ is a real number}\}$.

Chapter 2 Connecting the Concepts

1. $x - 6 = 15$
$x = 21$ Adding 6 to both sides

The solution is 21.

3. $3x = -18$
$x = -6$ Dividing both sides by 3

The solution is -6.

5. $-3x > -18$
$x < 6$ Dividing both sides by-3 and reversing the direction of the inequality symbol

The solution is $\{x < 6\}$.

7. $7 - 3x = 8$
$-3x = 1$ Subtracting 7 from both sides
$x = \frac{-1}{3}$ Dividing both sides by -3

9. $3 - t \geq 19$
$-t \geq 16$ Subtracting 3 from both sides
$t \leq -16$ Dividing both sides by -1 and reversing the direction of the inequality symblol

The solution is $\{t|t \leq -16\}$.

11. $3 - 5a > a + 9$
$-5a > a + 6$ Subtracting 3 from both sides
$-6a > 6$ Subtracting a from both sides
$a < -1$ Dividing both sides by -6 and reversing the direction of the inequality symbol

The solution is $\{a|a < -1\}$.

13. $\frac{2}{3}(x + 5) \geq -4$
$x + 5 \geq -6$ Multiplying both sides by $\frac{3}{2}$
$x \geq -11$ Subracting 5 from both sides

The solution is $\{x|x \geq -11\}$.

15. $0.5x - 2.7 = 3x + 7.9$
$0.5x = 3x + 10.6$ Adding 2.7 to both sides
$-2.5x = 10.6$ Subtracting $3x$ from both sides
$x = -4.24$ Dividing both sides by -2.5

The solution is -4.24.

17. $8 - \frac{y}{3} \leq 7$
$\frac{-y}{3} \leq -1$ Subtracting 8 from both sides
$y \geq 3$ Multiplying both sides by -3 and reversing the direction of the inequality symbol

The solution is $\{y|y \geq 3\}$.

19. $-15 > 7 - 5x$
$-22 > -5x$ Subtracting 7 from both sides
$\frac{22}{5} < x$, or $x > \frac{22}{5}$ Dividing both sides by -5 and reversing the direction of the inequality symbol.

The solution is $\left\{x|x > \frac{22}{5}\right\}$

Exercise Set 2.7

1. a is at least b can be translated as $b \leq a$.

3. a is at most b can be translated as $a \leq b$.

5. b is no more than a can be translated as $b \leq a$.

7. b is less than a can be translated as $b < a$.

9. Let n represent the number. Then we have

$n < 10$.

11. Let t represent the temperature. Then we have

$t \leq -3$.

13. Let d represent the number of years of driving experience. Then we have

$d \geq 5$.

15. Let a represent the age of the Mayan altar. Then we have

$a > 1200$.

17. Let h represent Tania's hourly wage. Then we have

$12 < h < 15$.

19. Let w represent the wind speed. Then we have

$w > 50$.

21. Let c represent the cost of a room at Pine Tree Bed and Breakfast. Then we have

$c < 120$.

23. **Familiarize.** Let s = the length of the service call, in hours. The total charge is \$55 plus \$40 times the number of hours RJ's was there.

Translate.

$$\underbrace{\$55 \text{ charge}}_{55} \text{ plus } \underbrace{\text{hourly rate}}_{40} \text{ times } \underbrace{\text{number of hours}}_{s} \underbrace{\text{is greater than}}_{>} \underbrace{\$150}_{150}.$$

$$55 + 40s > 150$$

Carry out. We solve the inequality.

$$\begin{aligned} 55 + 40s &> 150 \\ 40s &> 95 \\ s &> 2.375 \end{aligned}$$

Check. As a partial check, we show that the cost of a 2.375 hour service call is \$150.

$$\$55 + \$30(2.375) = \$55 + \$95 = \$150$$

State. The length of the service call was more than 2.375 hr.

25. **Familiarize.** Let q = Robbin's undergraduate grade point average. Unconditional acceptance is 500 plus 200 times the grade point average.

Translate.

$$\underbrace{\text{GMAT score of 500}}_{500} \text{ plus } \underbrace{200}_{200} \text{ times } \underbrace{\text{grade point average}}_{q} \underbrace{\text{is at least}}_{\geq} \underbrace{950}_{950}.$$

$$500 + 200q \geq 950$$

Carry out. We solve the inequality.

$$\begin{aligned} 500 + 200q &\geq 950 \\ 200q &\geq 450 \\ q &\geq 2.25 \end{aligned}$$

Check. As a partial check we show that the acceptance score is 950.
$500 + 200(2.25) = 500 + 450 = 950.$

State. For unconditional acceptance, Robbin must have a gpa of at least 2.25.

27. **Familiarize.** The average of the five scores is their sum divided by the number of tests, 5. We let s represent Rod's score on the last test.

Translate. The average of the five scores is given by

$$\frac{73 + 75 + 89 + 91 + s}{5}.$$

Since this average must be at least 85, this means that it must be greater than or equal to 85. Thus, we can translate the problem to the inequality

$$\frac{73 + 75 + 89 + 91 + s}{5} \geq 85.$$

Carry out. We first multiply by 5 to clear the fraction.

$$\begin{aligned} 5\left(\frac{73 + 75 + 89 + 91 + s}{5}\right) &\geq 5 \cdot 85 \\ 73 + 75 + 89 + 91 + s &\geq 425 \\ 328 + s &\geq 425 \end{aligned}$$

Check. As a partial check, we show that Rod can get a score of 97 on the fifth test and have an average of at least 85:

$$\frac{73 + 75 + 89 + 91 + 97}{5} = \frac{425}{5} = 85.$$

State. Scores of 97 and higher will earn Rod an average quiz grade of at least 85.

