2.1 The Addition Property of Equality

Classroom Examples, Now Try Exercises

1. Note: When solving equations we will write "Add 5" as a shorthand notation for "Add 5 to each side" and "Subtract 5" as a notation for "Subtract 5 from each side."

$$x-12 = -3$$
 Given
 $x-12+12 = -3+12$ Add 12.

x = 9 Combine like terms.

We check by substituting 9 for *x* in the *original* equation.

Check x - 12 = -3 Original equation

$$9-12 \stackrel{?}{=} -3$$
 Let $x = 9$.
-3 = -3 True

Since a true statement results, $\{9\}$ is the solution set.

N1. x-13 = 4 Given x-13+13 = 4+13 Add 13.

$$x = 17$$
 Combine like terms.

We check by substituting 17 for x in the *original* equation.

Check x-13 = 4 Original equation

$$17-13 \stackrel{?}{=} 4$$
 Let $x = 17$.
 $4 = 4$ True

Since a true statement results, $\{17\}$ is the solution set.

2.
$$m - 4.1 = -6.3$$

$$m - 4.1 + 4.1 = 6.3 + 4.1$$
 Add 4.1.
 $m = -2.2$

Check m = -2.2: -6.3 = -6.3 True

This is a shorthand notation for showing that if we substitute -2.2 for *m*, both sides are equal to -6.3, and hence a true statement results. In practice, this is what you will do, especially if you're using a calculator. The solution set is $\{-2.2\}$.

- N2. t-5.7 = -7.2t-5.7+5.7 = -7.2+5.7 Add 5.7. t = -1.5Check t = -1.5: -7.2 = -7.2 True The solution set is $\{-1.5\}$.
 - 3. -22 = x + 16 -22 - 16 = x + 16 - 16 Subtract 16. -38 = xCheck x = -38: -22 = -22 True The solution set is $\{-38\}$.
- N3. -15 = x + 12 -15 - 12 = x + 12 - 12 Subtract 12. -27 = xCheck x = -27: -15 = -15 True The solution set is $\{-27\}$.
 - 4. 11z-9=12z 11z-9-11z=12z-11z Subtract 11z. -9=zCheck z=-9:-108=-108 True The solution set is $\{-9\}$.
- N4. x 5 = 2x

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x-5-x=2x-x Subtract x. -5=x Combine terms. Check x = -5: -10 = -10 True The solution set is $\{-5\}$.

5.
$$\frac{7}{2}p+1 = \frac{9}{2}p$$

 $\frac{7}{2}p+1 - \frac{7}{2}p = \frac{9}{2}p - \frac{7}{2}p$ Subtract $\frac{7}{2}p$.
 $1 = p$
Check $p = 1: \frac{9}{2} = \frac{9}{2}$ True
The solution set is {1}.

N5.
$$\frac{2}{3}x + 4 = \frac{5}{3}x$$

 $\frac{2}{3}x + 4 - \frac{2}{3}x = \frac{5}{3}x - \frac{2}{3}x$ Subtract $\frac{2}{3}x$.
 $4 = x$ Combine terms.
Check $x = 4: \frac{20}{3} = \frac{20}{3}$ True
The solution set is {4}.

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- 6. 10 - x = -2x + 9Given 10 - x + 2x = -2x + 9 + 2x Add 2x. 10 + x = 9Combine terms. 10 + x - 10 = 9 - 10Subtract 10. x = -1Combine terms. Check x = -1: 11 = 11 True The solution set is $\{-1\}$.
- N6. 6x - 8 = 12 + 5x6x - 8 - 5x = 12 + 5x - 5x Subtract 5x. x - 8 = 12Combine terms. x - 8 + 8 = 12 + 8Add 8. x = 20Combine terms. Check x = 20:112 = 112 True The solution set is $\{20\}$.
 - 7. 9r + 4r + 6 2 = 9r + 4 + 3r
 - 13r + 4 = 12r + 4Combine terms. 13r + 4 - 12r = 12r + 4 - 12r Subtract 12r. r + 4 = 4Combine terms. r + 4 - 4 = 4 - 4Subtract 4. Combine terms. r = 0Check r = 0: 4 = 4 True

The solution set is $\{0\}$.

N7.
$$5x-10-12x = 4-8x-9$$

 $-7x-10 = -8x-5$ Combine terms.
 $-7x-10+8x = -8x-5+8x$ Add 8x.
 $x-10 = -5$ Combine terms.
 $x-10+10 = -5+10$ Add 10.
 $x = 5$ Combine terms.
Check $x = 5: -45 = -45$ True
The solution set is {5}.

8. 4(x+1) - (3x+5) = 14(x+1) - 1(3x+5) = 1-a = -1a4x + 4 - 3x - 5 = 1Distributive prop. Combine terms. x - 1 = 1x - 1 + 1 = 1 + 1Add 1. x = 2Check x = 2: 1 = 1 True The solution set is $\{2\}$.

N8.
$$4(3x-2) - (11x-4) = 3$$

 $4(3x-2) - 1(11x-4) = 3$ $-a = -1a$
 $12x-8-11x+4 = 3$ Distributive prop.
 $x-4 = 3$ Combine terms.
 $x-4+4 = 3+4$ Add 4.
 $x = 7$
Check $x = 7: 3 = 3$ True
The solution set is $\{7\}$.

Exercises

NIO

- 1. An equation includes an equality symbol, while an expression does not.
- 2. A <u>linear</u> equation in one <u>variable</u> (here *x*) can be written in the form Ax + B = C.
- **3.** Equations that have exactly the same solution set are equivalent equations.
- 4. The <u>addition</u> property of equality states that the same expression may be added to or subtracted from each side of an equation without changing the solution set.
- 5. (a) 5x+8-4x+7

This is an expression, not an equation, since there is no equals symbol. It can be simplified by rearranging terms and then combining like terms. 5x + 8 - 4x + 7 = 5x - 4x + 8 + 7

$$= x + 15$$

(b) -6y+12+7y-5This is an expression, not an equation, since there is no equals symbol. It can be simplified by rearranging terms and then combining like terms. -6y+12+7y-5 = -6y+7y+12-5= y + 7

(c) 5x+8-4x=7This is an equation because of the equals symbol. 5x + 8 - 4x = 7x + 8 = 7x = -1

The solution set is $\{-1\}$.

(d) This is an equation because of the equals symbol. -6y+12+7y = -5y+12 = -5y = -17

The solution set is $\{-17\}$.

6. Equations that have exactly the same solution sets are equivalent equations. r+2=6

$$x+2=0$$

 $x+2-2=6-2$ Subtract 2.
 $x=4$
So $x+2=6$ and $x=4$ are equivalent
equations.
 $10-x=5$
 $10-x-10=5-10$ Subtract 10.
 $-x=-5$
 $-1(-x)=-1(-5)$ Multiply by -1
 $x=5$

So 10 - x = 5 and x = -5 are not equivalent equations.

Subtract 3 from both sides to get x = 6, so x+3=9 and x=6 are equivalent equations. Subtract 4 from both sides to get x = 4. The second equation is x = -4, so 4+x=8 and x = -4 are not equivalent equations. The pairs of equations in A and C are equivalent.

7. Equations A $(x^2 - 5x + 6 = 0)$ and B $(x^3 = x)$

are *not* linear equations in one variable because they cannot be written in the form Ax + B = C. Note that in a linear equation the exponent on the variable must be 1.

8. Check by replacing the variable(s) in the *original* equation with the proposed solution. A true statement will result if the proposed solution is correct.

9.
$$x-3=9$$

 $x-3+3=9+3$

x = 12

Check this solution by replacing x with 12 in the original equation. x-3=9

$$12 - 3 \stackrel{?}{=} 9$$
 Let $x = 12$.
 $9 = 9$ True

Because the final statement is true, {12} is the solution set.

10.
$$x-9=8$$

 $x-9+9=8+9$
 $x=17$
Check $x=17$
 $17-9\stackrel{?}{=}8$ Let $x=17$.
 $8=8$ True
Thus, {17} is the solution set.
11. $x-12=19$

$$x - 12 = 19$$

 $x - 12 + 12 = 19 + 12$
 $x = 31$
Check $x = 31$

 $31-12 \stackrel{?}{=} 19$ Let x = 31. 19 = 19 True

Thus, $\{31\}$ is the solution set.

12.
$$x - 18 = 22$$

$$x - 18 + 18 = 22 + 18$$

 $x = 40$

Checking yields a true statement, so {40} is the solution set.

13.
$$x - 6 = -9$$

x-6+6 = -9+6x = -3

Checking yields a true statement, so $\{-3\}$ is the solution set.

14.
$$x-5 = -7$$

$$x-5+5 = -7+5$$
$$x = -2$$

Checking yields a true statement, so $\{-2\}$ is the solution set.

15. r+8=12r+8-8=12-8

$$r = 4$$

Checking yields a true statement, so {4} is the solution set.

16. x + 7 = 11x + 7 - 7 = 11 - 7x = 4

Checking yields a true statement, so {4} is the solution set.

17.
$$x + 28 = 19$$

 $x + 28 - 28 = 19 - 28$
 $x = -9$
Checking yields a true statement, so $\{-9\}$ is the solution set.

18. x + 47 = 26x + 47 - 47 = 26 - 47x = -21

Checking yields a true statement, so $\{-21\}$ is the solution set.

19.
$$x + \frac{1}{4} = -\frac{1}{2}$$
$$x + \frac{1}{4} - \frac{1}{4} = -\frac{1}{2} - \frac{1}{4}$$
$$x = -\frac{2}{4} - \frac{1}{4}$$
$$x = -\frac{3}{4}$$
Check $x = -\frac{3}{4}: -\frac{1}{2} = -\frac{1}{2}$ True
The solution set is $\left\{-\frac{3}{4}\right\}$.

20.
$$x + \frac{2}{3} = -\frac{1}{6}$$
$$x + \frac{2}{3} - \frac{2}{3} = -\frac{1}{6} - \frac{2}{3}$$
$$x = -\frac{1}{6} - \frac{4}{6}$$
$$x = -\frac{5}{6}$$
Check $x = -\frac{5}{6} : -\frac{1}{6} = -\frac{1}{6}$ True
The solution set is $\left\{-\frac{5}{6}\right\}$.

21.
$$7 + r = -3$$

 $r + 7 = -3$
 $r + 7 - 7 = -3 - 7$
 $r = -10$
The solution set is $\{-10\}$.

22. 8+k = -4

$$k+8 = -4$$

 $k+8-8 = -4-8$
 $k = -12$
The solution set is $\{-12\}$.

23. 2 = p + 15 2 - 15 = p + 15 - 15 -13 = pThe solution set is $\{-13\}$.

24. 5 = z + 19 5 - 19 = z + 19 - 19 -14 = zThe solution set is $\{-14\}$.

25.
$$-4 = x - 14$$

 $-4 + 14 = x - 14 + 14$
 $10 = x$
The solution set is {10}.

26.
$$-7 = x - 22$$

 $-7 + 22 = x - 22 + 22$
 $15 = x$
The solution set is {15}.

27.
$$-\frac{1}{3} = x - \frac{3}{5}$$
$$-\frac{1}{3} + \frac{3}{5} = x - \frac{3}{5} + \frac{3}{5}$$
$$-\frac{5}{15} + \frac{9}{15} = x$$
$$\frac{4}{15} = x$$
Check $x = \frac{4}{15} : -\frac{5}{15} = \frac{4}{15} - \frac{9}{15}$ True
The solution set is $\left\{\frac{4}{15}\right\}$.

28.
$$-\frac{1}{4} = x - \frac{2}{3}$$
$$-\frac{1}{4} + \frac{2}{3} = x - \frac{2}{3} + \frac{2}{3}$$
$$-\frac{3}{12} + \frac{8}{12} = x$$
$$\frac{5}{12} = x$$
Check $x = \frac{5}{12} : -\frac{3}{12} = \frac{5}{12} - \frac{8}{12}$ True
The solution set is $\left\{\frac{5}{12}\right\}$.

29. x-8.4 = -2.1 x-8.4+8.4 = -2.1+8.4 x = 6.3The solution set is {6.3}. 30. x-15.5 = -5.1 x-15.5+15.5 = -5.1+15.5 x = 10.4The solution set is {10.4}. 31. t+12.3 = -4.6 t+12.3-12.3 = -4.6-12.3 t = -16.9The solution set is {-16.9}.

- 32. x + 21.5 = -13.4x + 21.5 - 21.5 = -13.4 - 21.5x = -34.9The solution set is $\{-34.9\}$.
- **33.** 3x = 2x + 7 3x - 2x = 2x + 7 - 2x Subtract 2x. 1x = 7 or x = 7Check x = 7: 21 = 21 True The solution set is $\{7\}$.
- 34. 5x = 4x + 9 5x - 4x = 4x + 9 - 4x Subtract 4x. 1x = 9 or x = 9Check x = 9:45 = 45 True The solution set is $\{9\}$.

35. 10x+4=9x 10x+4-9x=9x-9x Subtract 9x. 1x+4=0 x+4-4=0-4 Subtract 4. x=-4Check x = -4: -36 = -36 True The solution set is $\{-4\}$.

36. 8t+5=7t 8t+5-7t=7t-7t Subtract 7t. 1t+5=0 t+5-5=0-5 Subtract 5. t=-5Check t=-5:-35=-35 True The solution set is $\{-5\}$. 37. 8x - 3 = 9x8x - 3 - 8x = 9x - 8x Subtract 8x. -3 = xCheck x = -3: 8(-3) - 3 = 9(-3) True The solution set is $\{-3\}$. 6x - 4 = 7x38. 6x-4-6x=7x-6x Subtract 7x. -4 = xCheck x = -4: 6(-4) - 4 = 7(-4) True The solution set is $\{-4\}$. 39. 6t - 2 = 5t6t - 2 - 5t = 5t - 5t Subtract 5t. t - 2 = 0t - 2 + 2 = 2Add 2. t = 2Check t = 2: 6(2) - 2 = 5(2) True The solution set is $\{2\}$. 4z - 6 = 3z**40.** 4z - 6 - 3z = 3z - 3z Subtract 3z. z - 6 = 0z - 6 + 6 = 6Add 6. z = 6Check z = 6: 4(6) – 6 = 3(6) True The solution set is $\{6\}$. $\frac{2}{5}w - 6 = \frac{7}{5}w$ 41. $\frac{2}{5}w - 6 - \frac{2}{5}w = \frac{7}{5}w - \frac{2}{5}w$ Subtract $\frac{2}{5}w$. $-6=\frac{5}{5}w$ -6 = wCheck $w = -6: \frac{2}{5}(-6) - 6 = \frac{7}{5}(-6)$ True The solution set is $\{-6\}$.

42. $\frac{2}{7}z-2=\frac{9}{7}z$ $\frac{2}{7}z - 2 - \frac{2}{7}z = \frac{9}{7}z - \frac{2}{7}z$ Subtract $\frac{2}{7}z$. $-2 = \frac{7}{7}z$ -2 = zCheck $z = -2: \frac{2}{7}(-2) - 2 = \frac{9}{7}(-2)$ True The solution set is $\{-2\}$.

43

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

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

$$x + 5 = 0$$

$$x + 5 - 5 = 0 - 5$$

$$x = -5$$
The solution set is $\{-5\}$.

4

44.
$$\frac{1}{5}x + 7 = -\frac{4}{5}x$$
$$\frac{1}{5}x + 7 + \frac{4}{5}x = -\frac{4}{5}x + \frac{4}{5}x$$
$$\frac{5}{5}x + 7 = 0$$
$$x + 7 - 7 = 0 - 7$$
$$x = -7$$
The solution set is {-7}.
45.
$$5.6x + 2 = 4.6x$$
$$5.6x + 2 = 4.6x$$
$$1.0x + 2 = 0$$
$$x + 2 - 2 = 0 - 2$$
$$x = -2$$
The solution set is {-2}.
46.
$$9.1x + 5 = 8.1x$$
$$9.1x + 5 - 8.1x = 8.1x - 8.1x$$
$$1.0x + 5 = 0$$
$$x + 5 - 5 = 0 - 5$$
$$x = -5$$
The solution set is {-5}.

1.4x - 3 - 0.4x = 0.4x - 0.4x
1.0x - 3 = 0
1.0x - 3 + 3 = 0 + 3
x = 3
The solution set is {3}.
48.
$$1.9t - 6 = 0.9t$$

 $1.9t - 6 - 0.9t = 0.9t - 0.9t$
 $1.0t - 6 + 6 = 0 + 6$
 $t = 6$
The solution set is {6}.
49. $5p = 4p$
 $5p - 4p = 4p - 4p$
 $p = 0$
The solution set is {0}.
50. $8z = 7z$
 $8z - 7z = 7z - 7z$
 $z = 0$
The solution set is {0}.
51. $3x + 7 - 2x = 0$
 $x + 7 = 0$
 $x + 7 = 0$
 $x + 7 - 7 = 0 - 7$
 $x = -7$
The solution set is {-7}.
52. $5x + 4 - 4x = 0$
 $x + 4 - 4 = 0 - 4$
 $x = -4$
The solution set is {-4}.
53. $3x + 7 = 2x + 4$
 $3x + 7 - 2x = 2x + 4 - 2x$
 $x + 7 = 4$
 $x + 7 - 7 = 4 - 7$
 $x = -3$
The solution set is {-3}.

1.4x - 3 = 0.4x

47.