29. **Familiarize.** Let c = the number of credits Millie must complete in the fourth quarter.

Translate.

$$\underbrace{\text{Average number of credits}}_{\frac{5+7+8+c}{4}} \underbrace{\text{is at least}}_{\geq} \underbrace{7}_{7}.$$

$$\frac{5 + 7 + 8 + c}{4} \geq 7$$

Carry out. We solve the inequality.

$$\begin{aligned} \frac{5 + 7 + 8 + c}{4} &\geq 7 \\ 4\left(\frac{5 + 7 + 8 + c}{4}\right) &\geq 4 \cdot 7 \\ 5 + 7 + 8 + c &\geq 28 \\ 20 + c &\geq 28 \\ c &\geq 8 \end{aligned}$$

Check. As a partial check, we show that Millie can complete 8 credits in the fourth quarter and average 7 credits per quarter.

$$\frac{5 + 7 + 8 + 8}{4} = \frac{28}{4} = 7$$

State. Millie must complete 8 credits or more in the fourth quarter.

31. **Familiarize.** The average number of plate appearances for 10 days is the sum of the number of appearance per day divided by the number of days, 10. We let p represent the number of plate appearances on the tenth day.

Translate. The average for 10 days is given by

$$\frac{5 + 1 + 4 + 2 + 3 + 4 + 4 + 3 + 2 + p}{10}.$$

Since the average must be at least 3.1, this means that it must be greater than or equal to 3.1. Thus, we can translate the problem to the inequality

$$\frac{5 + 1 + 4 + 2 + 3 + 4 + 4 + 3 + 2 + p}{10} \geq 3.1.$$

Carry out. We first multiply by 10 to clear the fraction.

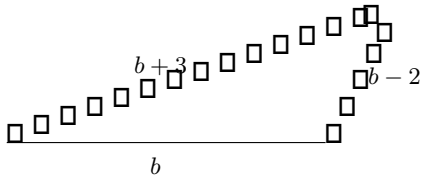
$$\begin{aligned} 10\left(\frac{5 + 1 + 4 + 2 + 3 + 4 + 4 + 3 + 2 + p}{10}\right) &\geq 10 \cdot 3.1 \\ 5 + 1 + 4 + 2 + 3 + 4 + 4 + 3 + 2 + p &\geq 31 \\ 28 + p &\geq 31 \\ p &\geq 3 \end{aligned}$$

Check. As a partial check, we show that 3 plate appearances in the 10th game will average 3.1

$$\frac{5 + 1 + 4 + 2 + 3 + 4 + 4 + 3 + 2 + 3}{10} = \frac{31}{10} = 3.1$$

State. On the tenth day, 3 or more plate appearances will give an average of at least 3.1.

33. **Familiarize.** We first make a drawing. We let b represent the length of the base. Then the lengths of the other sides are $b-2$ and $b+3$.



The perimeter is the sum of the lengths of the sides or $b+b-2+b+3$, or $3b+1$.

Translate.

$$\underbrace{\text{The perimeter}}_{\downarrow} \quad \underbrace{\text{is greater than}}_{\downarrow} \quad \underbrace{19 \text{ cm.}}_{\downarrow}$$
$$3b+1 \qquad > \qquad 19$$

Carry out.

$$\begin{aligned} 3b+1 &> 19 \\ 3b &> 18 \\ b &> 6 \end{aligned}$$

Check. We check to see if the solution seems reasonable.

When $b=5$, the perimeter is $3\cdot 5+1$, or 16 cm.

When $b=6$, the perimeter is $3\cdot 6+1$, or 19 cm.

When $b=7$, the perimeter is $3\cdot 7+1$, or 22 cm.

From these calculations, it would appear that the solution is correct.

State. For lengths of the base greater than 6 cm the perimeter will be greater than 19 cm.

35. **Familiarize.** Let $d=$ the depth of the well, in feet. Then the cost on the pay-as-you-go plan is $\$500+\$8d$. The cost of the guaranteed-water plan is \$4000. We want to find the values of d for which the pay-as-you-go plan costs less than the guaranteed-water plan.

Translate.

$$\underbrace{\text{Cost of pay-as-you-go plan}}_{\downarrow} \quad \underbrace{\text{is less than}}_{\downarrow} \quad \underbrace{\text{cost of guaranteed-water plan}}_{\downarrow}$$
$$500+8d \qquad < \qquad 4000$$

Carry out.

$$\begin{aligned} 500+8d &< 4000 \\ 8d &< 3500 \\ d &< 437.5 \end{aligned}$$

Check. We check to see that the solution is reasonable.

When $d=437$, $\$500+\$8\cdot 437=\$3996<\$4000$

When $d=437.5$, $\$500+\$8(437.5)=\$4000$

When $d=438$, $\$500+\$8(438)=\$4004>\$4000$

From these calculations, it appears that the solution is correct.

State. It would save a customer money to use the pay-as-you-go plan for a well of less than 437.5 ft.

37. **Familiarize.** Let $v=$ the blue book value of the car. Since the car was repaired, we know that \$8500 does not exceed $0.8v$ or, in other words, $0.8v$ is at least \$8500.

Translate.

$$\underbrace{\text{80\% of the blue book value}}_{\downarrow} \quad \underbrace{\text{is at least}}_{\downarrow} \quad \$8500.$$
$$0.8v \qquad \geq \qquad 8500$$

Carry out.

$$\begin{aligned} 0.8v &\geq 8500 \\ v &\geq \frac{8500}{0.8} \\ v &\geq 10,625 \end{aligned}$$

Check. As a partial check, we show that 80% of \$10,625 is at least \$8500:

$$0.8(\$10,625)=\$8500$$

State. The blue book value of the car was at least \$10,625.

39. **Familiarize.** Let $L=$ the length of the package.

Translate.

$$\underbrace{\text{Length}}_{\downarrow} \ \underbrace{\text{and}}_{\downarrow} \ \underbrace{\text{girth}}_{\downarrow} \ \underbrace{\text{is less than}}_{\downarrow} \ \underbrace{84 \text{ in}}_{\downarrow}$$
$$L \quad + \quad 29 \quad < \quad 84$$

Carry out.

$$\begin{aligned} L+29 &< 84 \\ L &< 55 \end{aligned}$$

Check. We check to see if the solution seems reasonable.

When $L=60$ $\quad 60+29=89$ in.
When $L=55$ $\quad 55+29=84$ in.
When $L=50$ $\quad 50+29=79$ in.

From these calculations, it would appear that the solution is correct.

State. For lengths less than 55 in, the box is considered a "package."

41. **Familiarize.** We will use the formula $F=\frac{9}{5}C+32$.

Translate.

$$\underbrace{\text{Fahrenheit temperature}}_{\downarrow} \quad \underbrace{\text{is above}}_{\downarrow} \quad 98.6^{\square}.$$
$$F \qquad > \qquad 98.6$$

Substituting $\frac{9}{5}C+32$ for F, we have

$$\frac{9}{5}C+32>98.6.$$

Carry out. We solve the inequality.

$$\begin{aligned} \frac{9}{5}C+32 &> 98.6 \\ \frac{9}{5}C &> 66.6 \\ C &> \frac{333}{9} \\ C &> 37 \end{aligned}$$

Check. We check to see if the solution seems reasonable.

When $C = 37$, $\frac{9}{5} \cdot 37 + 32 = 98.6$.

When $C = 38$, $\frac{9}{5} \cdot 38 + 32 = 100.4$.

It would appear that the solution is correct, considering that rounding occurred.

State. The human body is feverish for Celsius temperatures greater than 37°.

43. **Familiarize**. Let h = the height of the triangle, in ft. Recall that the formula for the area of a triangle with base b and height h is $A = \frac{1}{2}bh$.

Translate.

$$\begin{array}{ccccc} \text{Area} & \underbrace{\text{less than or equal to}} & \underbrace{12 \text{ ft}^2}. \\ \downarrow & \downarrow & \downarrow \\ \frac{1}{2}(8)h & \leq & 12 \end{array}$$

Carry out. We solve the inequality.

$$\frac{1}{2}(8)h \leq 12$$
$$4h \leq 12$$
$$h \leq 3$$

Check. As a partial check, we show that a length of 3 ft will result in an area of 12 ft^2.

$$\frac{1}{2}(8)(3) = 12$$

State. The height should be no more than 3 ft.

45. **Familiarize**. Let r = the amount of fat in a serving of the regular peanut butter, in grams. If reduced fat peanut butter has at least 25% less fat than regular peanut butter, then it has at most 75% as much fat as the regular peanut butter.

Translate.

$$\begin{array}{ccccccc} \underbrace{12 \text{ g of fat}} & \underbrace{\text{is at most}} & 75\% & \text{of} & \underbrace{\begin{array}{c}\text{the amount of}\\ \text{fat in regular}\\ \text{peanut butter.}\end{array}} \\ \downarrow & \downarrow & \downarrow & \downarrow & \downarrow \\ 12 & \leq & 0.75 & \cdot & r \end{array}$$

Carry out.

$$12 \leq 0.75r$$
$$16 \leq r$$

Check. As a partial check, we show that 12 g of fat does not exceed 75% of 16 g of fat:

$$0.75(16) = 12$$

State. Regular peanut butter contains at least 16 g of fat per serving.

47. **Familiarize**. Let d = the number of days after September 5.

Translate.

$$\begin{array}{ccccccc} \underbrace{\begin{array}{c}\text{Weight on}\\ \text{September 5}\end{array}} & \text{plus} & \underbrace{\begin{array}{c}\text{26 lb}\\ \text{per day}\end{array}} & \text{times} \\ \downarrow & \downarrow & \downarrow & \downarrow \\ 532 & + & 26 & \cdot \end{array}$$

$$\begin{array}{ccccc} \underbrace{\text{number of days}} & \text{exceeds} & \underbrace{818 \text{ lb.}} \\ \downarrow & \downarrow & \downarrow \\ d & > & 818 \end{array}$$

Carry out. We solve the inequality.

$$532 + 26d > 818$$
$$26d > 286$$
$$d > 11$$

Check. As a partial check, we can show that the weight of the pumpkin is 818 lb 11 days after September 5.

$$532 + 26 \cdot 11 = 532 + 286 = 818 \text{ lb}$$

State. The pumpkin's weight will exceed 818 lb more than 11 days after September 5, or on dates after September 16.

49. **Familiarize**. Let n = the number of text messages. The total cost is the monthly fee of \$39.95 plus taxes of \$6.65 plus .10 times the number of text messages, or $.10n$.

Translate.

$$\begin{array}{ccccccccc} \underbrace{\text{Monthly fee}} & \text{plus} & \underbrace{\text{taxes}} & \text{plus} & \underbrace{\begin{array}{c}\text{text}\\ \text{messages.}\end{array}} & \begin{array}{c}\text{cannot}\\ \text{exceed}\end{array} & \$60 \\ \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow \\ 39.95 & + & 6.65 & + & .10n & \leq & 60 \end{array}$$

Carry out. We solve the inequality.

$$39.95 + 6.65 + .10n \leq 60$$
$$46.60 + .10n \leq 60$$
$$.10n \leq 13.4$$
$$n \leq 134$$

Check. As a partial check, if the number of text messages is 134, the budget of \$60 will not be exceeded.