54. 9x + 5 = 8x + 49x + 5 - 8x = 8x + 4 - 8xx + 5 = 4x + 5 - 5 = 4 - 5x = -1Check x = -1: -4 = -4 True The solution set is $\{-1\}$. 8t + 6 = 7t + 655. 8t + 6 - 7t = 7t + 6 - 7tt + 6 = 6t + 6 - 6 = 6 - 6t = 0The solution set is $\{0\}$. 56. 13t + 9 = 12t + 913t + 9 - 12t = 12t + 9 - 12tt + 9 = 9t + 9 - 9 = 9 - 9t = 0The solution set is $\{0\}$. 57. -4x+7 = -5x+9-4x + 7 + 5x = -5x + 9 + 5xx + 7 = 9x + 7 - 7 = 9 - 7x = 2The solution set is $\{2\}$. 58. -6x + 3 = -7x + 10-6x+3+7x = -7x+10+7xx + 3 = 10x + 3 - 3 = 10 - 3*x* = 7 The solution set is $\{7\}$. 59. 5 - x = -2x - 115 - x + 2x = -2x - 11 + 2x Add 2x. 5 + x - 5 = -11 - 5Subtract 5. x = -16The solution set is $\{-16\}$. 3 - 8x = -9x - 160. 3 - 8x + 9x = -9x - 1 + 9x Add 9x. 3 + x = -13 + x - 3 = -1 - 3Subtract 3. x = -4The solution set is $\{-4\}$.

61. 1.2y - 4 = 0.2y - 41.2y - 4 - 0.2y = 0.2y - 4 - 0.2y1.0 v - 4 = -4y - 4 + 4 = -4 + 4y = 0The solution set is $\{0\}$. 7.7r - 6 = 6.7r - 662. 7.7r - 6 - 6.7r = 6.7r - 6 - 6.7r1.0r - 6 = -6r - 6 + 6 = -6 + 6r = 0The solution set is $\{0\}$. 63. 3x+6-10=2x-23x - 4 = 2x - 2Combine terms. 3x - 4 - 2x = 2x - 2 - 2x Subtract 2x. x - 4 = -2x - 4 + 4 = -2 + 4x = 2The solution set is $\{2\}$. **64.** 8x + 4 - 8 = 7x - 18x - 4 = 7x - 1Combine terms. 8x - 4 - 7x = 7x - 1 - 7x Subtract 7*x*. x - 4 = -1x - 4 + 4 = -1 + 4x = 3The solution set is $\{3\}$. **65.** 5t + 3 + 2t - 6t = 4 + 12(5+2-6)t+3=16t + 3 - 3 = 16 - 3t = 13Check t = 13: 16 = 16 True The solution set is $\{13\}$. **66.** 4x-6+3x-6x=3+10x - 6 = 13x - 6 + 6 = 13 + 6 Add 6. x = 19Check x = 19: 13 = 13 True The solution set is $\{19\}$.

67.
$$6x+5+7x+3=12x+4$$

 $13x+8=12x+4$
 $13x+8-12x=12x+4-12x$
 $x+8=4$
 $x+8-8=4-8$
 $x=-4$
Check $x = -4:-44 = -44$ True
The solution set is $\{-4\}$.
68. $4x+3+8x+1=11x+2$
 $12x+4=11x+2$
 $12x+4=11x+2-11x$
 $x+4=2$
 $x+4-4=2-4$
 $x=-2$
Check $x = -2:-20 = -20$ True
The solution set is $\{-2\}$.
69. $5.2q-4.6-7.1q = -0.9q-4.6$
 $-1.9q-4.6 = -0.9q-4.6$
 $-1.9q-4.6 = -0.9q-4.6$
 $-1.9q-4.6 = -0.9q-4.6$
 $-1.0q-4.6+4.6 = -4.6+4.6$
 $-q=0$
 $q=0$
Check $q = 0: -4.6 = -4.6$ True
The solution set is $\{0\}$.
70. $4.0x+2.7-9.6x = -4.6x+2.7$
 $2.7-5.6x = -4.6x+2.7$
 $2.7-5.6x = -4.6x+2.7$
 $2.7-2.7 = x+2.7-2.7$
 $0 = x$
Check $x = 0: 2.7 = 2.7$ True
The solution set is $\{0\}$.

71.
$$\frac{5}{7}x + \frac{1}{3} = \frac{2}{5} - \frac{2}{7}x + \frac{2}{5}$$
$$\frac{5}{7}x + \frac{1}{3} = \frac{4}{5} - \frac{2}{7}x$$
$$\frac{5}{7}x + \frac{2}{7}x + \frac{1}{3} = \frac{4}{5} - \frac{2}{7}x + \frac{2}{7}x \quad \text{Add } \frac{2}{7}x.$$
$$\frac{7}{7}x + \frac{1}{3} = \frac{4}{5} - \frac{2}{7}x + \frac{2}{7}x \quad \text{Add } \frac{2}{7}x.$$
$$\frac{7}{7}x + \frac{1}{3} = \frac{4}{5} - \frac{1}{3} \qquad \text{Combine terms.}$$
$$1x + \frac{1}{3} - \frac{1}{3} = \frac{4}{5} - \frac{1}{3} \qquad \text{Subtract } \frac{1}{3}.$$
$$x = \frac{12}{15} - \frac{5}{15} \qquad \text{LCD} = 15$$
$$x = \frac{7}{15}$$
$$\text{Check } x = \frac{7}{15} \cdot \frac{2}{3} = \frac{2}{3} \quad \text{True}$$
$$\text{The solution set is } \left\{\frac{7}{15}\right\}.$$

72. To solve the equation, follow the simplification steps below.

such solution.

$$\frac{6}{7}s - \frac{3}{4} = \frac{4}{5} - \frac{1}{7}s + \frac{1}{6}$$

$$\frac{6}{7}s - \frac{3}{4} = \frac{24}{30} - \frac{1}{7}s + \frac{5}{30} \quad \text{LCD} = 30$$

$$\frac{6}{7}s - \frac{3}{4} = \frac{29}{30} - \frac{1}{7}s \quad \text{Add.}$$

$$\frac{6}{7}s - \frac{3}{4} + \frac{1}{7}s = \frac{29}{30} - \frac{1}{7}s + \frac{1}{7}s \quad \text{Add} \frac{1}{7}s.$$

$$\frac{7}{7}s - \frac{3}{4} = \frac{29}{30} + \frac{3}{4} \quad \text{Combine terms.}$$

$$1s - \frac{3}{4} + \frac{3}{4} = \frac{29}{30} + \frac{3}{4} \quad \text{Add} \frac{3}{4}.$$

$$s = \frac{58}{60} + \frac{45}{60} \quad \text{LCD} = 60$$

$$s = \frac{103}{60}$$
Check $s = \frac{103}{60} : \frac{101}{140} = \frac{101}{140}$ True
The solution set is $\left\{\frac{103}{60}\right\}.$

73. (5y+6) - (3+4y) = 105y + 6 - 3 - 4y = 10Distributive prop. y + 3 = 10Combine terms. y + 3 - 3 = 10 - 3 Subtract 3. v = 7Check y = 7: 10 = 10 True The solution set is $\{7\}$. 74. (8r+3) - (1+7r) = 68r + 3 - 1 - 7r = 6r + 2 = 6r + 2 - 2 = 6 - 2r = 4Check r = 4: 6 = 6 True The solution set is $\{4\}$. **75.** 2(p+5) - (9+p) = -32p + 10 - 9 - p = -3p + 1 = -3p+1-1 = -3-1p = -4Check p = -4: -3 = -3 True The solution set is $\{-4\}$. **76.** 4(k+6) - (8+3k) = -54k + 24 - 8 - 3k = -5k + 16 = -5k + 16 - 16 = -5 - 16k = -21Check k = -21: -5 = -5 True The solution set is $\{-21\}$. **77.** -6(2b+1) + (13b-7) = 0-12b - 6 + 13b - 7 = 0b - 13 = 0b - 13 + 13 = 0 + 13h = 13Check b = 13: 0 = 0 True The solution set is $\{13\}$.

78. -5(3w-3) + (16w+1) = 0-15w + 15 + 16w + 1 = 0w + 16 = 0w + 16 - 16 = 0 - 16w = -16Check w = -16: 0 = 0 True The solution set is $\{-16\}$. 79. 10(-2x+1) = -19(x+1)-20x + 10 = -19x - 19-20x + 10 + 19x = -19x - 19 + 19x-x+10 = -19-x + 10 - 10 = -19 - 10-x = -29x = 29Check x = 29: -570 = -570 True The solution set is $\{29\}$. 2(-3r+2) = -5(r-3)80. -6r + 4 = -5r + 15-6r + 4 + 5r = -5r + 15 + 5r4 - r = 154 - r - 4 = 15 - 4-r = 11r = -11Check r = -11: 70 = 70 True The solution set is $\{-11\}$. **81.** -2(8p+2) - 3(2-7p) - 2(4+2p) = 0-16p - 4 - 6 + 21p - 8 - 4p = 0p - 18 = 0p - 18 + 18 = 0 + 18p = 18Check p = 18: 0 = 0 True The solution set is $\{18\}$. 82. -5(1-2z) + 4(3-z) - 7(3+z) = 0-5 + 10z + 12 - 4z - 21 - 7z = 0-z - 14 = 0-z - 14 + z = 0 + z-14 = zCheck z = -14: 0 = 0 True

The solution set is $\{-14\}$.

83. 4(7x-1)+3(2-5x)-4(3x+5) = -6 28x-4+6-15x-12x-20 = -6 x-18 = -6 x-18+18 = -6+18 x = 12Check x = 12: -6 = -6 True The solution set is {12}. 84. 9(2m-3)-4(5+3m)-5(4+m) = -3 18m-27-20-12m-20-5m = -3 m-67 = -3 m-67 = -3 m-67 = -3 + 67 m = 64Check m = 64: -3 = -3 True The solution set is {64}.

- **85.** Answers will vary. One example is x 6 = -8.
- **86.** Answers will vary. One example is $x + \frac{1}{2} = 1$.
- 87. "Three times a number is 17 more than twice the number." 3x = 2x + 17

$$3x - 2x = 2x + 17 - 2x$$

x = 17
The number is 17 and {17} is the solution set.

88. "One added to three times a number is three less than four times the number." 1+3x = 4x-3

$$1+3x-3x = 4x-3-3x$$

$$1 = x-3$$

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

$$4 = x$$

The number is 4 and $\{4\}$ is the solution set.

89. "If six times a number is subtracted from seven times the number, the result is -9."

$$7x - 6x = -9$$
$$x = -9$$

The number is -9 and $\{-9\}$ is the solution set.

90. "If five times a number is added to three times the number, the result is the sum of seven times the number and 9."

$$5x+3x = 7x+9$$

$$8x = 7x+9$$

$$8x-7x = 7x+9-7x$$

$$x = 9$$

The number is 9 and {9} is the solution set.

2.2 The Multiplication Property of Equality

Classroom Examples, Now Try Exercises

- 1. 15x = 75 $\frac{15x}{15} = \frac{75}{15}$ Divide by 15. x = 5Check x = 5:75 = 75 True The solution set is $\{5\}$.
- N1. 8x = 80 $\frac{8x}{8} = \frac{80}{8}$ Divide by 8. x = 10Check x = 10: 80 = 80 True The solution set is $\{10\}$.
- **2.** 8x = -20
 - $\frac{8x}{8} = -\frac{20}{8}$ Divide by 8. $x = -\frac{20}{8} = -\frac{5}{2}$ Write in lowest terms. Check $x = -\frac{5}{2}$: -20 = -20 True The solution set is $\left\{-\frac{5}{2}\right\}$.
- **N2.** 10x = -24

$$\frac{10x}{10} = -\frac{24}{10}$$
 Divide by 10.

$$x = -\frac{24}{10} = -\frac{12}{5}$$
 Write in lowest terms
Check $x = -\frac{12}{5}$: $-24 = -24$ True
The solution set is $\left\{-\frac{12}{5}\right\}$.

3.
$$5.04 = -0.7x$$

 $\frac{5.04}{-0.7} = \frac{-0.7x}{-0.7}$ Divide by -0.7.
 $x = -7.2$
Check $x = -7.2$: 5.04 = 5.04 True
The solution set is $\{-7.2\}$.

N3. 7.02 = -1.3x $\frac{7.02}{-1.3} = \frac{-1.3x}{-1.3}$ Divide by -1.3. x = -5.4Check x = -5.4; 7.02 = 7.02 True The solution set is $\{-5.4\}$.

4.
$$\frac{x}{4} = -6$$
$$\frac{1}{4}x = -6$$
$$4 \cdot \frac{1}{4}x = 4(-6)$$
 Multiply by 4.
$$x = -24$$
Check $x = -24: -6 = -6$ True
The solution set is $\{-24\}$.

N4.
$$\frac{x}{5} = -7$$

 $\frac{1}{5}x = -7$
 $5 \cdot \frac{1}{5}x = 5(-7)$ Multiply by 5.
 $p = -35$
Check $p = -35: -7 = -7$ True

The solution set is $\{-35\}$.

5.
$$-\frac{2}{3}t = -12$$

 $-\frac{3}{2}\left(-\frac{2}{3}t\right) = -\frac{3}{2}(-12)$ Multiply by $-\frac{3}{2}$.
 $1 \cdot t = -\frac{3}{2} \cdot \frac{-12}{1}$
 $t = 18$
Check $t = 18: -12 = -12$ True
The solution set is {18}.

N5. $\frac{4}{7}z = -16$ $\frac{7}{4}\left(\frac{4}{7}z\right) = \frac{7}{4}(-16) \qquad \text{Multiply by } \frac{7}{4}.$ $1 \cdot t = \frac{7}{4} \cdot \frac{-16}{1}$ t = -28Check t = -28: -16 = -16 True The solution set is $\{-28\}$. 6. -p = -7 $-1 \cdot p = -7 \qquad \qquad -p = -1 \cdot p$ $(-1)(-1) \cdot p = (-1)(-7)$ $1 \cdot p = 7$ p = 7Check p = 7: -7 = -7 True The solution set is $\{7\}$. N6. -x = -9 $-1 \cdot x = -9 \qquad \qquad -x = -1 \cdot x$ $(-1)(-1) \cdot x = (-1)(-9)$ Multiply by -1. $1 \cdot x = 9$ x = 9Check x = 9: -9 = -9 True The solution set is $\{9\}$. 7. 4r - 9r = 20-5r = 20Combine terms. $\frac{-5r}{-5} = \frac{20}{-5}$ Divide by – 5. r = -4Check r = -4:20 = 20 True The solution set is $\{-4\}$. **N7.** 9n - 6n = 213n = 21 Combine terms. $\frac{3n}{3} = \frac{21}{3}$ Divide by 3. n = 7Check n = 7: 21 = 21 True The solution set is $\{7\}$.

Exercises

1. (a) multiplication property of equality; to get xalone on the left side of the equation, multiply each side by $\frac{1}{3}$ (or divide each

side by 3).

- (**b**) addition property of equality; to get x alone on the left side of the equation, add -3 (or subtract 3) on each side.
- (c) multiplication property of equality; to get xalone on the left side of the equation, multiply each side by -1 (or divide each side by -1).
- (d) addition property of equality; to get x alone on the right side of the equation, add -6 (or subtract 6) on each side.
- 2. Choice C doesn't require the use of the multiplicative property of equality. After the equation is simplified, the variable x is alone on the left side. 5x - 4x = 7
 - x = 7
- 3. Choice B; to find the solution of $-x = -\frac{3}{4}$, multiply (or divide) each side by -1, or use the rule "If -x = a, then x = -a."
- 4. Choice A; to find the solution of -x = -24, multiply (or divide) each side of the equation by -1, or use the rule "If -x = a, then x = -a."
- 5. To get just *x* on the left side, multiply both sides of the equation by the reciprocal of $\frac{4}{5}$,

which is $\frac{5}{4}$.

- 6. To get just x on the left side, multiply both sides of the equation by the reciprocal of $\frac{2}{3}$, which is $\frac{3}{2}$.
- 7. This equation is equivalent to $\frac{1}{10}x = 5$. To get just x on the left side, multiply both sides of the equation by the reciprocal of $\frac{1}{10}$, which is 10.

- 8. This equation is equivalent to $\frac{1}{100}x = 10$. To get just x on the left side, multiply both sides of the equation by the reciprocal of $\frac{1}{100}$, which is 100.
- 9. To get just *x* on the left side, multiply both sides of the equation by the reciprocal of $-\frac{9}{2}$, wh

ich is
$$-\frac{2}{9}$$
.

10. To get just x on the left side, multiply both sides of the equation by the reciprocal of $-\frac{8}{2}$,

which is
$$-\frac{3}{8}$$
.

- **11.** This equation is equivalent to -1x = 0.75. To get just x on the left side, multiply both sides of the equation by the reciprocal of -1, which is -1.
- 12. This equation is equivalent -1x = 0.48. To get just x on the left side, multiply both sides of the equation by the reciprocal of -1, which is -1.
- **13.** To get just x on the left side, divide both sides of the equation by the coefficient of x, which is 6.
- 14. To get just x on the left side, divide both sides of the equation by the coefficient of x, which is 7.
- 15. To get just x on the left side, divide both sides of the equation by the coefficient of x, which is -4.
- 16. To get just x on the left side, divide both sides of the equation by the coefficient of *x*, which is -13.
- 17. To get just x on the left side, divide both sides of the equation by the coefficient of *x*, which is 0.12.
- **18.** To get just x on the left side, divide both sides of the equation by the coefficient of *x*, which is 0.21.
- **19.** This equation is equivalent to -1x = 25. To get just x on the left side, divide both sides of the equation by the coefficient of x, which is -1.
- **20.** This equation is equivalent to -1x = 50. To get just x on the left side, divide both sides of the equation by the coefficient of x, which is -1.