State. Liam can send or receive 134 text messages and stay within his budget.

51. **Familiarize**. We will use the formula $R = -0.0065t + 4.3259$.

Translate.

$$\begin{array}{ccccc} \underbrace{\text{The world record}} & \underbrace{\text{is less than}} & \underbrace{3.6 \text{ minutes}}. \\ \downarrow & \downarrow & \downarrow \\ -0.0065t + 4.3259 & < & 3.6 \end{array}$$

Carry out. We solve the inequality.

$$-0.0065t + 4.3259 < 3.6$$
$$-0.0065t < -0.7259$$
$$t > 111.68$$

Check. As a partial check, we can show that the record is more than 3.6 min 111 yr after 1900 and is less than 3.6 min 112 yr after 1900.

For $t = 111$, $R = -0.0065(111) + 4.3259 = 3.7709$.

State. The world record in the mile run is less than 3.6 min more than 112 yr after 1900, or in years after 2012.

53. **Familiarize**. We will use the equation $y = 0.06x + 0.50$.

Translate.

$$\underbrace{\text{The cost}}_{\downarrow} \quad \underbrace{\text{is at most}}_{\downarrow} \quad \underset{\downarrow}{\$14}.$$
$$0.06x + 0.50 \quad \leq \quad 14$$

Carry out. We solve the inequality.

$$0.06x + 0.50 \leq 14$$
$$0.06x \leq 13.50$$
$$x \leq 225$$

Check. As a partial check, we show that the cost for driving 225 mi is \$14.

$$0.06(225) + 0.50 = 14$$

State. The cost will be at most \$14 for mileages less than or equal to 225 mi.

55. **Writing Exercise**. Answers may vary. Fran is more than 3 years older than Todd.

57. $-2 + (-5) - 7 = -2 + (-5) + (-7) = -14$

59. $3 \cdot (-10) \cdot (-1) \cdot (-2) = (-30) \cdot (-1) \cdot (-2)$
$= (30) \cdot (-2) = -60$

61. $(3 - 7) - (4 - 8) = (-4) - (-4) = (-4) + (4) = 0$

63. $\dfrac{-2 - (-6)}{8 - 10} = \dfrac{-2 + 6}{8 + (-10)} = \dfrac{4}{-2} = -2$

65. **Writing Exercise**. Answers may vary.

A boat has a capacity of 2800 lb. How many passengers can go on the boat if each passenger is considered to weigh 150 lb.

67. **Familiarize**. We use the formula $F = \dfrac{9}{5}C + 32$.

Translate. We are interested in temperatures such that $5° < F < 15°$. Substituting for F, we have:

$$5 < \frac{9}{5}C + 32 < 15$$

Solve.

$$5 < \frac{9}{5}C + 32 < 15$$
$$5 \cdot 5 < 5\left(\frac{9}{5}C + 32\right) < 5 \cdot 15$$
$$25 < 9C + 160 < 75$$
$$-135 < 9C < -85$$
$$-15 < C < -9\frac{4}{9}$$

Check. The check is left to the student.

State. Green ski wax works best for temperatures between $-15°$C and $-9\frac{4}{9}°$C.

69. Since $8^2 = 64$, the length of a side must be less than or equal to 8 cm (and greater than 0 cm, of course). We can also use the five-step problem-solving procedure.

Familiarize. Let s represent the length of a side of the square. The area s is the square of the length of a side, or s^2.

Translate.

$$\underbrace{\text{The area}}_{\downarrow} \quad \underbrace{\text{is no more than}}_{\downarrow} \quad \underset{\downarrow}{64 \text{ cm}^2}.$$
$$s^2 \quad \leq \quad 64$$

Carry out.

$$s^2 \leq 64$$
$$s^2 - 64 \leq 0$$
$$(s + 8)(s - 8) \leq 0$$

We know that $(s+8)(s-8) = 0$ for $s = -8$ or $s = 8$. Now $(s+8)(s-8) < 0$ when the two factors have opposite signs. That is:

$s+8>0$ *and* $s-8<0$	*or*	$s+8<0$ *and* $s-8>0$
$s>-8$ *and* $s<8$	*or*	$s<-8$ *and* $s>8$
This can be expressed as $-8 < s < 8$.		This is not possible.

Then $(s + 8)(s - 8) \leq 0$ for $-8 \leq s \leq 8$.

Check. Since the length of a side cannot be negative we only consider positive values of s, or $0 < s \leq 8$. We check to see if this solution seems reasonable.

When $s = 7$, the area is 7^2, or 49 cm^2.

When $s = 8$, the area is 8^2, or 64 cm^2.

When $s = 9$, the area is 9^2, or 81 cm^2.

From these calculations, it appears that the solution is correct.

State. Sides of length 8 cm or less will allow an area of no more than 64 cm^2. (Of course, the length of a side must be greater than 0 also.)

71. **Familiarize**. Let f = the fat content of a serving of regular tortilla chips, in grams. A product that contains 60% less fat than another product has 40% of the fat content of that product. If Reduced Fat Tortilla Pops cannot be labeled lowfat, then they contain at least 3 g of fat.

Translate.

$$40\% \text{ of } \underbrace{\text{the fat content of regular tortilla chips}}_{\downarrow} \quad \underbrace{\text{is at least}}_{\downarrow} \quad \underbrace{\text{3 grams of fat}}_{\downarrow}$$
$$0.4 \cdot f \quad \geq \quad 3$$

Carry out.

$$0.4f \geq 3$$
$$f \geq 7.5$$

Check. As a partial check, we show that 40% of 7.5 g is not less than 3 g.

$$0.4(7.5) = 3$$

State. A serving of regular tortilla chips contains at least

73. Familiarize. Let p = the price of Neoma's tenth book. If the average price of each of the first 9 books is \$12, then the total price of the 9 books is 9·\$12, or \$108. The average price of the first 10 books will be $\frac{\$108+p}{10}$.

Translate.

$$\underbrace{\text{The average price of 10 books}}_{\downarrow} \quad \underbrace{\text{is at least}}_{\downarrow} \quad \$15.$$
$$\frac{108+p}{10} \qquad \geq \qquad 15$$

Carry out. We solve the inequality.

$$\frac{108+p}{10} \geq 15$$
$$108+p \geq 150$$
$$p \geq 42$$

Check. As a partial check, we show that the average price of the 10 books is \$15 when the price of the tenth book is \$42.

$$\frac{\$108+\$42}{10} = \frac{\$150}{10} = \$15$$

State. Neoma's tenth book should cost at least \$42 if she wants to select a \$15 book for her free book.

75. Let b = the total purchases of bestsellers, h = the total purchases of hardcovers, p = the total purchases of other items at Barnes & Noble.

(1) Solving $0.40b > 25$, we get \$62.50
(2) Solving $0.20h > 25$, we get \$125
(3) Solving $0.10p > 25$, we get \$250

Thus when a customer's bestseller purchases are more than \$62.50, or hardcover purchases are more than \$125, or other purchases are more than \$250, the customer saves money by purchasing the card.

Chapter 2 Review

1. True

3. True

5. True

7. True

9.
$$\begin{aligned} x+9 &= -16 \\ x+9-9 &= -16-9 && \text{Adding } -9 \\ x &= -25 && \text{Simplifying} \end{aligned}$$

The solution is -25.

11.
$$\begin{aligned} -\tfrac{x}{5} &= 13 \\ -5\left(-\tfrac{x}{5}\right) &= -5\,(13) && \text{Multiplying by } -5 \\ x &= -65 && \text{Simplifying} \end{aligned}$$

The solution is -65.

13.
$$\frac{2}{5}t = -8$$
$$\frac{5}{2}\cdot\frac{2}{5}t = \frac{5}{2}(-8) \qquad \text{Multiplying by } \frac{5}{2}$$
$$t = -20$$

The solution is -20.

15.
$$\begin{aligned} -\tfrac{2}{3}+x &= -\tfrac{1}{6} \\ 6\left(-\tfrac{2}{3}+x\right) &= 6\left(-\tfrac{1}{6}\right) && \text{Multiplying by 6} \\ -4+6x &= -1 && \text{Simplifying} \\ -4+6x+4 &= -1+4 && \text{Adding 4} \\ 6x &= 3 && \text{Simplifying} \\ x &= \tfrac{1}{2} && \text{Multiplying by } \tfrac{1}{6} \end{aligned}$$

The solution is $\frac{1}{2}$.

17.
$$\begin{aligned} 5-x &= 13 \\ 5-x-5 &= 13-5 && \text{Adding } -5 \\ -x &= 8 && \text{Simplifying} \\ x &= -8 && \text{Multiplying by } -1 \end{aligned}$$

The solution is -8.

19.
$$\begin{aligned} 7x-6 &= 25x \\ 7x-6-7x &= 25x-7x && \text{Adding } -7x \\ -6 &= 18x && \text{Simplifying} \\ -\tfrac{1}{3} &= x && \text{Multiplying by } \tfrac{1}{18} \end{aligned}$$

The solution is $-\frac{1}{3}$.

21.
$$\begin{aligned} 14y &= 23y-17-10 \\ 14y &= 23y-27 && \text{Simplifying} \\ 14y-14y &= 23y-27-14y && \text{Adding } -14y \\ 0 &= 9y-27 && \text{Simplifying} \\ 0+27 &= 9y-27+27 && \text{Adding 27} \\ 27 &= 9y && \text{Simplifying} \\ 3 &= y && \text{Multiplying by } \tfrac{1}{2} \end{aligned}$$

The solution is 3.

23.
$$\begin{aligned} \tfrac{1}{4}x-\tfrac{1}{8}x &= 3-\tfrac{1}{16}x \\ 16\left(\tfrac{1}{4}x-\tfrac{1}{8}x\right) &= 16\left(3-\tfrac{1}{16}x\right) && \text{Multiplying by 16} \\ 4x-2x &= 48-x && \text{Distributive Law} \\ 2x &= 48-x && \text{Simplifying} \\ 2x+x &= 48-x+x && \text{Adding } x \\ 3x &= 48 && \text{Simplifying} \\ x &= 16 && \text{Multiplying by } \tfrac{1}{3} \end{aligned}$$

The solution is 16.

25.
$$\begin{aligned} 4\,(5x-7) &= -56 \\ 20x-28 &= -56 && \text{Distributive Law} \\ 20x-28+28 &= -56+28 && \text{Adding 28} \\ 20x &= -28 && \text{Simplifying} \\ x &= -\tfrac{28}{20} && \text{Multiplying by } \tfrac{1}{20} \\ x &= -\tfrac{7}{5} && \text{Simplifying} \end{aligned}$$

The solution is $-\frac{7}{5}$.