21. 6x = 36 $\frac{6x}{6} = \frac{36}{6}$ Divide by 6. 1x = 6x = 6Check x = 6:36 = 36 True The solution set is $\{6\}$. **22.** 8x = 64 $\frac{8x}{8} = \frac{64}{8}$ Divide by 8. x = 8Check x = 8:64 = 64 True The solution set is $\{8\}$. **23.** 2*m* = 15 $\frac{2m}{2} = \frac{15}{2}$ Divide by 2. $m = \frac{15}{2}$ Check $m = \frac{15}{2}: 15 = 15$ True The solution set is $\left\{\frac{15}{2}\right\}$. **24.** 3*m* = 10 $\frac{3m}{3} = \frac{10}{3}$ Divide by 3. $m = \frac{10}{2}$ Check $m = \frac{10}{3}: 10 = 10$ True The solution set is $\left\{\frac{10}{3}\right\}$. **25.** 4x = -20 $\frac{4x}{4} = \frac{-20}{4}$ Divide by 4. x = -5Check x = -5: -20 = -20 True The solution set is $\{-5\}$. **26.** 5x = -60 $\frac{5x}{5} = \frac{-60}{5}$ Divide by 5. r = -12Check x = -12: -60 = -60True The solution set is $\{-12\}$.

27. -7x = 28 $\frac{-7x}{-7} = \frac{28}{-7}$ Divide by -7. x = -4Check x = -4: 28 = 28 True The solution set is $\{-4\}$. **28.** -9x = 36 $\frac{-9x}{-9} = \frac{36}{-9}$ Divide by -9. x = -4Check x = -4: 36 = 36 True The solution set is $\{-4\}$. **29.** 10t = -36 $\frac{10t}{-36} = -36$ Divide by 10. $\frac{10}{10} = \frac{10}{10}$ $t = -\frac{36}{10} = -\frac{18}{5}$ Lowest terms Check $t = -\frac{18}{5}: -36 = -36$ True The solution set is $\left\{-\frac{18}{5}\right\}$, or $\{-3.6\}$. **30.** 10s = -54 $\frac{10s}{10} = \frac{-54}{10}$ Divide by 10. $s = -\frac{54}{10} = -\frac{27}{5}$ Lowest terms Check $s = -\frac{27}{5}: -54 = -54$ True The solution set is $\left\{-\frac{27}{5}\right\}$, or $\{-5.4\}$. **31.** -6x = -72 $\frac{-6x}{-6} = \frac{-72}{-6}$ Divide by -6. x = 12Check x = 12: -72 = -72 True The solution set is $\{12\}$. **32.** -4x = -64 $\frac{-4x}{-4} = \frac{-64}{-4}$ Divide by -4. x = 16

x = 10Check x = 16: -64 = -64 True The solution set is {16}.

33. 4r = 0 $\frac{4r}{4} = \frac{0}{4}$ Divide by 4. r = 0Check r = 0: 0 = 0 True The solution set is $\{0\}$. **34.** 7x = 0 $\frac{7x}{7} = \frac{0}{7}$ Divide by 7. Check x = 0: 0 = 0 True The solution set is $\{0\}$. 35. -x = 12 $-1 \cdot (-x) = -1 \cdot 12$ Multiply by -1. x = -12Check x = -12: 12 = 12 True The solution set is $\{-12\}$. 36. -t = 14 $-1 \cdot (-t) = -1 \cdot 14$ Multiply by -1. t = -14Check t = -14: 14 = 14 True The solution set is $\{-14\}$. $-x = -\frac{3}{4}$ 37. $-1 \cdot (-x) = -1 \cdot \left(-\frac{3}{4}\right)$ $x = \frac{3}{4}$ Check $x = \frac{3}{4}: -\frac{3}{4} = -\frac{3}{4}$ True

38. $-x = -\frac{1}{2}$ $-1 \cdot (-x) = -1 \cdot \left(-\frac{1}{2}\right)$ $x = \frac{1}{2}$ Check $x = \frac{1}{2} : -\frac{1}{2} = -\frac{1}{2}$ True The solution set is $\left\{\frac{1}{2}\right\}$.

The solution set is $\left\{\frac{3}{4}\right\}$.

39. 0.2t = 8 $\frac{0.2t}{0.2} = \frac{8}{0.2}$ t = 40Check t = 40:8 = 8 True The solution set is {40}.

- 40. 0.9x = 18 $\frac{0.9x}{0.9} = \frac{18}{0.9}$ x = 20Check x = 20:18 = 18 True The solution set is $\{20\}$.
- 41. -0.3x = 9 $\frac{-0.3x}{-0.3} = \frac{9}{-0.3}$ x = -30Check x = -30:9 = 9 True The solution set is $\{-30\}$.
- 42. -0.5x = 20 $\frac{-0.5x}{-0.5} = \frac{20}{-0.5}$ Divide by -0.5. x = -40Check x = -40: 20 = 20 True The solution set is $\{-40\}$.
- **43.** 0.6x = -1.44 $\frac{0.6x}{0.6} = \frac{-1.44}{0.6}$ Divide by 0.6. x = -2.4Check x = -2.4: -1.44 = -1.44 True The solution set is $\{-2.4\}$.
- **44.** 0.8x = -2.96
 - $\frac{0.8x}{0.8} = \frac{-2.96}{0.8}$ Divide by 0.8. x = -3.7Check x = -3.7: -2.96 = -2.96 True The solution set is $\{-3.7\}$.

45.
$$-9.1 = -2.6x$$

 $\frac{-9.1}{-2.6} = \frac{-2.6x}{-2.6}$ Divide by -2.6 .
 $x = 3.5$
Check $x = 3.5: -9.1 = -9.1$ True
The solution set is $\{3.5\}$.

46.
$$-7.2 = -4.5x$$

 $\frac{-7.2}{-4.5} = \frac{-4.5x}{-4.5}$ Divide by -4.5 .
 $x = 1.6$
Check $x = 1.6$: $-7.2 = -7.2$ True
The solution set is $\{1.6\}$.

47. -2.1m = 25.62 $\frac{-2.1m}{-2.1} = \frac{25.62}{-2.1}$ Divide by -2.1. m = -12.2Check m = -12.2: 25.62 = 25.62 True The solution set is $\{-12.2\}$.

48.
$$-3.9x = 32.76$$

 $\frac{-3.9x}{-3.9} = \frac{32.76}{-3.9}$
 $x = -8.4$
Check $x = -8.4$: $32.76 = 32.76$ True
The solution set is $\{-8.4\}$.

49.
$$\frac{1}{4}x = -12$$

 $4 \cdot \frac{1}{4}x = 4(-12)$ Multiply by 4.
 $1x = -48$
 $x = -48$
Check $x = -48: -12 = -12$ True
The solution set is $\{-48\}$.

50.
$$\frac{1}{5}p = -3$$

 $5 \cdot \frac{1}{5}p = 5(-3)$ Multiply by 5.
 $p = -15$
Check $p = -15: -3 = -3$ True
The solution set is $\{-15\}$.

51.
$$\frac{z}{6} = 12$$
$$\frac{1}{6}z = 12$$
$$6 \cdot \frac{1}{6}z = 6 \cdot 12$$
$$z = 72$$
Check z = 72: 12 = 12 True
The solution set is {72}.

52. $\frac{x}{5} = 15$ $\frac{1}{5}x = 15$ $5 \cdot \frac{1}{5}x = 5 \cdot 15$ x = 75Check x = 75: 15 = 15 True The solution set is {75}.

53.
$$\frac{x}{7} = -5$$
$$\frac{1}{7}x = -5$$
$$7\left(\frac{1}{7}x\right) = 7(-5)$$
$$x = -35$$
Check x = -35: -5 = -5 True The solution set is {-35}.

54.
$$\frac{r}{8} = -3$$
$$\frac{1}{8}r = -3$$
$$8\left(\frac{1}{8}r\right) = 8(-3)$$
$$r = -24$$
Check $r = -24: -3 = -3$ True The solution set is $\{-24\}$.

55.
$$\frac{2}{7}p = 4$$

 $\frac{7}{2}\left(\frac{2}{7}p\right) = \frac{7}{2}(4)$ Multiply by $\frac{7}{2}$.
 $p = 14$
Check $p = 14: 4 = 4$ True
The solution set is $\{14\}$.

56.
$$\frac{3}{8}x = 9$$

$$\left(\frac{8}{3}\right)\left(\frac{3}{8}x\right) = \left(\frac{8}{3}\right)(9) \quad \text{Multiply by } \frac{8}{3}.$$

$$x = 24$$
Check $x = 24:9 = 9 \quad \text{True}$
The solution set is {24}.

 $-\frac{5}{6}t = -15$ 57. $-\frac{6}{5}\left(-\frac{5}{6}t\right) = -\frac{6}{5}(-15)$ Multiply by $-\frac{6}{5}$ t = 18Check t = 18: -15 = -15 True The solution set is $\{18\}$. $-\frac{3}{4}z = -21$ 58. $-\frac{4}{3}\left(-\frac{3}{4}z\right) = -\frac{4}{3}(-21)$ Multiply by $-\frac{4}{3}$. Check z = 28: -21 = -21 True The solution set is $\{28\}$. $-\frac{7}{9}x = \frac{3}{5}$ 59. $-\frac{9}{7}\left(-\frac{7}{9}x\right) = -\frac{9}{7}\cdot\frac{3}{5}$ Multiply by $-\frac{9}{7}$. $x = -\frac{27}{35}$ Check $x = -\frac{27}{25}: \frac{3}{5} = \frac{3}{5}$ True The solution set is $\left\{-\frac{27}{35}\right\}$. $-\frac{5}{6}x = \frac{4}{9}$ 60. $\left(-\frac{6}{5}\right)\left(-\frac{5}{6}x\right) = \left(-\frac{6}{5}\right)\left(\frac{4}{9}\right)$ Multiply by $-\frac{6}{5}$. $x = -\frac{2 \cdot 3 \cdot 4}{5 \cdot 3 \cdot 3} = -\frac{8}{15}$ Check $x = -\frac{8}{15}: \frac{4}{9} = \frac{4}{9}$ True The solution set is $\left\{-\frac{8}{15}\right\}$. **61.** 4x + 3x = 217x = 21 $\frac{7x}{7} = \frac{21}{7}$ x = 3Check x = 3: 21 = 21True The solution set is $\{3\}$.

62. 8x + 3x = 12111x = 121 $\frac{11x}{11} = \frac{121}{11}$ x = 11Check x = 11:121 = 121True The solution set is $\{11\}$. **63.** 6r - 8r = 10-2r = 10 $\frac{-2r}{-2} = \frac{10}{-2}$ Check r = -5:10 = 10 True The solution set is $\{-5\}$. **64.** 3p - 7p = 24-4p = 24 $\frac{-4p}{-4} = \frac{24}{-4}$ Check p = -6:24 = 24True The solution set is $\{-6\}$. **65.** $\frac{2}{5}x - \frac{3}{10}x = 2$ $\frac{4}{10}x - \frac{3}{10}x = 2$ $\frac{1}{10}x = 2$ $10 \cdot \frac{1}{10}x = 10 \cdot 2$ x = 20Check x = 20: 8 - 6 = 2True The solution set is $\{20\}$. **66.** $\frac{2}{3}x - \frac{5}{9}x = 4$ $\frac{6}{9}x - \frac{5}{9}x = 4$ $\frac{1}{9}x = 4$ $9 \cdot \frac{1}{9} x = 9 \cdot 4$ x = 36Check x = 36: 24 - 20 = 4True The solution set is $\{36\}$.

67. 7m + 6m - 4m = 639m = 63 $\frac{9m}{9} = \frac{63}{9}$ m = 7Check m = 7:63 = 63True The solution set is $\{7\}$. **68.** 9r + 2r - 7r = 684r = 68 $\frac{4r}{4} = \frac{68}{4}$ r = 17Check r = 17: 68 = 68 True The solution set is $\{17\}$. **69.** -6x + 4x - 7x = 0-9x = 0 $\frac{-9x}{-9} = \frac{0}{-9}$ x = 0Check x = 0: 0 = 0 True The solution set is $\{0\}$. **70.** -5x + 4x - 8x = 0-9x = 0 $\frac{-9x}{-9} = \frac{0}{-9}$ x = 0Check x = 0: 0 = 0True The solution set is $\{0\}$. **71.** 8w - 4w + w = -35w = -3 $\frac{5w}{5} = \frac{-3}{5}$ $w = -\frac{3}{5}$ Check $w = -\frac{3}{5}: -3 = -3$ True The solution set is $\left\{-\frac{3}{5}\right\}$.

72.
$$9x-3x+x = -4$$

 $7x = -4$
 $7x = -\frac{4}{7}$
 $x = -\frac{4}{7}$
Check $x = -\frac{4}{7}$: $-4 = -4$ True
The solution set is $\left\{-\frac{4}{7}\right\}$.
73. $\frac{1}{3}x - \frac{1}{4}x + \frac{1}{12}x = 3$
 $\left(\frac{1}{3} - \frac{1}{4} + \frac{1}{12}\right)x = 3$ Distributive property
 $\left(\frac{4}{12} - \frac{3}{12} + \frac{1}{12}\right)x = 3$ LCD = 12
 $\frac{1}{6}x = 3$ Lowest terms
 $6\left(\frac{1}{6}x\right) = 6(3)$ Multiply by 6.
 $x = 18$
Check $x = 18:6 - 4.5 + 1.5 = 3$ True
The solution set is $\{18\}$.
74. $\frac{2}{5}x + \frac{1}{10}x - \frac{1}{20}x = 18$ Distributive prop.
 $\left(\frac{8}{20} + \frac{2}{20} - \frac{1}{20}\right)x = 18$ Distributive prop.
 $\left(\frac{8}{20} + \frac{2}{20} - \frac{1}{20}\right)x = 18$ LCD = 20
 $\frac{9}{20}x = 18$ Add fractions.
 $\frac{20}{9}\left(\frac{9}{20}x\right) = \frac{20}{9}(18)$ Multiply by $\frac{20}{9}$.
 $x = 40$
Check $x = 40:16 + 4 - 2 = 18$ True
The solution set is $\{40\}$.
75. $0.9w - 0.5w + 0.1w = -3$
 $0.5w = -3$ Combine terms.
 $\frac{0.5w}{0.5} = \frac{-3}{0.5}$ Divide by 0.5.
 $w = -6$
Check $w = -6: -3 = -3$ True
The solution set is $\{-6\}$.

76.
$$0.5x - 0.6x + 0.3x = -1$$

 $0.2x = -1$ Simplify.
 $\frac{0.2x}{0.2} = \frac{-1}{0.2}$ Divide by 0.2
 $x = -5$
Check $x = -5: -1 = -1$ True
The solution set is $\{-5\}$.

77. Answers will vary. One example is $\frac{3}{2}x = -6$.

- **78.** Answers will vary. One example is 100x = 17.
- 79. "When a number is multiplied by 4, the result is 6." 4x = 6

$$4x = 6$$

$$\frac{4x}{4} = \frac{6}{4}$$

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

The number is $\frac{3}{2}$ and $\left\{\frac{3}{2}\right\}$ is the solution set.

80. "When a number is multiplied by -4, the result is 10."

$$-4x = 10$$

$$\frac{-4x}{-4} = \frac{10}{-4}$$

$$x = -\frac{10}{4} = -\frac{5}{2}$$
The number is $-\frac{5}{2}$ and $\left\{-\frac{5}{2}\right\}$ is the solution set

solution set.

81. "When a number is divided by -5, the result is 2."

$$\frac{x}{-5} = 2$$
$$(-5)\left(-\frac{1}{5}x\right) = (-5)(2)$$
$$x = -10$$

The number is -10 and $\{-10\}$ is the solution set.

82. "If twice a number is divided by 5, the result is 4."

$$\frac{2x}{5} = 4$$
$$\left(\frac{5}{2}\right)\left(\frac{2}{5}x\right) = \left(\frac{5}{2}\right)\left(\frac{4}{1}\right)$$
$$x = 10$$

The number is 10 and $\{10\}$ is the solution set.

2.3 More on Solving Linear Equations

Classroom Examples, Now Try Exercises

- 1. Step 1 (not necessary) Step 2 -5p+4=19 -5p+4-4=19-4 Subtract 4. -5p=15 Combine terms. Step 3 $\frac{-5p}{-5} = \frac{15}{-5}$ Divide by -5. p = -3Step 4 Check p = -3: 15+4=19 True The solution set is $\{-3\}$.
- N1. Step 1 (not necessary) Step 2 7+2m = -3 7+2m-7 = -3-7 Subtract 7. 2m = -10 Combine terms. Step 3 $\frac{2m}{2} = \frac{-10}{2}$ Divide by 2. m = -5Step 4 Check m = -5: 7-10 = -3 True The solution set is $\{-5\}$.

2. *Step 1* (not necessary) Step 2 5 - 8x = 2x - 55 - 8x + 8x = 2x - 5 + 8x Add 8x. 5 = 10x - 5Combine terms. 5+5=10x-5+5 Add 5. 10 = 10xCombine terms. Step 3 $\frac{10}{10} = \frac{10x}{10}$ Divide by 10. 1 = xStep 4 Check x = 1: 5 - 8 = 2 - 5 True The solution set is $\{1\}$. N2. *Step 1* (not necessary) Step 2 2q + 3 = 4q - 92q+3-2q = 4q-9-2q Subtract 2q. 3 = 2q - 9Combine terms. 3+9=2q-9+9Add 9. 12 = 2qCombine terms. Step 3 $\frac{12}{2} = \frac{2q}{2}$ Divide by 2. 6 = qStep 4 Check q = 6: 12 + 3 = 24 - 9 True The solution set is $\{6\}$. 3. Step 1 11 + 3(x+1) = 5x + 1611+3x+3=5x+16 Distributive property 3x+14 = 5x+16 Combine terms. Step 2 3x + 14 - 14 = 5x + 16 - 14 Subtract 14. 3x = 5x + 23x-5x = 5x+2-5x Subtract 5x. -2x = 2Step 3 $\frac{-2x}{-2} = \frac{2}{-2}$ Divide by -2. x = -1Step 4 Check x = -1: 11 = 11 True The solution set is $\{-1\}$.