27.
$$3(x-4)+2 = x+2+2(x-5)$$
$$3x-12+2 = x+2x-10$$
$$3x-10 = 3x-10$$

All real numbers are solutions and the equation is an iden-

29.

$V = \frac{1}{3}Bh$	
$3 \cdot V = 3\left(\frac{1}{3}Bh\right)$	Multiplying by 3
$3V = Bh$	Simplifying
$\frac{1}{h}(3V) = \frac{1}{h}(Bh)$	Multiplying by $\frac{1}{h}$
$\frac{3V}{h} = B$	Simplifying

31.

$tx = ax + b$	
$tx - ax = ax + b - ax$	Adding $-ax$
$tx - ax = b$	Simplifying
$x(t - a) = b$	Factoring x
$x = \frac{b}{t-a}$	Multiplying by $\frac{1}{t-a}$

33. $\frac{11}{25} = \frac{4}{4} \cdot \frac{11}{25} = \frac{44}{100} = 0.44$

0.44.
↳↑
44%

First, move the decimal point two places to the right; then write a % symbol: The answer is 44%.

35. Translate.

49	is	35%	of	What number?
↓	↓	↓	↓	↓
49	=	0.35	·	y

We solve the equation and then convert to percent notation.

$$49 = 0.35y$$
$$\frac{49}{0.35} = y$$
$$140 = y$$

The answer is 140.

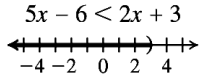
37. $x \le -5$

We substitute -7 for x giving $-7 \le -5$, which is a true statement since -7 is to the left of -5 on the number line, so -7 is a solution of the inequality $x \le -5$.

39.

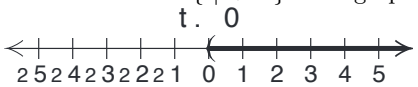
$5x - 6 < 2x + 3$	
$5x - 6 + 6 < 2x + 3 + 6$	Adding 6
$5x < 2x + 9$	Simplifying
$5x - 2x < 2x + 9 - 2x$	Adding $-2x$
$3x < 9$	Simplifying
$x < 3$	Multiplying by $\frac{1}{3}$

The solution set is $\{x|x < 3\}$. The graph is as follows:



41. $t > 0$

The solution set is $\{t|t > 0\}$. The graph is as follows:



43.

$9x \ge 63$	
$\frac{1}{9}(9x) \ge \frac{1}{9} \cdot 63$	Multiplying by $\frac{1}{9}$
$x \ge 7$	Simplifying

The solution set is $\{x|x \ge 7\}$

45.

$7 - 3y \ge 27 + 2y$	
$7 - 3y - 7 \ge 27 + 2y - 7$	Adding -7
$-3y \ge 20 + 2y$	Simplifying
$-3y - 2y \ge 20 + 2y - 2y$	Adding $-2y$
$-5y \ge 20$	Simplifying
$y \le -4$	Multiplying by $-\frac{1}{5}$ and reversing the inequality symbol

The solution set is $\{y|y \le -4\}$.

47.

$-4y < 28$	
$-\frac{1}{4}(-4y) > -\frac{1}{4} \cdot 28$	Multiplying by $-\frac{1}{4}$ and reversing the inequality symbol
$y > -7$	Simplifying

The solution set is $\{y|y > -7\}$.

49.

$4 - 8x < 13 + 3x$	
$4 - 8x - 4 < 13 + 3x - 4$	Adding -4
$-8x < 9 + 3x$	Simplifying
$-8x - 3x < 9 + 3x - 3x$	Adding $-3x$
$-11x < 9$	Simplifying
$-\frac{1}{11}(-11x) > -\frac{1}{11} \cdot 9$	Multiplying by $-\frac{1}{11}$
$x > -\frac{9}{11}$	Simplifying

The solution set is $\left\{x \,|x > -\frac{9}{11}\right\}$.

51.

$7 \le 1 - \frac{3}{4}x$	
$7 - 1 \le 1 - \frac{3}{4}x - 1$	Adding - 1
$6 \le -\frac{3}{4}x$	Simplifying
$-\frac{4}{3} \cdot 6 \ge -\frac{4}{3}\left(-\frac{3}{4}x\right)$	Multiplying by $-\frac{4}{3}$
$-8 \ge x$	Simplifying

The solution set is $\{x| - 8 \ge x\}$, or $\{x|x \le -8\}$.

53. Familiarize. Let x = the length of the first piece, in ft. Since the second piece is 2 ft longer than the first piece, it must be $x + 2$ ft.

Translate.

The sum of the lengths of the two pieces		is 18 ft.
↓	↓	↓
$x + (x + 2)$	=	18

Carry out. We solve the equation.

$$x + (x + 2) = 18$$
$$2x + 2 = 18$$
$$2x = 16$$
$$x = 8$$

Check. If the first piece is 8 ft long, then the second piece must be 8+2, or 10 ft long. The sum of the lengths of the two pieces is 8 ft+10 ft, or 18 ft. The answer checks.

State. The lengths of the two pieces are 8 ft and 10 ft.

55. Familiarize. Let x = the first odd integer and let $x + 2$ = the next consecutive odd integer.

Translate.

$$\underbrace{\text{The sum of the two consecutive odd integers}}_{\downarrow} \quad \text{is } 116$$
$$x + (x+2) \qquad = 116$$

Carry out. We solve the equation.

$$\begin{aligned} x + (x+2) &= 116 \\ 2x + 2 &= 116 \\ 2x &= 114 \\ x &= 57 \end{aligned}$$

Check. If the first odd integer is 57, then the next consecutive odd integer would be 57+2, or 59. The sum of these two integers is 57+59, or 116. This result checks.