N3. Step 1 3(z-6)-5z = -7z+73z - 18 - 5z = -7z + 7Distributive property -2z - 18 = -7z + 7Combine terms. Step 2 -2z - 18 + 18 = -7z + 7 + 18Add 18. -2z = -7z + 25-2z + 7z = -7z + 25 + 7z Add 7z. 5z = 25Step 3 $\frac{5z}{5} = \frac{25}{5}$ Divide by 5. z = 5Step 4 Check z = 5: -28 = -28True The solution set is $\{5\}$. 4. Step 1 4x - (x + 7) = 94x - x - 7 = 9 Distributive property 3x - 7 = 9Step 2 3x - 7 + 7 = 9 + 7 Add 7. 3x = 16Step 3 $\frac{3x}{3} = \frac{16}{3}$ Divide by 3. $x = \frac{16}{3}$ Step 4 Check $x = \frac{16}{3}$: 9 = 9 True The solution set is $\left\{\frac{16}{3}\right\}$. N4. Step 1 5x - (x + 9) = x - 4Distributive property 5x - x - 9 = x - 44x - 9 = x - 4Step 2 4x - 9 + 9 = x - 4 + 9Add 9. 4x = x + 54x - x = x + 5 - x Subtract x. 3x = 5Step 3 $\frac{3x}{3} = \frac{5}{3}$ Divide by 3. $x = \frac{5}{3}$

Step 4
Check
$$x = \frac{5}{3}$$
: $-\frac{7}{3} = -\frac{7}{3}$ True
The solution set is $\left\{\frac{5}{3}\right\}$.
5. Step 1
 $2-3(2+6z) = 4(z+1)-8$
 $2-6-18z = 4z + 4 - 8$ Distributive property
 $-4-18z = 4z - 4$
Step 2
 $-4-18z + 4 = 4z - 4 + 4$ Add 4.
 $-18z = 4z$ Subtract 4z.
 $-22z = 0$
Step 3
 $\frac{-22z}{-22} = \frac{0}{-22}$ Divide by -22 .
 $z = 0$
Step 4
Check $z = 0$: $2-3(2) \stackrel{?}{=} 4(1)-8$
 $-4 = -4$ True
The solution set is $\{0\}$.
N5. Step 1
 $24-4(7-2t) = 4(t-1)$
 $24-28+8t = 4t - 4$ Distributive property
 $-4+8t = 4t - 4$
Step 2
 $-4+8t + 4 = 4t - 4 + 4$ Add 4.
 $8t = 4t$
 $8t - 4t = 4t - 4t$ Subtract 4t.
 $4t = 0$
Step 3
 $\frac{4t}{4} = \frac{0}{4}$ Divide by 4.
 $t = 0$

Step 4
Check
$$t = 0$$
: $24 - 4(7) \stackrel{?}{=} 4(-1)$
 $-4 = -4$ True

The solution set is $\{0\}$.

6.
$$3x - x + 10 = 2x - 4 + 14$$

$$2x + 10 = 2x + 10$$

$$2x + 10 - 10 = 2x + 10 - 10$$
 Subtract 10.

$$2x = 2x$$

$$2x - 2x = 2x - 2x$$
 Subtract 2x.

$$0 = 0$$
 True

The variable x has "disappeared," and a true statement has resulted. The original equation is an identity. This means that for every real number value of x, the equation is true. Thus, the solution set is {all real numbers}.

N6.
$$-3(x-7) = 2x - 5x + 21$$

 $-3x + 21 = -3x + 21$
 $-3x + 21 - 21 = -3x + 21 - 21$ Subtract 21.
 $-3x = -3x$
 $-3x + 3x = -3x + 3x$ Add 3x.
 $0 = 0$ True

The variable x has "disappeared," and a true statement has resulted. The original equation is an identity. This means that for every real number value of x, the equation is true. Thus, the solution set is {all real numbers}.

7. 3x+8 = 6(x-1)-3x3x+8 = 6x-6-3xDistributive prop.3x+8 = 3x-6Combine terms.3x-8-3x = 3x-6-3xSubtract 3x.8 = -6False

The variable x has "disappeared," and a *false* statement has resulted. This means that for every real number value of x, the equation is false. Thus, the equation has no solution and its solution set is the empty set, or null set, symbolized \emptyset .

N7. -4x+12 = 3-4(x-3) -4x+12 = 3-4x+12 Distr. prop. -4x+12 = -4x+15 Combine. -4x+12+4x = -4x+15+4x Add 4x. 12 = 15 False

The variable x has "disappeared," and a *false* statement has resulted. This means that for every real number value of x, the equation is false. Thus, the equation has no solution and its solution set is the empty set, or null set, symbolized \emptyset .

8. Step 1 $\frac{1}{3}x - \frac{5}{12} = \frac{3}{4} + \frac{1}{2}x$ The LCD of all the fractions in the equation is 12, so multiply each side by 12 to clear the fractions. $12\left(\frac{1}{3}x - \frac{5}{12}\right) = 12\left(\frac{3}{4} + \frac{1}{2}x\right)$ $12\left(\frac{1}{3}x\right) - 12\left(\frac{5}{12}\right) = 12\left(\frac{3}{4}\right) + 12\left(\frac{1}{2}x\right)$ 4x - 5 = 9 + 6xStep 2 4x - 6x - 5 = 9 + 6x - 6x Subtract 6x. -2x-5=9-2x-5+5=9+5Add 5. -2x = 14Step 3 $\frac{-2x}{-2} = \frac{14}{-2}$ Divide by -2. x = -7Step 4 Check x = -7: $-\frac{7}{3} - \frac{5}{12} = \frac{3}{4} - \frac{7}{2}$ $\frac{-28-5}{12} \stackrel{?}{=} \frac{3-14}{4}$ $-\frac{33}{12} = -\frac{11}{4}$ True The solution set is $\{-7\}$.

N8. Step 1

$$\frac{1}{2}x + \frac{5}{8}x = \frac{3}{4}x - 6$$

The LCD of all the fractions in the equation is 8, so multiply each side by 8 to clear the fractions.

$$8\left(\frac{1}{2}x+\frac{5}{8}x\right) = 8\left(\frac{3}{4}x-6\right)$$

$$8\left(\frac{1}{2}x\right)+8\left(\frac{5}{8}x\right) = 8\left(\frac{3}{4}x\right)-8(6)$$

$$4x+5x = 6x-48$$

$$9x = 6x-48$$
Step 2
$$9x-6x = 6x-48-6x$$
Subtract $6x$

$$3x = -48$$
Step 3
$$\frac{3x}{3} = \frac{-48}{3}$$
Divide by 3.
$$x = -16$$

Step 4
Check
$$x = -16$$
: $-8 - 10 \stackrel{?}{=} -12 - 6$
 $-18 = -18$ True
The solution set is $\{-16\}$.

9. Step 1

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

$$12\left[\frac{1}{4}(x+3) - \frac{2}{3}(x+1)\right] = 12(-2)$$

$$12\left[\frac{1}{4}(x+3)\right] - 12\left[\frac{2}{3}(x+1)\right] = -24$$

$$3(x+3) - 8(x+1) = -24$$

$$3(x+3) - 8(x+1) = -24$$

$$3x+9 - 8x - 8 = -24$$

$$-5x+1 = -24$$
Step 2
$$-5x+1 - 1 = -24 - 1$$
Subtract 1.
$$-5x = -25$$
Combine like terms.
Step 3
$$\frac{-5x}{-5} = \frac{-25}{-5}$$
Divide by -5.
$$x = 5$$
Step 4
Check $x = 5$: $2 - 4 = -2$ True
The solution set is $\{5\}$.

N9. *Step 1*

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

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

$$6\left[\frac{2}{3}(x+2)\right] - 6\left[\frac{1}{2}(3x+4)\right] = -24$$

$$4(x+2) - 3(3x+4) = -24$$

$$4(x+2) - 3(3x+4) = -24$$

$$4x+8 - 9x - 12 = -24$$

$$-5x - 4 = -24$$

Step 2

$$-5x - 4 + 4 = -24 + 4$$
 Add 4.

$$-5x = -20$$
 Combine like terms.
Step 3

$$\frac{-5x}{-5} = \frac{-20}{-5}$$
 Divide by -5.

$$x = 4$$

Step 4
Check $x = 4$: $4 - 8 = -4$ True
The solution set is $\{4\}$.

10. Step 1 0.5(2-3x) = 4.5 - 0.1(x+7)To clear decimals, multiply both sides by 10. 10[0.5(2-3x)] = 10[4.5-0.1(x+7)]5(2-3x) = 45-1(x+7)10 - 15x = 45 - x - 710 - 15x = 38 - xStep 2 10 - 15x + x = 38 - x + x10 - 14x = 3810 - 10 - 14x = 38 - 10-14x = 28Step 3 $\frac{-14x}{-14} = \frac{28}{-14}$ x = -2Step 4 Check x = -2: $0.5(8) \stackrel{?}{=} 4.5 - 0.1(5)$ 4 = 4True The solution set is $\{-2\}$. N10. Step 1 0.05(13-t) - 0.2t = 0.08(30)To clear decimals, multiply both sides by 100. 100[0.05(13-t)-0.2t] = 100[0.08(30)]5(13-t) - 20t = 8(30)

$$65-5t-20t = 240$$

$$65-25t = 240$$

$$5tep 2$$

$$65-25t-65 = 240-65$$

$$-25t = 175$$

$$5tep 3$$

$$\frac{-25t}{-25} = \frac{175}{-25}$$

$$t = -7$$

$$5tep 4$$

Check $t = -7$: $1+1.4 \stackrel{?}{=} -2.4$

$$2.4 = 2.4$$
 True
The solution set is $\{-7\}$.

- 11. To find the other number, you would divide 36 by *x*, so an expression for the other number is $\frac{36}{-1}$.
 - x

N11. First, suppose that the sum of two numbers is 18, and one of the numbers is 10. How would you find the other number? You would subtract 10 from 18. Instead of using 10 as one of the numbers, use *m*. This gives us the expression 18-m for the other number.

Exercises

- 1. Use the addition property of equality to subtract 8 from each side.
- 2. Combine like terms on the left.
- **3.** Clear the parentheses by using the distributive property.
- 4. Use the multiplication property of equality to multiply each side by $\frac{4}{3}$.
- 5. Clear fractions by multiplying by the LCD, 6.
- **6.** Clear the decimals by multiplying each side by 10.
- (a) 6 = 6 (The original equation is a(n) <u>identity</u>.) This goes with choice B, {all real numbers}.
 - (b) x = 0 (The original equation is a(n)<u>conditional</u>.) This goes with choice A, $\{0\}$.
 - (c) -5 = 0 (The original equation is a(n) <u>contradiction</u>.) This goes with choice C, \emptyset .
- 8. 100[0.03(x-10)] = 3(x-10) = 3x-30, so choice D is correct.
- 9. 3x + 2 = 14

3x+2-2 = 14-2 Subtract 2. 3x = 12 Combine like terms. $\frac{3x}{3} = \frac{12}{3}$ Divide by 3. x = 4Check x = 4: 12+2 = 14 True The solution set is {4}.

10. 4x + 3 = 27

4x+3-3 = 27-3 Subtract 3. 4x = 24 Combine like terms. $\frac{4x}{4} = \frac{24}{4}$ Divide by 4. x = 6Check x = 6: 24+3 = 27 True The solution set is $\{6\}$.

11.
$$-5z-4=21$$

 $-5z-4+4=21+4$ Add 4.
 $-5z=25$ Combine like terms.
 $\frac{-5z}{-5}=\frac{25}{-5}$ Divide by -5.
 $z=-5$
Check $z=-5$: $25-4=21$ True
The solution set is $\{-5\}$.
12. $-7w-4=10$

 $-7w-4+4 = 10+4 \quad \text{Add 4.}$ $-7w = 14 \quad \text{Combine like terms.}$ $\frac{-7w}{-7} = \frac{14}{-7} \quad \text{Divide by } -7.$ w = -2

Check
$$w = -2$$
: $14 - 4 = 10$ True

The solution set is $\{-2\}$.

13.
$$4p-5=2p$$

$$4p-5-4p=2p-4p$$
Subtract 4p.
$$-5=-2p$$
Combine like terms.
$$\frac{-5}{-2} = \frac{-2p}{-2}$$
Divide by -2.
$$\frac{5}{2} = p$$
Check $p = \frac{5}{2}$: 10-5=5 True
The solution set is $\left\{\frac{5}{2}\right\}$.

14.
$$6q-2=3q$$

 $6q-2-6q=3q-6q$ Subtract $6q$.
 $-2=-3q$ Combine like terms.
 $\frac{-2}{-3}=\frac{-3q}{-3}$ Divide by -3 .
 $\frac{2}{3}=q$
Check $q=\frac{2}{3}$: $4-2=2$ True
The solution set is $\left\{\frac{2}{3}\right\}$.

15. 2x + 9 = 4x + 11 -2x + 9 = 11 Subtract 4*x*. -2x = 2 Subtract 9. x = -1 Divide by -2. Check x = -1: 7 = 7 True The solution set is $\{-1\}$. **16.** 7p + 8 = 9p - 2 -2p + 8 = -2 Subtract 9*p*. -2p = -10 Subtract 8.

p = 5 Divide by -2.

Check p = 5: 43 = 43 True The solution set is $\{5\}$.

17. For this equation, Step 1 is not needed. Step 2 5m + 8 - 8 = 7 + 3m - 8Subtract 8. 5m = 3m - 15m-3m = 3m-1-3m Subtract 3m. 2m = -1Step 3 $\frac{2m}{2} = \frac{-1}{2}$ $m = -\frac{1}{2}$ Step 4 Substitute $-\frac{1}{2}$ for *m* in the original equation. 5m+8=7+3m $5\left(-\frac{1}{2}\right)+8\stackrel{?}{=}7+3\left(-\frac{1}{2}\right)$ Let $m=-\frac{1}{2}$. $-\frac{5}{2}+8\stackrel{?}{=}7+\left(-\frac{3}{2}\right)$ $\frac{11}{2} = \frac{1}{2}$ True The solution set is $\left\{-\frac{1}{2}\right\}$.

18. 4r + 2 = r - 64r + 2 - r = r - 6 - r Subtract *r*. 3r + 2 = -63r + 2 - 2 = -6 - 2 Subtract 2. 3r = -8 $\frac{3r}{3} = -\frac{-8}{3}$ Divide by 3. $r = -\frac{8}{3}$ Check $r = -\frac{8}{3}$: $-\frac{32}{3} + \frac{6}{3} = -\frac{8}{3} - \frac{18}{3}$ True The solution set is $\left\{-\frac{8}{3}\right\}$. 19. -12x-5=10-7x-12x-5+7x = 10-7x+7x Add 7x. -5x-5=10-5x-5+5=10+5Add 5. -5x = 15 $\frac{-5x}{-5} = \frac{15}{-5}$ Divide by -5. x = -3Check x = -3: 36 - 5 = 10 + 21True The solution set is $\{-3\}$. -16w - 3 = 13 - 8w20. -16w - 3 + 8w = 13 - 8w + 8w Add 8w. -8w - 3 = 13-8w - 3 + 3 = 13 + 3Add 3. -8w = 16 $\frac{-8w}{-8} = \frac{16}{-8}$ Divide by -8. w = -2Check w = -2: 32 - 3 = 13 + 16True The solution set is $\{-2\}$. **21.** 12h-5=11h+5-h12h - 5 = 10h + 5Combine like terms. 2h - 5 = 5Subtract 10h. 2h = 10Add 5. h = 5Divide by 2. Check h = 5: 55 = 55True The solution set is $\{5\}$.

22. -4x - 1 = -5x + 1 + 3x-4x - 1 = -2x + 1Combine like terms. -2x-1=1Add 2x. -2x = 2Add 1. x = -1Divide by -2. Check x = -1: 3 = 3True The solution set is $\{-1\}$. **23.** 7r - 5r + 2 = 5r + 2 - r2r + 2 = 4r + 2Combine like terms. 2 = 2r + 2Subtract 2r. 0 = 2rSubtract 2. 0 = rDivide by 2. Check r = 0: 2 = 2 True The solution set is $\{0\}$. **24.** 9p-4p+6=7p+6-3p5p+6 = 4p+6Combine terms. p + 6 = 6Subtract 4 p. p = 0Subtract 6. Check p = 0: 6 = 6 True The solution set is $\{0\}$. **25.** 3(4x+2)+5x=30-x12x+6+5x=30-x Distributive prop. 17x + 6 = 30 - x Combine like terms. 18x + 6 = 30Add 1x. 18x = 24Subtract 6. $x = \frac{24}{18} = \frac{4}{3}$ Divide by 18. Check $x = \frac{4}{3}$: $\frac{86}{3} = \frac{86}{3}$ True The solution set is $\left\{\frac{4}{3}\right\}$. **26.** 5(2m+3) - 4m = 2m + 2510m+15-4m=2m+25 Distributive prop. 6m+15 = 2m+25 Combine terms. 6m = 2m + 10 Subtract 15. 4m = 10Subtract 2m $m = \frac{10}{4} = \frac{5}{2}$ Divide by 4. Check $m = \frac{5}{2}$: 30 = 30 True The solution set is $\left\{\frac{5}{2}\right\}$.