State. The integers are 57 and 59.

57. **Familiarize.** Let $x =$ the regular price of the picnic table. Since the picnic table was reduced by 25%, it actually sold for 75% of its original price.

Translate.

$$75\% \text{ of } \underbrace{\text{the original price}}_{\downarrow} \text{ is } \$120?$$
$$0.75 \cdot \qquad x \qquad = \ 120$$

Carry out. We solve the equation.

$$\begin{aligned} 0.75x &= 120 \\ x &= \frac{120}{0.75} \\ x &= 160 \end{aligned}$$

Check. If the original price was \$160 with a 25% discount, then the purchaser would have paid 75% of \$160, or $0.75 \cdot$ \$160, or \$120. This result checks.

State. The original price was \$160.

59. **Familiarize.** Let $x =$ the measure of the first angle. The measure of the second angle is $x+50^\square$, and the measure of the third angle is $2x-10^\square$. The sum of the measures of the angles of a triangle is $180^\square$.

Translate.

$$\underbrace{\text{The sum of the measures of the angles}}_{\downarrow} \quad \text{is } 180^\square$$
$$x + (x+50) + (2x-10) \quad = \ 180$$

Carry out. We solve the equation.

$$\begin{aligned} x + (x+50) + (2x-10) &= 180 \\ 4x + 40 &= 180 \\ 4x &= 140 \\ x &= 35 \end{aligned}$$

Check. If the measure of the first angle is $35^\square$, then the measure of the second angle is $35^\square+50^\square$, or $85^\square$, and the measure of the third angle is $2 \cdot 35^\circ - 10^\circ$, or $60^\square$. The sum of the measures of the first, second, and third angles is $35^\square+85^\square+60^\square$, or $180^\square$. These results check.

State. The measures of the angles are $35^\square$, $85^\square$, and $60^\square$.

61. **Familiarize.** Let $n =$ the number of copies. The total cost is the setuup fee of \$6 plus \$4 per copy, or $4n$.

Translate.

$$\underbrace{\text{Set up fee}}_{\downarrow} \ \text{plus} \ \underbrace{\text{cost per copy}}_{\downarrow} \ \underbrace{\text{cannot exceed}}_{\downarrow} \ \$65$$
$$6 \quad + \quad 4n \quad \leq \quad 65$$

Carry out. We solve the inequality.

$$\begin{aligned} 6 + 4n &\leq 65 \\ 4n &\leq 59 \\ n &\leq \frac{59}{4} \\ n &\leq 14.75 \end{aligned}$$

Check. As a partial check, if the number of copies is 14, the total cost \$6+\$4·14, ir \$62 does not exceed the budget of \$65. **State.** Myra can make 14 or fewer copies.

63. **Writing Exercise.** The solutions of an equation can usually each be checked. The solutions of an inequality are normally too numerous to check. Checking a few numbers from the solution set found cannot guarantee that the answer is correct, although if any number does not check, the answer found is incorrect.

65. **Familiarize.** Let $x =$ the length of the Nile River, in mi. Let x+65 represent the length of the Amazon River, in mi.

Translate.

$$\underbrace{\text{The combined length of both rivers}}_{\downarrow} \quad \text{is } 8385 \text{ mi}$$
$$x + (x+65) \quad = \ 8385$$

Carry out. We solve the equation.

$$\begin{aligned} x + (x+65) &= 8385 \\ 2x + 65 &= 8385 \\ 2x &= 8320 \\ x &= 4160 \end{aligned}$$

Check. If the Nile River is 4160 mi long, then the Amazon River is 4160 mi+65 mi, or 4225 mi. The combined length of both rivers is then 4160 mi+4225 mi, or 8385 mi. These results check..

State. The Amazon River is 4225 mi long, and the Nile River is 4160 mi long.

67.
$$\begin{aligned} 2|n| + 4 &= 50 \\ 2|n| &= 46 \\ |n| &= 23 \end{aligned}$$

The distance from some number n and the origin is 23 units. The solution is $n = 23$, or $n = -23$.

69.
$$\begin{aligned} y &= 2a - ab + 3 \\ y &= a(2-b) + 3 \\ y - 3 &= a(2-b) \\ \frac{y-3}{2-b} &= a \end{aligned}$$

The solution is $a = \frac{y-3}{2-b}$.

Chapter 2 Test

1.
$$\begin{aligned} t+7 &= 16 \\ t+7-7 &= 16-7 && \text{Adding } -7 \\ t &= 9 && \text{Simplifying} \end{aligned}$$
The solution is 9.

3.
$$\begin{aligned} 6x &= -18 \\ \tfrac{1}{6}(6x) &= \tfrac{1}{6}(-18) && \text{Multiplying by } \tfrac{1}{6} \\ x &= -3 && \text{Simplifying} \end{aligned}$$
The solution is -3.

5.
$$\begin{aligned} 3t+7 &= 2t-5 \\ 3t+7-7 &= 2t-5-7 && \text{Adding -7} \\ 3t &= 2t-12 && \text{Simplifying} \\ 3t-2t &= 2t-12-2t && \text{Adding } -2 \\ t &= -12 && \text{Simplifying} \end{aligned}$$
The solution is -12.

7.
$$\begin{aligned} 8-y &= 16 \\ 8-y-8 &= 16-8 && \text{Adding } -8 \\ -y &= 8 && \text{Simplifying} \\ y &= -8 && \text{Multiply by } -1 \end{aligned}$$
The solution is -8.