27.
$$-2p+7 = 3 - (5p+1)$$

 $-2p+7 = 3 - 5p - 1$ Distributive property
 $-2p+7 = -5p+2$ Combine like terms.
 $3p+7 = 2$ Add 5p.
 $3p = -5$ Subtract 7.
 $p = -\frac{5}{3}$
Check $p = -\frac{5}{3}$: $\frac{31}{3} = \frac{31}{3}$ True
The solution set is $\left\{-\frac{5}{3}\right\}$.

28. 4x+9=3-(x-2) 4x+9=3-x+2Distributive property 4x+9=-x+5Combine like terms. 5x+9=5Add 1x. 5x=-4Subtract 9. $x=-\frac{4}{5}$ Divide by 5.
Check $x=-\frac{4}{5}: \frac{29}{5}=\frac{29}{5}$ True
The solution set is $\left\{-\frac{4}{5}\right\}.$

29.
$$11x-5(x+2) = 6x+5$$

 $11x-5x-10 = 6x+5$
 $6x-10 = 6x+5$
 $6x-10-6x = 6x+5-6x$
 $-10 = 5$

Since -10 = 5 is a false statement, the equation has no solution set, symbolized by \emptyset .

30.
$$6x-4(x+1) = 2x+4$$

 $6x-4x-4 = 2x+4$
 $2x-4 = 2x+4$
 $-4 = 4$ Subtract 2x.
Since $A = 4$ is a false statement th

Since -4 = 4 is a false statement, the equation has no solution set, symbolized by \emptyset .

31.
$$6(3w+5) = 2(10w+10)$$

 $18w+30 = 20w+20$
 $18w = 20w-10$ Subtract 30.
 $-2w = -10$ Subtract 20w.
 $w = 5$ Divide by -2.
Check $w = 5$: 120 = 120 True
The solution set is {5}.

32. 4(2x-1) = -6(x+3)8x - 4 = -6x - 18 Distributive property 14x - 4 = -18Add 6x. 14x = -14Add 4. x = -1Divide by 14. Check x = -1: -12 = -12 True The solution set is $\{-1\}$. -(4x+2)-(-3x-5)=333. -1(4x+2)-1(-3x-5) = 3-4x - 2 + 3x + 5 = 3-x + 3 = 3-x = 0x = 0Check x = 0: 3 = 3 True The solution set is $\{0\}$. 34. -(6k-5)-(-5k+8) = -3-1(6k-5)-1(-5k+8) = -3-6k + 5 + 5k - 8 = -3-k - 3 = -3-k = 0k = 0Check k = 0: -3 = -3 True The solution set is $\{0\}$.

35.
$$3(2x-4) = 6(x-2)$$

 $6x-12 = 6x-12$
 $-12 = -12$ Subtract 6x.
 $0 = 0$ Add 12.

The variable has "disappeared." Since the resulting statement is a true one, any real number is a solution. We indicate the solution set as {all real numbers}.

36. 3(6-4x) = 2(-6x+9)

$$18 - 12x = -12x + 18$$

$$18 = 18$$
 Add $12x$.

Since 18 = 18 is a true statement, the solution set is {all real numbers}.

37.
$$6(4x-1) = 12(2x+3)$$

$$24x - 6 = 24x + 36$$

-6 = 36 Subtract 24x.

The variable has "disappeared," and the resulting equation is false. Therefore, the equation has no solution set, symbolized by \emptyset .

38. 6(2x+8) = 4(3x-6)12x+48 = 12x-2448 = -24 Subtract 12x.

Since 48 = -24 is a false statement, the equation has no solution set, symbolized by \emptyset .

39. The least common denominator of all the fractions in the equation is 10.

$$10\left(\frac{3}{5}t - \frac{1}{10}t\right) = 10\left(t - \frac{5}{2}\right)$$
$$10\left(\frac{3}{5}t\right) + 10\left(-\frac{1}{10}t\right) = 10t + 10\left(-\frac{5}{2}\right)$$
$$6t - t = 10t - 25$$
$$5t = 10t - 25$$
$$-5t = -25$$
$$\frac{-5t}{-5} = \frac{-25}{-5}$$
$$t = 5$$
Check $t = 5$: $\frac{5}{2} = \frac{5}{2}$ True
The solution set is {5}.

40. The least common denominator of all the fractions in the equation is 14, so multiply both sides by 14 and solve for r.

$$14\left(-\frac{2}{7}r+2r\right) = 14\left(\frac{1}{2}r+\frac{17}{2}\right)$$
$$-4r+28r = 7r+119$$
$$24r = 7r+119$$
$$17r = 119$$
$$r = \frac{119}{17} = 7$$

Check r = 7: 12 = 12 True The solution set is $\{7\}$.

41. The least common denominator of all the fractions in the equation is 12, so multiply both sides by 12 and solve for *x*.

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

9x-4x+60 = 10x
5x+60 = 10x
60 = 5x
 $\frac{60}{5} = \frac{5x}{5}$
12 = x
Check x = 12:9-4+5 = 10 True
The solution set is {12}.

42. The least common denominator of all the fractions in the equation is 15, so multiply both sides by 15 and solve for *x*.

$$15\left(\frac{1}{5}x - \frac{2}{3}x - 2\right) = 15\left(-\frac{2}{5}x\right)$$

$$3x - 10x - 30 = -6x$$

$$-7x - 30 = -6x$$

$$-30 = x$$

Check $x = -30: -6 + 20 - 2 = 12$ True
The solution set is $\{-30\}$.

43. The least common denominator of all the fractions in the equation is 35, so multiply both sides by 35 and solve for x.

$$35\left[\frac{1}{7}(3x+2) - \frac{1}{5}(x+4)\right] = 35(2)$$

$$5(3x+2) - 7(x+4) = 70$$

$$15x + 10 - 7x - 28 = 70$$

$$8x - 18 = 70$$

$$8x = 88$$

$$\frac{8x}{8} = \frac{88}{8}$$

$$x = 11$$

Check $x = 11:5 - 3 = 2$ True
The solution set is $\{11\}.$

44. The least common denominator of all the fractions in the equation is 12, so multiply both

sides by 12 and solve for x.

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

$$3(3x-1) + 2(x+3) = 36$$

$$9x-3+2x+6 = 36$$

$$11x+3 = 36$$

$$11x = 33$$

$$\frac{11x}{11} = \frac{33}{11}$$

$$x = 3$$
Check $x = 3: 2+1=3$ True

The solution set is $\{3\}$.

2.3 More on Solving Linear Equations 115

45. The LCD of all the fractions is 4.

$$4\left[-\frac{1}{4}(x-12) + \frac{1}{2}(x+2)\right] = 4(x+4)$$

$$4\left(-\frac{1}{4}\right)(x-12) + 4\left(\frac{1}{2}\right)(x+2) = 4x+16$$

$$(-1)(x-12) + 2(x+2) = 4x+16$$

$$-x+12 + 2x + 4 = 4x+16$$

$$x+16 = 4x+16$$

$$-3x+16 = 16$$

$$-3x = 0$$

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

$$x = 0$$

Check x = 0: 4 = 4 True

The solution set is $\{0\}$.

46. The least common denominator of all the fractions in the equation is 9, so multiply both sides by 9 and solve for *p*.

$$9\left[\frac{1}{9}(p+18) + \frac{1}{3}(2p+3)\right] = 9(p+3)$$

$$p+18+3(2p+3) = 9p+27$$

$$p+18+6p+9 = 9p+27$$

$$7p+27 = 9p+27$$

$$-2p+27 = 27$$

$$-2p = 0$$

$$\frac{-2p}{-2} = \frac{0}{-2}$$

$$p = 0$$

Check p = 0: 3 = 3 True

The solution set is $\{0\}$.

47. The least common denominator of all the fractions in the equation is 6, so multiply both sides by 6 and solve for *k*.

$$6\left[\frac{2}{3}k - \left(k - \frac{1}{2}\right)\right] = 6\left[\frac{1}{6}(k - 51)\right]$$

$$6\left(\frac{2}{3}k\right) - 6\left(k - \frac{1}{2}\right) = 6\left[\frac{1}{6}(k - 51)\right]$$

$$4k - 6k + 3 = 1(k - 51)$$

$$-2k + 3 = k - 51$$

$$-3k + 3 = -51$$

$$-3k = -54$$

$$k = 18$$

Check $k = 18: -\frac{11}{2} = -\frac{11}{2}$ True
The solution set is {18}.

48. The least common denominator is 12.

$$12\left[-\frac{5}{6}q - (q-1)\right] = 12\left[\frac{1}{4}(-q+80)\right]$$
$$12\left(-\frac{5}{6}q\right) - 12(q-1) = 12\left[\frac{1}{4}(-q+80)\right]$$
$$-10q - 12q + 12 = 3(-q+80)$$
$$-22q + 12 = -3q + 240$$
$$-19q + 12 = 240$$
$$-19q + 12 = 240$$
$$-19q = 228$$
$$q = \frac{228}{-19} = -12$$
Check q = -12: 23 = 23 True
The solution set is {-12}.

49. To clear the equation of decimals, we multiply by 100. 100(0.75x - 3.2) = 100(0.55 - 0.5x) 75x - 320 = 55 - 50x 75x - 320 + 50x = 55 - 50x + 50x125x - 320 = 55

$$125x - 320 + 320 = 55 + 320$$

$$125x = 375$$

$$\frac{125x}{125} = \frac{375}{125}$$

$$x = 3$$

Check $x = 3: -0.95 = -0.95$ True
The solution set is {3}.

50.
$$100(1.35x-0.6) = 100(1.65+2.1x)$$

 $135x-60 = 165+210x$
 $135x-60-135x = 165+210x-135x$
 $-60 = 165+75x$
 $-60-165 = 165+75x-165$
 $-225 = 75x$
 $\frac{-225}{75} = \frac{75x}{75}$
 $x = -3$
Check $x = -3: -4.65 = -4.65$ True
The solution set is $\{-3\}$.

51. Solve the equation for t.

$$0.8t + 0.15 = 2t - 1.35$$

$$100(0.8t + 0.15) = 100(2t - 1.35)$$

$$80t + 15 = 200t - 135$$

$$80t + 15 - 80t = 200t - 135 - 80t$$

$$15 = 120t - 135$$

$$15 + 135 = 120t - 135 + 135$$

$$150 = 120t$$

$$\frac{150}{120} = \frac{120t}{120}$$

$$t = \frac{5}{4}$$
Check $t = \frac{5}{4}$: 1.15 = 1.15 True
The solution set is $\left\{\frac{5}{4}\right\}$.

52. To eliminate the decimal in 3.4, we need to multiply both sides by 10. But to eliminate the decimal in -0.12 and 0.84, we need to multiply by 100, so we choose 100.

$$-0.12p + 3.4 = 0.84 + 5p$$

$$100[-0.12p + 3.4] = 100[0.84 + 5p]$$

$$-12p + 340 = 84 + 500p$$

$$-12p + 340 + 12p = 84 + 500p + 12p$$

$$340 - 84 = 84 + 512p$$

$$340 - 84 = 84 + 512p - 84$$

$$256 = 512p$$

$$\frac{256}{512} = \frac{512p}{512}$$

$$p = \frac{1}{2}$$
Check $p = \frac{1}{2}$: 3.34 = 3.34 True
The solution set is $\left\{\frac{1}{2}\right\}$.

53. To eliminate the decimal in 0.2 and 0.1, we need to multiply both sides by 10. But to eliminate the decimal in 0.05, we need to multiply by 100, so we choose 100. $100[0 \ 2(60) + 0.05 \ r] = 100[0 \ 1(60 + r)]$

$$100[0.2(60)+0.05x] = 100[0.1(60+x)]$$
$$20(60)+5x = 10(60+x)$$
$$1200+5x = 600+10x$$
$$1200-5x = 600$$
$$-5x = -600$$
$$x = \frac{-600}{-5} = 120$$
Check x = 120 : 18 = 18 True
The solution set is {120}.

54.
$$0.3(30) + 0.15x = 0.2(30 + x)$$

 $100[0.3(30) + 0.15x] = 100[0.2(30 + x)]$
 $30(30) + 15x = 20(30 + x)$
 $900 + 15x = 600 + 20x$
 $900 - 5x = 600$
 $-5x = -300$
 $x = 60$
Check $x = 60$: $18 = 18$ True
The solution set is $\{60\}$.

55. 1.00x + 0.05(12 - x) = 0.10(63)To clear the equation of decimals, we multiply both sides by 100. 100[1.00x + 0.05(12 - x)] = 100[0.10(63)] 100x + 5(12 - x) = 10(63) 100x + 60 - 5x = 630 95x + 60 = 630 95x = 570 $x = \frac{570}{95} = 6$ Check x = 6: 6.3 = 6.3 True The solution set is $\{6\}$. 56. 0.92x + 0.98(12 - x) = 0.96(12)100[0.92x + 0.98(12 - x)] = 100[0.96(12)]92x + 98(12 - x) = 96(12)92x + 1176 - 98x = 1152-6x + 1176 = 1152-6x = -24 $x = \frac{-24}{-6} = 4$ Check x = 4: 11.52 = 11.52 True The solution set is $\{4\}$. 57. 0.6(10,000) + 0.8x = 0.72(10,000 + x)60(10,000) + 80x = 72(10,000 + x)600,000 + 80x = 720,000 + 72x600,000 + 8x = 720,0008x = 120,000 $x = \frac{120,000}{8}$ x = 15,000Check x = 15,000: 18,000 = 18,000True The solution set is $\{15,000\}$. **58.** 0.2(5000) + 0.3x = 0.25(5000 + x)20(5000) + 30x = 25(5000 + x)100,000 + 30x = 125,000 + 25x5x + 100,000 = 125,0005x = 25,000 $x = \frac{25,000}{5} = 5000$

Check x = 5000 : 2500 = 2500 True The solution set is $\{5000\}$.

59. 10(2x-1) = 8(2x+1)+14 20x-10 = 16x+8+14 20x-10 = 16x+22 4x-10 = 22 4x = 32 x = 8Check x = 8: 150 = 150 True The solution set is {8}.

60. 9(3k-5) = 12(3k-1) - 5127k - 45 = 36k - 12 - 5127k - 45 = 36k - 63-45 = 9k - 6318 = 9k2 = kCheck k = 2: 9 = 9 True The solution set is $\{2\}$. **61.** 24 - 4(7 - 2t) = 4(t - 1)24 - 28 + 8t = 4t - 4-4 + 8t = 4t - 4-4 + 8t - 4t = 4t - 4 - 4t-4 + 4t = -44t = 0t = 0Check t = 0: -4 = -4True The solution set is $\{0\}$. 62. 8-2(2-x) = 4(x+1)8 - 4 + 2x = 4x + 44 + 2x = 4x + 44 + 2x - 2x = 4x + 4 - 2x4 = 2x + 42x = 0x = 0Check x = 0: 4 = 4 True The solution set is $\{0\}$. **63.** 4(x+8) = 2(2x+6) + 204x + 32 = 4x + 12 + 204x + 32 = 4x + 324x = 4x0 = 0Since 0 = 0 is a true statement, the solution set is {all real numbers}. **64.** 4(x+3) = 2(2x+8) - 44x + 12 = 4x + 16 - 44x + 12 = 4x + 1212 = 12

Since 12 = 12 is a true statement, the solution set is {all real numbers}.

65. To clear fractions, multiply both sides by the LCD, which is 4.

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

$$4\left(\frac{1}{2}\right)(x+2) + 4\left(\frac{3}{4}\right)(x+4) = 4x+20$$

$$2(x+2) + 3(x+4) = 4x+20$$

$$2x+4 + 3x + 12 = 4x+20$$

$$5x+16 = 4x+20$$

$$x+16 = 20$$

$$x = 4$$
Check $x = 4$: $9 = 9$ True

The solution set is {4}.

66. To clear fractions, multiply both sides by the LCD, which is 6.

$$6\left[\frac{1}{3}(x+3) + \frac{1}{6}(x-6)\right] = 6(x+3)$$

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

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

$$2x+6+x-6 = 6x+18$$

$$3x = 6x+18$$

$$-3x = 18$$

$$x = \frac{18}{-3} = -6$$

Check $x = -6; -3 = -3$ True

The solution set is $\{-6\}$.

67. To eliminate the decimals, multiply both sides by 10.

$$10[0.1(x+80)+0.2x] = 10(14)$$

$$1(x+80)+2x = 140$$

$$x+80+2x = 140$$

$$3x+80 = 140$$

$$3x = 60$$

$$x = 20$$
Check x = 20: 14 = 14 True
The solution set is {20}.

68. To clear the decimals, multiply both sides by 10. 3(x+15) + 4(x+25) = 2503x + 45 + 4x + 100 = 2507x + 145 = 250

$$7x = 105$$

$$x = 15$$

Check x = 15: 25 = 25 True The solution set is $\{15\}$.

69.
$$9(v+1)-3v = 2(3v+1)-8$$

 $9v+9-3v = 6v+2-8$
 $6v+9 = 6v-6$
 $9 = -6$

Because 9 = -6 is a false statement, the equation has no solution set, symbolized by \emptyset .

- 70. 8(t-3) + 4t = 6(2t+1) 10 8t - 24 + 4t = 12t + 6 - 10 12t - 24 = 12t - 4 -24 = -4Because -24 = -4 is a false statement, the equation has no solution set, symbolized by \emptyset .
- 71. The sum of q and the other number is 11. To find the other number, you would subtract q from 11, so an expression for the other number is 11-q.
- 72. The sum of *r* and the other number is 34. To find the other number, you would subtract *r* from 34, so an expression for the other number is 34 r.
- **73.** The product of x and the other number is 9. To find the other number, you would divide 9 by x, so an expression for the other number is $\frac{9}{x}$.
- 74. The product of *m* and the other number is -6. To find the other number, you would divide -6 by *m*, so an expression for the other number is $\frac{-6}{m}$.
- **75.** If a baseball player gets 65 hits in one season, and *h* of the hits are in one game, then 65-h of the hits came in the rest of the games.
- 76. If a hockey player scores 42 goals in one season, and *n* of the goals are in one game, then 42 n of the goals came in the rest of the games.
- 77. If Monica is x years old now, then 15 years from now she will be x+15 years old. Five years ago, she was x-5 years old.
- 78. If Chandler is y years old now, then four years ago he was y-4 years old. Eleven years from now, he will be y+11 years old.
- **79.** Since the value of each quarter is 25 cents, the value of r quarters is 25r cents.

- 80. Since the value of each dime is 10 cents, the value of y dimes is 10y cents.
- 81. Since each bill is worth 5 dollars, the number of bills is $\frac{t}{5}$.
- 82. Since each bill is worth 10 dollars, the number of bills is $\frac{v}{10}$.
- 83. Since each adult ticket costs x dollars, the cost of 3 adult tickets is 3x. Since each child's ticket costs y dollars, the cost of 2 children's tickets is 2y. Therefore, the total cost is 3x + 2y(dollars).
- **84.** Since each adult ticket costs *p* dollars, the cost of 4 adult tickets is 4p. Since each child's ticket costs q dollars, the cost of 6 children's tickets is 6q. Therefore, the total cost is 4p + 6q(dollars).

Summary Exercises Applying Methods for Solving Linear Equations

1. This is an equation since it has an equals sign. x + 2 = -3

x = -5 Subtract 2. Check x = -5; -3 = -3 True The solution set is $\{-5\}$.

- 2. This is an expression since it does not have an equals sign. 4p-6+3p-8=7p-14
- 3. This is an expression since it does not have an equals sign.

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

= $-3m-2$

4. This is an equation since it has an equals sign. 6q - 9 = 12 + 3q

33 = 33 True

$$3q-9=12$$

 $3q=21$
 $q=7$
Check $q=7$:

The solution set is $\{7\}$.

5. This is an equation since it has an equals sign. 5x-9=3(x-3)

5x-9=3x-9 Distributive property 2x - 9 = -9Subtract 3*x*. Add 9. 2x = 0x = 0Divide by 2. Check x = 0: -9 = -9True The solution set is $\{0\}$.

6. This is an equation since it has an equals sign. To clear fractions, multiply both sides by the LCD, which is 12.

$$12\left(\frac{2}{3}x+8\right) = 12\left(\frac{1}{4}x\right)$$

$$8x+96 = 3x$$

$$5x+96 = 0$$

$$5x = -96$$

$$x = -\frac{96}{5}$$
Check $x = -\frac{96}{5}$: $-\frac{24}{5} = -\frac{24}{5}$ True
The solution set is $\left\{-\frac{96}{5}\right\}$.

7. This is an expression since it does not have an equals sign. 2-

$$-6(z+1) - 4(z-2) - 10$$

= 2 - 6z - 6 - 4z + 8 - 10
= -10z - 6

8. This is an equation since it has an equals sign. 7(p-2) + p = 2(p+2)

$$7p-14+p=2p+4$$

 $8p-14=2p+4$
 $6p-14=4$
 $6p=18$
 $p=3$
Check $p=3: 10=10$ True
The solution set is {3}.

9. This is an expression since it does not have an equals sign.

$$\frac{1}{2}(x+10) - \frac{2}{3}x = \frac{1}{2}x + 5 - \frac{2}{3}x$$
$$= \frac{3}{6}x + 5 - \frac{4}{6}x$$
$$= -\frac{1}{6}x + 5$$

1

10. This is an expression since it does not have an equals sign. -4(k+2) + 3(2k-1) = -4k - 8 + 6k - 3= 2k - 11**11.** -6z = -14 $z = \frac{-14}{-6}$ Divide by -6. $=\frac{7}{3}$ Check $z = \frac{7}{3}: -14 = -14$ True The solution set is $\left\{\frac{7}{3}\right\}$. 12. 2m+8=162m = 8 Subtract 8. m = 4 Divide by 2. Check m = 4: 16 = 16 True The solution set is $\{4\}$. **13.** 12.5x = -63.75 $x = \frac{-63.75}{12.5}$ Divide by 12.5. = -5.1Check x = -5.1: -63.75 = -63.75True The solution set is $\{-5.1\}$. **14.** -x = -12x = 12 Multiply by -1. Check x = 12: -12 = -12 True The solution set is $\{12\}$. **15.** $\frac{4}{5}x = -20$ $x = \left(\frac{5}{4}\right)(-20)$ Multiply by $\frac{5}{4}$. = -25Check x = -25: -20 = -20 True The solution set is $\{-25\}$. **16.** 7m - 5m = -122m = -12 Combine like terms. m = -6Divide by 2. Check m = -6: -12 = -12 True The solution set is $\{-6\}$.

17. -x = 6 x = -6 Multiply by -1. Check x = -6: 6 = 6 True The solution set is $\{-6\}$.

18.
$$\frac{x}{-2} = 8$$
$$-\frac{1}{2}x = 8$$
$$x = -2(8)$$
 Multiply by - 2.
$$= -16$$
Check x = -16: 8 = 8 True
The solution set is {-16}.

19.
$$4x + 2(3 - 2x) = 6$$

 $4x + 6 - 4x = 6$

6 = 6Since 6 = 6 is a true statement, the solution set is {all real numbers}.

20.
$$x - 16.2 = 7.5$$

x = 23.7 Add 16.2. Check x = 23.7: 7.5 = 7.5 True The solution set is {23.7}.

21.
$$7m - (2m - 9) = 39$$

 $7m - 2m + 9 = 39$
 $5m + 9 = 39$
 $5m = 30$
 $m = 6$
Check $m = 6$: $39 = 39$ True
The solution set is $\{6\}$.

22.
$$2 - (m+4) = 3m - 2$$

 $2 - m - 4 = 3m - 2$
 $-m - 2 = 3m - 2$
 $-4m - 2 = -2$
 $-4m = 0$
 $m = \frac{0}{-4} = 0$
Check $m = 0: -2 = -2$ True
The solution set is $\{0\}$.

- 23. -3(m-4) + 2(5+2m) = 29 -3m+12+10+4m = 29 m+22 = 29 m = 7Check m = 7: 29 = 29 True The solution set is $\{7\}$.
- **24.** To eliminate the decimals, multiply both sides by 10.

10[-0.3x + 2.1(x - 4)] = 10(-6.6)-3x + 21(x - 4) = -66 -3x + 21x - 84 = -66 18x - 84 = -66 18x = 18 x = 1 Check x = 1: -0.3 - 6.3 = -6.6 True The solution set is {1}.

25. To eliminate the decimals, multiply both sides by 100.

$$100[0.08x + 0.06(x + 9)] = 100(1.24)$$

$$8x + 6(x + 9) = 124$$

$$8x + 6x + 54 = 124$$

$$14x + 54 = 124$$

$$14x = 70$$

$$x = 5$$
Check $x = 5$: $0.4 + 0.84 = 1.24$ True
The solution set is $\{5\}$.

26.
$$3(m+5)-1+2m = 5(m+2)$$

 $3m+15-1+2m = 5m+10$
 $5m+14 = 5m+10$
 $14 = 10$
Because $14 = 10$ is a false statement,

Because 14 = 10 is a false statement, the equation has no solution set, symbolized by \emptyset .

27.
$$-2t + 5t - 9 = 3(t - 4) - 5$$

 $-2t + 5t - 9 = 3t - 12 - 5$
 $3t - 9 = 3t - 17$
 $-9 = -17$

Because -9 = -17 is a false statement, the equation has no solution set, symbolized by \emptyset .

- 28. To eliminate the decimals, multiply both sides by 10. 10[2.3x+13.7] = 10[1.3x+2.9]23x+137 = 13x+2910x+137 = 2910x = -108x = -10.8Check x = -10.8: -11.14 = -11.14 True The solution set is $\{-10.8\}$.
- 29. To eliminate the decimals, multiply both sides by 10. 10[0.2(50) + 0.8r] = 10[0.4(50 + r)]2(50) + 8r = 4(50 + r)100 + 8r = 200 + 4r100 + 4r = 2004r = 100

r = 25Check r = 25: 10 + 20 = 30 True The solution set is $\{25\}$.

30.
$$r+9+7r = 4(3+2r)-3$$

 $8r+9 = 12+8r-3$
 $8r+9 = 8r+9$
 $9 = 9$
Since $9 = 9$ is a true statem

Since 9=9 is a true statement, the solution set is {all real numbers}.

31.
$$2(3+7x) - (1+15x) = 2$$

 $6+14x - 1 - 15x = 2$
 $-x + 5 = 2$
 $-x = -3$
 $x = 3$
Check $x = 3$: $48 - 46 = 2$ True
The solution set is {3}.

32. To eliminate the decimals, multiply both sides by 10. 10[0.6(100 - x) + 0.4x] = 10[0.5(92)]

$$6(100 - x) + 4x = 5(92)$$

$$600 - 6x + 4x = 460$$

$$600 - 2x = 460$$

$$-2x = -140$$

$$x = 70$$

Check $x = 70$: $18 + 28 = 46$ True
The solution set is $\{70\}$.

33. To clear fractions, multiply both sides by the LCD, which is 4. $4\left(\frac{1}{4}x - 4\right) = 4\left(\frac{3}{2}x + \frac{3}{4}x\right)$

$$\begin{array}{c}
(4 &) & (2 & 4) \\
x - 16 = 6x + 3x \\
x - 16 = 9x \\
- 16 = 8x \\
x = -2
\end{array}$$
Check $x = -2$: $-4.5 = -3 - 1.5$ True

The solution set is $\{-2\}$.

34. To clear fractions, multiply both sides by the LCD, which is 12.

$$12\left[\frac{3}{4}(z-2) - \frac{1}{3}(5-2z)\right] = 12(-2)$$

$$9(z-2) - 4(5-2z) = -24$$

$$9z - 18 - 20 + 8z = -24$$

$$17z - 38 = -24$$

$$17z = 14$$

$$z = \frac{14}{17}$$
Check $z = \frac{14}{17}: -\frac{15}{17} - \frac{19}{17} = -2$ True
The solution set is $\left\{\frac{14}{17}\right\}$.

2.4 Applications of Linear Equations

Classroom Examples, Now Try Exercises

1. Step 2 Let x = the number. Step 3 The a number product of increased 5, and by 8, is -60. \downarrow \downarrow \downarrow \downarrow 5. -60(x+8)= Step 4 Solve the equation. 5(x+8) = -605x + 40 = -60Distributive property 5x = -100 Subtract 40. x = -20Divide by 5. Step 5 The number is -20.

Step 6 -20 plus 8 is -12 times 5 is -60, so -20 is the number. **N1.** Step 2 Let x = the number. Step 3 a number The product of increased 7, and by 3, is -63. \downarrow \downarrow \downarrow \downarrow 7. -63 (x+3)= Step 4 Solve the equation. 7(x+3) = -637x + 21 = -63 Distributive property 7x = -84 Subtract 21. x = -12 Divide by 7. Step 5 The number is -12. Step 6 -12 plus 3 is -9, times 7 is -63, so -12 is the number. **2.** Step 2 Let x = the number. Step 3 the product of 19 less the If added 9 and a than the result 5 is is to number, number. \downarrow \downarrow \downarrow \downarrow \downarrow 5 9*x* + x - 19= Step 4 Solve the equation. 5+9x = x-195+9x-5 = x-19-5 Subtract 5. 9x = x - 249x - x = x - 24 - x Subtract x. 8x = -24 $\frac{8x}{-24} = \frac{-24}{-24}$ Divide by 8. 8 8 x = -3Step 5 The number is -3. Step 6 9 times -3 is -27. 5 added to -27 is -22, which is 19 less than -3, so -3 is the number.

N2. *Step 2* Let x = the number. Step 3 7 less the If 5 added than 3 times а result the number. is to number, is \downarrow \downarrow \downarrow \downarrow \downarrow 5 + 3x - 7х = Step 4 Solve the equation. 5 + x = 3x - 75 + x - 5 = 3x - 7 - 5Subtract 5. x = 3x - 12x-3x = 3x-12-3x Subtract 3x. -2x = -12 $\frac{-2x}{-2} = \frac{-12}{-2}$ Divide by -2. x = 6Step 5 The number is 6. Step 6 5 added to 6 is 11. 3 times 6 is 18, and 7 less than 18 is 11, so 6 is the number. **3.** Step 2 Let x = the number of medals France won. Then x + 4 number of medals Japan won. Step 3 the number of the number of medals The medals France won total is plus Japan won. \downarrow \downarrow \downarrow \downarrow \downarrow 72 (x+4)= х + Step 4 Solve the equation. x + (x + 4) = 722x + 4 = 72 Combine like terms. 2x = 68 Subtract 4. x = 34 Divide by 2.

Step 5

34 + 4 = 38 medals. Step 6 38 is 4 more than 34, and the sum of 38 and 34 is 72.

France won 34 medals and Japan won

N3. Step 2 Let x = the number of medals Great Britain won. Let x - 21 = the number of medals Germany won. Step 3 the number of the number of The medals Great medals Britain won Germany won. total plus is \downarrow \downarrow \downarrow \downarrow \downarrow 109 + (x-21)= х Step 4 Solve the equation. x + (x - 21) = 1092x - 21 = 109 Combine like terms. 2x = 130 Add 21. Divide by 2. x = 65Step 5 Great Britain won 65 medals and Germany won 65 - 21 = 44 medals. Step 6 44 is 21 less than 65, and the sum of 65 and 44 is 109. **4.** Step 2 Let x = the number of orders for muffins. Then $\frac{1}{6}x$ = the number of orders for croissants. Step 3 orders for The orders for croissants. muffins plus total is \downarrow \downarrow \downarrow \downarrow \downarrow $\frac{1}{6}x$ 56 = х + Step 4 Solve the equation. $56 = 1x + \frac{1}{6}x$ x = 1x $56 = \frac{6}{6}x + \frac{1}{6}x$ LCD = 6 $56 = \frac{7}{4}x$ Combine like terms. $\frac{6}{7}(56) = \frac{6}{7}\left(\frac{7}{6}x\right)$ Multiply by $\frac{6}{7}$. 48 = x

Step 5 The number of orders for muffins was 48, so the number of orders for croissants was

 $\frac{1}{6}(48) = 8.$

Step 6

One-sixth of 48 is 8, and the sum of 48 and 8 is 56.

N4. Step 2

Let x = the number of orders for chocolate scones.

Then $\frac{2}{3}x$ = the number of orders for bagels. Step 3

orders for

The		chocolate	orders for		
total	is scones		plus	bagels.	
\downarrow	\downarrow	\downarrow	\downarrow	\downarrow	
525	=	x	+	$\frac{2}{3}x$	

Step 4

Solve the equation.

$$525 = 1x + \frac{2}{3}x \qquad x = 1x$$

$$525 = \frac{3}{3}x + \frac{2}{3}x \qquad \text{LCD} = 3$$

$$525 = \frac{5}{3}x \qquad \text{Combine like terms.}$$

$$\frac{3}{5}(525) = \frac{3}{5}\left(\frac{5}{3}x\right) \qquad \text{Multiply by } \frac{3}{5}.$$

$$315 = x$$

Step 5

The number of orders for chocolate scones was 315, so the number of orders for bagels was

$$\frac{2}{3}(315) = 210.$$

Two-thirds of 315 is 210, and the sum of 315 and 210 is 525.

5. Step 2

Let x = the number of members.

Then 2x = the number of nonmembers. (If each member brought two nonmembers, there would be twice as many nonmembers as members.)

	Step 3								
Numb	er		number		the total				
of			of		in				
membe	ers pl	us r	nonmember	rs is	attendance.				
\downarrow		Ļ	\downarrow	\downarrow	\downarrow				
x	-	ł	2x	=	27				
N5.	Sitep 4 Solve the equation. x + 2x = 27 3x = 27 $\frac{3x}{3} = \frac{27}{3}$ x = 9 Step 5 There were 9 members and $2 \cdot 9 = 18$ nonmembers. Step 6 18 is twice as much as 9, and the sum of 9 and 18 is 27. N5. Step 2 Let $x =$ the number of residents. Then $4x =$ the number of guests. (If each resident brought four guests, there would be four times as many guests as								
	Step 3								
Numb	er		number		the total				
of		_	of		in				
resider	nts p	olus	guests	is	attendance.				
\downarrow		\downarrow	\downarrow	\downarrow	\downarrow				
	Step 4 Solve th x + 4x = 5x =	the equal = 175 = 175 = $\frac{175}{5}$ = 35 vere 35	tion. residents a es as much	nd 4.3	5 = 140 and the sum of				
	35 and	140 is 1	175.						
6. *Step 2*

Let x = the length of the middle-sized piece. Then x+10 = the length of the longest piece and x-5 = the length of the shortest piece. Step 3

middle-

Shortest plus sized longest is length. plus

 \downarrow \downarrow \downarrow \downarrow \downarrow \downarrow \downarrow x-5+ x + x + 10= 50 Step 4 Solve the equation. (x-5) + x + (x+10) = 503x + 5 = 503x = 45 $\frac{3x}{3} = \frac{45}{3}$ $3 \overline{3}$ x = 15Step 5 The middle-sized piece is 15 inches long, the longest piece is 15+10=25 inches long, and

the shortest piece is 15-5=10 inches long. Step 6

Since 25 inches is 10 inches longer than 15 inches, 15 inches is 5 inches longer than 10 inches, and 15 + 25 + 10 = 50 inches (the length of the pipe), the answers are correct.