9.
$$\begin{aligned} 4(x+2) &= 36 \\ 4x+8 &= 36 && \text{Distributive Law} \\ 4x+8-8 &= 36-8 && \text{Adding } -8 \\ 4x &= 28 && \text{Simplifying} \\ \tfrac{1}{4}(4x) &= \tfrac{1}{4}(28) && \text{Multiplying by } \tfrac{1}{4} \\ x &= 7 && \text{Simplifying} \end{aligned}$$
The solution is 7.

11.
$$\begin{aligned} 13t-(5-2t) &= 5(3t-1) \\ 13t-5+2t &= 15t-5 \\ 15t-5 &= 15t-5 \end{aligned}$$
All real numbers are solutions and the equation is an identity.

13.
$$\begin{aligned} 14x+9 &> 13x-4 \\ 14x+9-9 &> 13x-4-9 && \text{Adding } -9 \\ 14x &> 13x-13 && \text{Simplifying} \\ 14x-13x &> 13x-13-13x && \text{Adding } -13x \\ x &> -13 && \text{Simplifying} \end{aligned}$$
The solution set is $\{x|x > -13\}$.

15.
$$\begin{aligned} 4y &\le -30 \\ \tfrac{1}{4}(4y) &\le \tfrac{1}{4}(-30) && \text{Multiplying by } \tfrac{1}{4} \\ y &\le -\tfrac{15}{2} && \text{Simplifying} \end{aligned}$$
The solution set is $\{y|y \le -\frac{15}{2}\}$.

17.
$$\begin{aligned} 3-5x &> 38 \\ 3-5x-3 &> 38-3 && \text{Adding -3} \\ -5x &> 35 && \text{Simplifying} \\ -\tfrac{1}{5}(-5x) &< -\tfrac{1}{5}(35) && \text{Multiplying by } -\tfrac{1}{5} \text{ and reversing the inequality symbol} \\ x &< -7 && \text{Simplifying} \end{aligned}$$
The solution set is $\{x|x < -7\}$.

19.
$$\begin{aligned} 5-9x &\ge 19+5x \\ 5-9x-5 &\ge 19+5x-5 && \text{Adding } -5 \\ -9x &\ge 14+5x && \text{Simplifying} \\ -9x-5x &\ge 14+5x-5x && \text{Adding } -5x \\ -14x &\ge 14 && \text{Simplifying} \\ -\tfrac{1}{14}(-14x) &\le -\tfrac{1}{14}(14) && \text{Multiplying by } -\tfrac{1}{14} \text{ and reversing the inequality symbol} \\ x &\le -1 && \text{Simplifying} \end{aligned}$$
The solution set is $\{x|x \le -1\}$.

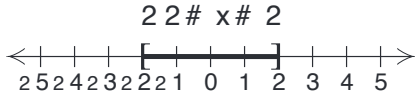
21.
$$\begin{aligned} w &= \tfrac{P+l}{2} \\ 2 \cdot w &= 2(\tfrac{P+l}{2}) && \text{Multiplying by 2} \\ 2w &= P+l && \text{Simplifying} \\ 2w-P &= P+l-P && \text{Adding } -P \\ 2w-P &= l && \text{Simplifying} \end{aligned}$$
The solution is $l = 2w - P$.

23. 0.003 First move the decimal point two places to the right; then write a % symbol. The answer is 0.3%.

25. Translate.

What percent	of	75	is	33?
↓	↓	↓	↓	↓
y	$\cdot$	75	$=$	33

We solve the equation and then convert to percent notation.
$$\begin{aligned} y \cdot 75 &= 33 \\ y &= \frac{33}{75} \\ y &= 0.44 = 44\% \end{aligned}$$
The solution is 44%.

27.


29. Familiarize. Let x = the distance from Springer Mountain in miles. then 3 × mi is the distance from Mt. Katahdin.

Translate.

Southern Distance	and	northern distance	is	Appalachian trail.
↓	↓	↓	↓	↓
x	$+$	$3x$	$\cdot$	2100

Carry out. We solve the equation.
$$\begin{aligned} x+3x &= 2100 \\ 4x &= 2100 \\ x &= 525 \\ 3x &= 1575 \end{aligned}$$
Check.
$525 + 1575 = 2100$.

State. The distance is 525 mi from Springer Moutain and 1575 mi from Mt. Katahdin.

31. Familiarize. Let x = the electric bill before the temperature of the water heater was lowered. If the bill dropped by 7%, then the Kellys paid 93% of their original bill.
Translate.

93%	of	the original bill	is	$60.45.
↓	↓	↓	↓	↓
93%	$\cdot$	x	$=$	60.45

Carry out. We solve the equation.

$$0.93x = 60.45$$
$$x = \frac{60.45}{0.93}$$
$$x = 65$$

Check. If the original bill was \$65, and the bill was reduced by 7%, or $0.07 \cdot \$65$, or \$4.55, the new bill would be \$65−\$4.55, or \$60.45. This result checks. State. The original bill was \$65.

33.

$$c = \frac{2cd}{a - d}$$

$(a-d)c = (a-d)\left(\frac{2cd}{a-d}\right)$	Multiplying by $a-d$
$ac - dc = 2cd$	Simplifying
$ac - dc + dc = 2cd + dc$	Adding dc
$ac = 3cd$	Simplifying
$\frac{1}{3c}(ac) = \frac{1}{3c}(3cd)$	Multiplying by $\frac{1}{3c}$
$\frac{a}{3} = d$	Simplifying

The solution is $d = \frac{a}{3}$.

35. Let h = the number of hours of sun each day. Then we have $4 \le h \le 6$.