N6. *Step 2*

Let x = the time spent practicing free throws. Then 2x = the time spent lifting weights and x + 2 = the time spent watching game films. Step 3

Free		lifting		watching		total	
throws	plus	weights	plus	films	is	time.	
\downarrow	\downarrow	\downarrow	\downarrow	\downarrow	\downarrow	\downarrow	
x	+	2x	+	<i>x</i> +2	=	6	
	Step 4						
	Solve th	he equation	n.				
	x + 2x -	+(x+2) =	6				
	4x + 2 = 6						
	4x = 4						
	4x 4						
	$\overline{4} = \overline{4}$						
		<i>x</i> =	1				
	Step 5						
	The time spent practicing free throws is 1 hour,						
	the time spent lifting weights is $2(1) = 2$ hours.						

and the time spent watching game films is 1+2=3 hours.

Step 6

Since 2 hours is twice as much time as 1 hour, 3 hours is 2 more hours than 1 hour, and the sum of the times is 1+2+3=6 hours (the total time spent), the answers are correct.

7. Step 2

total

Let x = the lesser page number. Then x+1 = the greater page number. Step 3 Because the sum of the page numbers is 569, an equation is x + (x+1) = 569. Step 4 Solve the equation. 2x+1 = 569 Combine like terms. 2x = 568 Subtract 1. x = 284 Divide by 2. Step 5 The lesser page number is 284, and the greater page number is 284 + 1 = 285. Step 6 285 is one more than 284, and the sum of 284 and 285 is 569. **N7.** Step 2 Let x = the lesser page number. Then x+1 = the greater page number. Step 3 Because the sum of the page numbers is 593, an equation is x + (x+1) = 593. Step 4 Solve the equation. 2x+1=593 Combine like terms. 2x = 592 Subtract 1. x = 296 Divide by 2. Step 5 The lesser page number is 296, and the greater page number is 296 + 1 = 297. Step 6 297 is one more than 296, and the sum of 296 and 297 is 593. 8. Let x = the lesser even integer. Then x + 2 = the greater even integer. From the given information, we have $6 \cdot x + (x+2) = 86.$ Solve the equation. 7x + 2 = 86

$$7x = 84$$

 $x = 12$

The lesser even integer is 12 and the greater consecutive even integer is 12+2=14. Six times 12 is 72 and 72 plus 14 is 86.

N8. Let x = the lesser odd integer.

Then x + 2 = the greater odd integer. From the given information, we have $2 \cdot x + 3(x + 2) = 191$. Solve the equation. 2x + 3x + 6 = 191 5x + 6 = 191 5x = 185x = 37

The lesser odd integer is 37 and the greater consecutive odd integer is 37 + 2 = 39. Two times 37 is 74, three times 39 is 117, and 74 plus 117 is 191.

9. Let x = the degree measure of the angle.

Then 90 - x = the degree measure of its complement.

```
The
                            eight times
complement
                             the angle.
                    is
       T
                    \downarrow
                                  \downarrow
   90 - x
                    _
                                 8x
Solve the equation.
90 - x = 8x
    90 = 9x
    10 = x
The measure of the angle is 10^{\circ}.
```

N9. Let x = the degree measure of the angle. Then 90 - x = the degree measure of its complement.

	The		twice
	complement	is	the angle.
	\downarrow	\downarrow	\downarrow
	90 - x	=	2x
	Solve the equa	tion.	
	90 - x = 2x		
	90 = 3x		
	30 = x		
	The measure of	f the a	ngle is 30°.
10.	Step 2		

Let x = the degree measure of the angle. Then 90 - x = the degree measure of its complement, and 180 - x = the degree measure of its supplement.

Step 3 complement supplement 174 plus equals \downarrow \downarrow \downarrow \downarrow \downarrow 90 - x+ 180 - x= 174 Step 4 Solve the equation. 270 - 2x = 174-2x = -96Subtract 270. x = 48Divide by -2. Step 5 The measure of the angle is 48°. Step 6 The complement of 48° is $90^{\circ} - 48^{\circ} = 42^{\circ}$ and the supplement is $180^{\circ} - 48^{\circ} = 132^{\circ}$. The sum of 42° and 132° is 174° . **N10.** Step 2 Let x = the degree measure of the angle. Then 90 - x = the degree measure of its complement, and 180 - x = the degree measure of its supplement. Step 3 46° less than 3 times The supplement equals its complement. \downarrow \downarrow \downarrow 180 - x $3 \cdot (90 - x) - 46$ = Step 4 Solve the equation. 180 - x = 3(90 - x) - 46180 - x = 270 - 3x - 46Distributive prop. 180 - x = 224 - 3xCombine terms. 180 + 2x = 224Add 3x. 2x = 44Subtract 180. x = 22Divide by 2. Step 5 The measure of the angle is 22° . Step 6 The complement of 22° is $90^{\circ} - 22^{\circ} = 68^{\circ}$, and 46° less than 3 times 68° is $3(68^{\circ}) - 46^{\circ} = 204^{\circ} - 46^{\circ} = 158^{\circ}$. The supplement is $180^\circ - 22^\circ = 158^\circ$.

Exercises

- 1. Choice D, $6\frac{1}{2}$, is *not* a reasonable answer in an applied problem that requires finding the number of cars on a dealer's lot, since you cannot have $\frac{1}{2}$ of a car. The number of cars must be a whole number.
- 2. Choice D, 25, is *not* a reasonable answer since the number of hours a light bulb is on during a day cannot be more than 24.
- **3.** Choice A, -10, is *not* a reasonable answer since distance cannot be negative.
- **4.** Choice C, -5, is *not* a reasonable answer since time cannot be negative.
- 5. Step 2 Let x = the number. Step 3 The sum of a number and 9 -26.is \downarrow \downarrow \downarrow \downarrow 9 = -26 *x* + Step 4 Solve the equation. x + 9 = -26x = -35Step 5 The number is -35. Step 6 The sum of -35 and 9 is -26. **6.** *Step 2* Let x = the number. Step 3 The difference of a number and 11 -31. is \downarrow \downarrow \downarrow x - 11= -31 Step 4 Solve the equation. x - 11 = -31x = -20Step 5 The number is -20. Step 6 Check that -20 is the correct answer by substituting this result into the words of the original problem. The difference of -20 and 11

is -31.

7.	Step 2					
	Let $x = $ the	numbe	er.			
	Step 3					
The pro	oduct	and a	number			
of a	8,	increas	ed by 6,	is		104.
\downarrow			\downarrow	\downarrow		\downarrow
8.		(<i>x</i>	+6)	=		104
	Step 4		<i>,</i>			
	Solve the e	quation.				
	8(x+6) = 1	04				
	8x + 48 = 1	04				
	8x = 5	56				
	x = 7	7				
	Step 5					
	The number	r is 7.				
	Step 6	- · · · 1				
	Check that	/ 1s the	correct a	nswer b	y Is of	tha
	original pro	blem. 7	increase	d by 6 i	s 13.	The
	product of 8	8 and 13	3 is 104, s	so 7 is tl	ne nu	imber.
8	Sten 2					
0.	Let $x = $ the	numbe	er.			
	Step 3					
	The produc	et a	and 3 mor	e than		
	of 5,	1	wice a m	umber,	is	85.
	J		J		1	1
	* 5		(2x+	3)	* _	¥ 85
	Sten 4	•	(0)	_	85
	Solve the e	quation.				
	10x + 15 = 8	85				
	10x = 2	70				
	x = x	7				
	Step 5					
	The numbe	r is 7.				
	Step 6 Chaole that	7 is the	correct o	nowor h	• 7	
	substituting	this res	sult into f	he word	y Is of	the
	original pro	blem. I	f the num	ber is 7	, the	n twice
	the number	is 14, a	nd 3 mor	e than t	wice	the
	number is 1	7. The	product o	of 5 and	17 is	s 85, so
	7 is the num	nber.				
9.	Step 2					
	Let $x = $ the	unkno	wn numb	er. The	1 5 <i>x</i>	+2
	represents '	'2 is add	led to fiv	e times	a nu	mber,"
	and $4x+5$	represe	nts "5 mc	ore than	tour	times
	the number	•				
	Step 5 5x+2-4x	+ 5				
	JA F 4 - 4X					

Step 4 Solve the equation. 5x + 2 = 4x + 5x + 2 = 5x = 3Step 5 The number is 3. Step 6 Check that 3 is the correct answer by substituting this result into the words of the original problem. Two added to five times a number is 2 + 5(3) = 17 and 5 more than four times the number is 5 + 4(3) = 17. The values are equal, so the number 3 is the correct answer.

10. *Step 2*

Let x = the unknown number. Then 8 + 4xrepresents "four times a number added to 8," and 5+3x represents "three times the number, added to 5." Step 3 8 + 4x = 5 + 3xStep 4 Solve the equation. 8 + 4x = 5 + 3x8 + x = 5x = -3Step 5 The number is -3. Step 6 Check that -3 is the correct answer by substituting this result into the words of the original problem. Four times a number is added to 8 is 8+4(-3) = -4 and three times the number added to 5 is 5+3(-3) = -4. The values are equal, so the number -3 is the correct answer.

11. *Step 2*

Let x = the unknown number. Then x-2 is two subtracted from the number, 3(x-2) is triple the difference, and x+6 is six more than the number. *Step 3* 3(x-2) = x+6 Step 4 Solve the equation. 3x-6 = x+62x-6 = 62x = 12x = 6Step 5 The number is 6. Step 6 Check that 6 is the correct answer by substituting this result into the words of the original problem. Two subtracted from the number is 6-2 = 4. Triple this difference is 3(4) = 12, which is equal to 6 more than the number, since 6+6=12.

12. *Step 2*

Let x = the unknown number. Then x + 3 is 3 is added to a number, 2(x+3) is this sum is doubled, and x + 2 is 2 more than the number. Step 3 2(x+3) = x+2Step 4 Solve the equation. 2x + 6 = x + 2x + 6 = 2x = -4Step 5 The number is -4. Step 6 Check that -4 is the correct answer by substituting this result into the words of the original problem. Three added to the number is -1, double this value is -2. Two more than -4 is also -2, so the number is -4.

13. Step 2

Let x = the unknown number. Then $\frac{3}{4}x$ is $\frac{3}{4}$ of the number, and $\frac{3}{4}x + 6$ is 6 added to $\frac{3}{4}$ of the number. x - 4 is 4 less than the number. Step 3 $\frac{3}{4}x + 6 = x - 4$

Step 4 Solve the equation.

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

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

$$-\frac{1}{4}x = -10$$

$$-4\left(-\frac{1}{4}x\right) = -4(-10)$$

$$x = 40$$

Step 5 The number is 40. Step 6 Check that 40 is the correct answer by substituting this result into the words of the original problem. $\frac{3}{4}$ of 40 is 30. When 6 is added to 30, the sum is 36, which is 4 less than

40 because 6 is added to 30.

14. *Step 2*

Let x = the unknown number. Then $\frac{2}{3}x$ is $\frac{2}{3}$ of the number, and $10 + \frac{2}{3}x$ is $\frac{2}{3}$ of the

number added to 10. x + 5 is 5 more than the number.

Step 3
$$2$$

 $10 + \frac{2}{3}x = x + 5$ Step 4

Solve the equation.

$$10 + \frac{2}{3}x = x + 5$$

$$10 - \frac{1}{3}x = 5$$

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

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

$$x = 15$$

Step 5
The number is 15.
Step 6
Check that 15 is the correct answer by
substituting this result into the words of the

original problem. $\frac{2}{3}$ of 15 is 10. When 10 is added to 10, the sum is 20, which is 5 more

than 15 because 5 is added to 10.

15. Step 2

Let x = the unknown number. Then 3x is three times the number, x + 7 is 7 more than the number, 2x is twice the number, and -11-2xis the difference between -11 and twice the number. Step 3 3x + (x+7) = -11 - 2xStep 4 Solve the equation. 4x + 7 = -11 - 2x6x + 7 = -116x = -18x = -3Step 5 The number is -3. Step 6 Check that -3 is the correct answer by substituting this result into the words of the original problem. The sum of three times a number and 7 more than the number is 3(-3) + (-3+7) = -5 and the difference between -11 and twice the number is -11-2(-3) = -5. The values are equal, so the number -3 is the correct answer.

16. Step 2

Let x = the unknown number. Then 2x + 4 is 4 is added to twice the number, 2(2x+4) is the sum multiplied by 2, and 3x + 4 is the number is multiplied by 3 and 4 is added to the product. Step 3 2(2x+4) = 3x+4Step 4 Solve the equation. 4x + 8 = 3x + 4x + 8 = 4x = -4Step 5 The number is -4. Step 6 Check that -4 is the correct answer by substituting this result into the words of the original problem. Twice the number is 2(-4) = -8. Four added to twice the number is -8+4 = -4. This sum multiplied by 2 is 2(-4) = -8. The number multiplied by 3 is 3(-4) = -12. Four added to this product is -12 + 4 = -8. Because both results are -8, the answer, -4, checks.

17. Step	Step 1					
We n	nust fi	nd the number of	of Democr	ats and the		
numb	ber of	Republicans.				
Step 2	2					
Let x	c = the	number of Rep	publicans.			
Then	x-4	= the number of	of Democr	ats.		
Step.	Step 3					
Number of	per of number of total					
Democrats	+ Republicans		equals	members.		
\downarrow	\downarrow \downarrow		\downarrow	\downarrow		
(x-4) + <u>x</u>		<u>x</u>	=	<u>150</u>		

Step 4
Solve the equation.
$$(x-4)+x=150$$

 $2x-4=150$
 $2x=154$
 $x=77$

Step 5 There were 77 Republicans and 77 - 4 = 73Democrats. Step 6 Check that the numbers found are the correct answers by substituting the result into the

words of the original problem. 73 is 4 fewer than 77, and 77 + 73 = 150.

18. Step 1

We must find the two consecutive <u>integers</u>. *Step 2*

Let x = the lesser of the two <u>consecutive</u> even integers.

Then $\underline{x+2}$ = the greater of the two consecutive even integers.

Step 3

The lesser		the greater		
consecutive		consecutive		the
even integer	+	even integer	is	total.
\downarrow	\downarrow	\downarrow	\downarrow	
x	+	<i>x</i> +2	=	254

Step 4 Solve the equation. x + (x + 2) = 2542x + 2 = 2542x = 252x = 126Step 5 The lesser even integer is 126, and the greater even integer is 126 + 2 = 128. Step 6 Check that the numbers found are the correct answers by substituting the result into the words of the original problem. 126 and 128 are consecutive even integers, and 126 + 128 = 254. **19.** Let x = the number of drive-in movie screens in Ohio. Then x + 2 = the number of drive-in movie screens in New York. Since the total number of screens was 56, we can write the equation x + (x + 2) = 56. Solve the equation. 2x + 2 = 562x = 54x = 27Since x = 27, x + 2 = 29.

There were 27 drive-in movie screens in Ohio and 29 in New York. Since 29 is 2 more than 27 and 27 + 29 = 56, this answer checks.

20. Let x = the number of *Cheers* viewers. Then x + 8 = the number of M * A * S * Hviewers.

newers.

Since the total number of viewers is 92 (all numbers in millions), we can write the equation x + (x+8) = 92.

Solve the equation. 2x + 8 = 92

$$2x + 8 - 92$$

 $2x = 84$
 $x = 42$
Since $x = 42, x + 8 = 50$.

There were 42 million *Cheers* viewers and 50 million M*A*S*H viewers. Since 42+50=92, this answer checks.

21. Let x = the number of Republicans. Then x + 6 = the number of Democrats. Since the total number of Democrats and Republicans was 98, we can write the equation x + (x + 6) = 98.

Solve the equation. 2x + 6 = 98

$$2x = 92$$

x = 46

Since x = 46, x + 6 = 52.

There were 46 Republicans and 52 Democrats. Since 46 + 52 = 98, this answer checks.

- **22.** Let x = the number of Democrats.
 - Then x + 32 = the number of Republicans. Since the total number of Democrats and Republicans was 432, we can write the equation x + (x + 32) = 432. Solve the equation. 2x + 32 = 4322x = 400x = 200Since x = 200, x + 32 = 232.

There were 200 Democrats and 232 Republicans. Since 200 + 232 = 432, this answer checks.

23. Let x = revenue from ticket sales for Madonna. Then x - 29 = the revenue from the ticket sales for Bruce Springsteen. Since the total revenue from ticket sales was

\$427 (all numbers in millions), we can write the equation x + (x - 29) = 427.

Solve the equation.

$$2x - 29 = 427$$

 $2x = 456$
 $x = 228$
Since $x = 228, x - 29 = 199$.

Madonna took in \$228 million and Bruce Springsteen took in \$199 million. Since 199 is 29 less than 228 and 228 + 199 = 427, this answer checks.

24. Let x = the number of Toyota Camry sales. Then x - 27 = the number of Honda Accord sales. Since the total number of sales was 691 (all numbers in thousands), we can write the equation x + (x - 27) = 691. Solve the equation. 2x - 27 = 6912x = 718x = 359Since x = 359, x - 27 = 332. There were 359 thousand Toyota Camry sales and 332 thousand Honda Accord sales. Since

332 is 27 less than 359 and 359 + 332 = 691, this answer checks.

25. Let x = the number of games the Heat lost. Then 4x + 2 = the number of games the Heat won. Since the total number of games played was 82, we can write the equation x + (4x + 2) = 82. Solve the equation. 5x + 2 = 82

$$5x = 80$$

 $x = 16$
Since $x = 16, 4x + 2 = 66$.

The Heat won 66 games and lost 16 games. Since 66+16=82, this answer checks.

- **26.** Let x = the number of games the Indians lost. Then 2x - 48 = the number of games the Indians won. Since the total number of games played was 162, we can write the equation x + (2x - 48) = 162.Solve the equation. 3x - 48 = 1623x = 210x = 70Since x = 70, 2x - 48 = 92. The Indians won 92 games and lost 70 games.
 - Since 92 + 70 = 162, this answer checks.

27. Let x = the number of mg of vitamin C in a one-cup serving of pineapple juice. Then 4x-3 = the number of mg of vitamin C in a one-cup serving of orange juice. Since the total amount of vitamin C in a serving of the two juices is 122 mg, we can write x + (4x-3) = 122. Solve the equation. 5x-3 = 1225x = 125x = 25Since x = 25, 4x-3 = 97.

A one-cup serving of pineapple juice has 25 mg of vitamin C and a one-cup serving of orange juice has 97 mg of vitamin C. Since 97 is 3 less than four times 25 and 25+97 = 122, this answer checks.

28. Let *x* = the number of calories in a one-cup serving of tomato juice.

Then 3x + 9 = the number of calories in a onecup serving of pineapple juice.

Since the total number of calories in a serving of the two juices is 173, we can write

$$x + (3x + 9) = 173.$$

Solve the equation.
$$4x + 9 = 173$$
$$4x = 164$$
$$x = 41$$

Since x = 41, 3x + 9 = 132.

A one-cup serving of tomato juice has 41 calories and a one-cup serving of pineapple juice has 132 calories. Since 132 is 9 more than three times 41 and 41+132=173, this answer checks.

29. Let x = the number of Blu-Ray discs sold.

Then
$$\frac{2}{3}x$$
 = the number of DVDs sold.

The total number of Blu-Rays and DVDs sold

was 280, so
$$x + \frac{2}{3}x = 280$$
.

Solve the equation.

$$1x + \frac{2}{3}x = 280$$

$$\frac{5}{3}x = 280$$

$$\frac{3}{5}\left(\frac{5}{3}x\right) = \frac{3}{5}(280)$$

$$x = \frac{3}{5} \cdot \frac{280}{1} = 168$$

Since $x = 168, \frac{2}{3}x = \frac{2}{3}(168) = 112$.
There were 112 DVDs sold.

30. Let x = the number of calories burned doing aerobics. Then $\frac{2}{5}x =$ the number of calories burned doing weight training. The total number of calories burned was 371, so $x + \frac{2}{5}x = 371$. Solve the equation. $1x + \frac{2}{5}x = 371$

$$\frac{7}{5}x = 371$$

$$\frac{5}{7}\left(\frac{7}{5}x\right) = \frac{5}{7}(371)$$

$$x = \frac{5}{7} \cdot \frac{371}{1} = 265$$
Since $x = 265, \frac{2}{5}x = \frac{2}{5}(265) = 106$.

Weight training burns 106 calories.

31. Let x = the number of kg of onions. Then 6.6x = the number of kg of grilled steak. The total weight of these two ingredients was 617.6 kg, so x + 6.6x = 617.6. Solve the equation. 1x + 6.6x = 617.6 7.6x = 617.6 $x = \frac{617.6}{7.6} \approx 81.3$

Since
$$x = \frac{617.6}{7.6}$$
, $6.6x = 6.6 \left(\frac{617.6}{7.6}\right) \approx 536.3$.

To the nearest tenth of a kilogram, 81.3 kg of onions and 536.3 kg of grilled steak were used to make the taco.

32. Let x = the population of China.

Then 0.9x = the population of India. The combined population of the two countries was 2.5 billion, so x + 0.9x = 2.5. Solve the equation. 1x + 0.9x = 2.51.9x = 2.5 $x = \frac{2.5}{1.9} = \frac{25}{19}$ Since $x = \frac{25}{19} \approx 1.3, 0.9x = 0.9\left(\frac{25}{19}\right) = \frac{45}{38} \approx 1.2$.

To the nearest tenth of a billion, the population of China was 1.3 billion and the population of India was 1.2 billion.

33. Let x = the value of the 1945 nickel.

Then 2x = the value of the 1950 nickel. The total value of the two coins is \$24.00, so x + 2x = 24. Solve the equation. 3x = 24

x = 8 Divide by 8.

Since x = 8, 2x = 2(8) = 16.

The value of the 1945 Philadelphia nickel is \$8.00 and the value of the 1950 Denver nickel is \$16.00.

34. Let x = the number of pounds of nickel. Then 3x = the number of pounds of copper. The total number of pounds would be 560, so x + 3x = 560. Solve the equation. 4x = 560

$$x = \frac{560}{4} = 140$$

Since x = 140, 3x = 3(140) = 420. To make 560 pounds of five-cent coins, use 420 pounds of copper.

35. Let x = the number of ounces of rye flour. Then 4x = the number of ounces of whole-wheat flour. The total number of ounces would be 32, so x + 4x = 32. Solve the equation. 5x = 32 $x = \frac{32}{5} = 6.4$

Since x = 6.4, 4x = 4(6.4) = 25.6. To make a loaf of bread weighing 32 oz, use 6.4 oz of rye flour and 25.6 oz of whole-wheat flour.

36. Let x = the number of milligrams of inert ingredients.

Then 9x = the number of milligrams of active ingredients.

The total number of milligrams would be 250, so x + 9x = 250.

Solve the equation.

$$10x = 250$$

$$x = \frac{250}{10} = 25$$

Since x = 25, 9x = 9(25) = 225. In a single 250-mg caplet, there would be 25 mg of inert ingredients and 225 mg of active ingredients.

37. Let *x* = the number of tickets booked on United Airlines.

Then x+7 = the number of tickets booked on American Airlines, and 2x+4 = the number of tickets booked on Southwest Airlines. The total number of tickets booked was 55, so x+(x+7)+(2x+4) = 55. Solve the equation. 4x+11 = 554x = 44

$$x = \frac{44}{4} = 11$$

Since x = 11, x + 7 = 11 + 7 = 18 and 2x + 4 = 2(11) + 4 = 26. He booked 18 tickets on American, 11 tickets on United, and 26 tickets on Southwest. **38.** Let x = the number of hours making telephone calls.

Then x+0.5 = the number of hours writing emails, and 2x = the number of hours attending meetings. The total number of hours is 7.5, so x+(x+0.5)+2x = 7.5. Solve the equation. 4x+0.5 = 7.54x = 7

$$x = \frac{7}{4} = 1.75$$

Since x = 1.75, x + 0.5 = 1.75 + 0.5 = 2.25 and 2x = 2(1.75) = 3.5. In her 7.5 hour-day, she spent 1.75 hours making telephone calls, 2.25 hours writing e-mails, and 3.5 hours attending meetings.

39. Let x = the length of the shortest piece.

Then x+5 = the length of the middle piece, and x+9 = the length of the longest piece. The total length is 59 inches, so x+(x+5)+(x+9) = 59. Solve the equation. 3x+14 = 593x = 45x = 15Since x = 15, x+5 = 20 and x+9 = 24. The shortest piece should be 15 inches, the middle piece should be 20 inches, and the longest piece should be 24 inches. The answer

longest piece should be 24 inches. The answer checks since 15 + 20 + 24 = 59.

40. Let x = the length of the shortest piece.

Then 2x = the length of the middle piece, and x+8 = the length of the longest piece. The total length is 3 feet, or 36 inches, so x + (2x) + (x+8) = 36. Solve the equation. 4x+8 = 36 4x = 28 x = 7Since x = 7, 2x = 14 and x + 8 = 15.

The shortest piece should be 7 inches, the middle piece should be 14 inches, and the longest piece should be 15 inches. The answer checks since 7+14+15 = 36.

41. Let x = the number of silver medals. Then x = the number of bronze medals, and x+17 = the number of gold medals. The total number of medals earned by the United States was 104, so x+x+(x+17) = 104. Solve the equation. 3x+17 = 104 3x = 87 x = 29Since x = 29, x+17 = 46. The United States earned 46 gold medals, 29 silver medals, and 29 bronze medals. The answer checks since 46+29+29 = 104.

42. Let x = the number of bronze medals. Then x + 4 = the number of silver medals, and x + 15 = the number of gold medals. The total number of medals earned by China was 88, so x + (x + 4) + (x + 15) = 88. Solve the equation. 3x + 19 = 88 3x = 69 x = 23Since x = 23, x + 4 = 27 and x + 15 = 38.

Since x = 23, x + 4 = 27 and x + 15 = 38. China earned 38 gold medals, 27 silver medals, and 23 bronze medals. The answer checks since 23 + 27 + 38 = 88.

43. Let x = the distance of Mercury from the sun. Then x+31.2 = the distance of Venus from the sun, and x+57 = the distance of Earth from the sun.

Since the total of the distances from these three planets is 196.2 (all distances in millions of miles), we can write the equation

x + (x + 31.2) + (x + 57) = 196.2.

Solve the equation. 3x + 88.2 = 196.2 3x = 108 x = 36Mercury is 36 millio

Mercury is 36 million miles from the sun, Venus is 36+31.2 = 67.2 million miles from the sun, and Earth is 36+57 = 93 million miles from the sun. The answer checks since 36+67.2+93 = 196.2. 44. Let x = the number of satellites of Saturn. Then x+5 = the number of satellites of Jupiter, and x-35 = the number of satellites of Uranus. Since the total number of satellites is 156, x+(x+5)+(x-35) = 156. Solve the equation. 3x-30 = 1563x = 186

$$x = \frac{186}{3} = 62$$

Since x = 62, x + 5 = 67 and x - 35 = 27. Uranus has 27 known satellites.

45. Let x = the measure of angles *A* and *B*. Then x+60 = the measure of angle *C*. The sum of the measures of the angles of any triangle is 180° , so x + x + (x+60) = 180. Solve the equation. 3x+60 = 180

> 3x = 120x = 40

Angles A and B have measures of 40 degrees, and angle C has a measure of 40+60=100degrees. The answer checks since 40+40+100=180.

46. Let x = the measure of angles *B* and *C*. Then x+141 = the measure of angle *A*. The sum of the measures of the angles of any triangle is 180° , so (x+141) + x + x = 180. Solve the equation.

3x + 141 = 1803x = 39

x = 13

Since x = 13, x + 141 = 154.

The measure of angle A is 154° ; the measures of angles B and C are both 13° . The answer checks since 154+13+13=180.

47. Let x = the number on the first locker. Then x+1 = the number on the next locker. Since the numbers have a sum of 137, we can write the equation x + (x+1) = 137. Solve the equation. 2x+1=1372x = 136

$$x = \frac{136}{2} = 68$$

Since x = 68, x + 1 = 69. The lockers have numbers 68 and 69. Since 68 + 69 = 137, this answer checks.

48. Let x = the number on the first check. Then x+1 = the number on the second check. Since the sum of the numbers is 357, we can write the equation x + (x+1) = 357. Solve the equation. 2x+1 = 3572x = 356

$$x = \frac{356}{2} = 178$$

Since x = 178, x + 1 = 179.

The checkbook check numbers are 178 and 179. Since 178 + 179 = 357, this answer checks.

49. Because the two pages are back-to-back, they must have page numbers that are consecutive integers.

Let x = the lesser page number. Then x+1 = the greater page number. x + (x+1) = 203

$$2x + 1 = 203$$

 $2x = 202$
 $x = 101$
Since $x = 101, x + 1 = 102$
The area counter on $x = 10$

The page numbers are 101 and 102. This answer checks since the sum is 203.

50. Let x = the first apartment number. Then x+1 = the second apartment number. Since the sum of the numbers is 59, we have x + (x+1) = 59. Solve the equation.

2x+1 = 59 2x = 58 x = 29Since x = 29, x+1 = 30.

The apartment numbers are 29 and 30. Since 29 + 30 = 59, this answer checks.

51. Let x = the lesser even integer.

Then x + 2 = the greater even integer. "The lesser added to three times the greater gives a sum of 46" can be written as x + 3(x + 2) = 46. x + 3x + 6 = 46

4x + 6 = 464x = 40x = 10

Since x = 10, x + 2 = 12.

The integers are 10 and 12. This answer checks since 10+3(12) = 46.

52. Let x = the lesser even integer.

Then x + 2 = the greater even integer. "Six times the lesser added to the greater gives a sum of 86" can be written as 6x + x + 2 = 86. 7x + 2 = 86

7x = 84

$$x = 12$$

Since x = 12, x + 2 = 14.

The integers are 12 and 14. This answer checks since 6 times 12 is 72, plus 14 is 86.

53. Let x = the lesser odd integer.

Then x + 2 = the greater odd integer. "59 more than the lesser is 4 times the greater" can be written as x + 59 = 4(x + 2).

$$x+59 = 4x+8$$

$$59 = 3x+8$$

$$51 = 3x$$

$$17 = x$$

Since $x = 17, x+2 = 19$.

The integers are 17 and 19. This answer checks since 17 + 59 = 76 and $4 \cdot 19 = 76$.

54. Let x = the lesser odd integer.

Then x + 2 = the greater odd integer. "Twice the greater is 17 more than the lesser" can be written as 2(x+2) = x+17.

$$2x + 4 = x + 17$$

$$x + 4 = 17$$

x = 13.

Since x = 13, x + 2 = 15.

The integers are 13 and 15. This answer checks since 2(15) = 13 + 17.

55. Let x = the lesser integer. Then x+1 = the greater integer.

> x+3(x+1) = 43 x+3x+3 = 43 4x+3 = 43 4x = 40 x = 10Since x = 10, x+1 = 11. The integers are 10 and 11. This answer checks since 10+3(11) = 43.

56. Let x = the lesser integer.

Then x+1 = the greater integer. 5x+3(x+1) = 59 5x+3x+3 = 59 8x+3 = 59 8x = 56 x = 7Since x = 7, x+1 = 8. The integers are 7 and 8. This answer checks since 5(7)+3(8) = 35+24 = 59.

57. Let x = the first even integer. Then x + 2 = the second even integer, and x + 4 = the third even integer. x + (x + 2) + (x + 4) = 60 3x + 6 = 60 3x = 54x = 18

> Since x = 18, x + 2 = 20 and x + 4 = 22. The first even integer is 18. This answer checks since 18 + 20 + 22 = 60.

58. Let x = the first odd integer. Then x + 2 = the second odd integer, and x + 4 = the third odd integer. x + (x + 2) + (x + 4) = 69 3x + 6 = 69 3x = 63 x = 21Since x = 21, x + 2 = 23 and x + 4 = 25. The third odd integer is 25. This answer checks since 21 + 23 + 25 = 69. **59.** Let x = the first odd integer. Then x + 2 = the second odd integer, and x + 4 = the third odd integer. 2[(x+4)-6] = [x+2(x+2)]-23 2(x-2) = x + 2x + 4 - 23 2x - 4 = 3x - 19 -4 = x - 19 15 = xSince x = 15, x + 2 = 17 and x + 4 = 19. The integers are 15, 17, and 19.

60. Let x = the first even integer.

Then x + 2 = the second even integer, and x + 4 = the third even integer. x + (x + 4) = 3(x + 2) - 22 x + x + 4 = 3x + 6 - 22 2x + 4 = 3x - 16 -x + 4 = -16 -x = -20 x = 20Since x = 20, x + 2 = 22 and x + 4 = 24.

The integers are 20, 22, and 24.

61. Let x = the measure of the angle. Then 90 - x = the measure of its complement. The phrase "complement is four times its measure" can be written as 90 - x = 4x. Solve the equation. 90 = 5x

$$x = \frac{90}{5} = 18$$

The measure of the angle is 18° . The complement is $90^\circ - 18^\circ = 72^\circ$, which is four times 18° .

62. Let x = the measure of the angle. Then 90 - x = the measure of its complement. The phrase "complement is five times its measure" can be written as 90 - x = 5x. Solve the equation.

$$90 = 6x$$
$$x = \frac{90}{6} =$$

15

The measure of the angle is 15° . The complement is $90^{\circ}-15^{\circ}=75^{\circ}$, which is five times 15° .

63. Let x = the measure of the angle. Then 180 - x = the measure of its supplement. The phrase "supplement is eight times its measure" can be written as 180 - x = 8x. Solve the equation. 180 = 9x $x = \frac{180}{9} = 20$

9 The measure of the angle is 20°. The supplement is $180^\circ - 20^\circ - 160^\circ$ while the supplement is $180^\circ - 20^\circ - 160^\circ$ while the supplement is $180^\circ - 20^\circ - 160^\circ$.

supplement is $180^\circ - 20^\circ = 160^\circ$, which is eight times 20° .

64. Let x = the measure of the angle. Then 180 - x = the measure of its supplement. The phrase "supplement is three times its measure" can be written as 180 - x = 3x. Solve the equation. 180 = 4x $x = \frac{180}{4} = 45$

The measure of the angle is 45° . The supplement is $180^{\circ} - 45^{\circ} = 135^{\circ}$, which is three times 45° .

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65. Let x = the measure of the angle. Then
      90 - x = the measure of its complement, and
      180 - x = the measure of its supplement.
     Its
                                                 twice its
                                     more
supplement measures 39°
                                              complement.
                                      than
      \downarrow
                     \downarrow
                                \downarrow
                                        \downarrow
                                                     \downarrow
  180 - x
                               39
                                                 2(90-x)
                     =
                                        +
     Solve the equation.
      180 - x = 39 + 2(90 - x)
      180 - x = 39 + 180 - 2x
      180 - x = 219 - 2x
      x + 180 = 219
             x = 39
     The measure of the angle is 39°. The
     complement is 90^{\circ} - 39^{\circ} = 51^{\circ}. Now 39^{\circ} more
     than twice its complement is
      39^{\circ} + 2(51^{\circ}) = 141^{\circ}, which is the supplement
     of 39^{\circ} since 180^{\circ} - 39^{\circ} = 141^{\circ}.
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66.	Let $x = $ the n	neasure of th	e angle.
	Then $180 - x$	= the measu	are of its supplement,
	and $90 - x = 1$	the measure	of its complement.
	The		38° less than 3 times
	supplement	is	its complement.
	\downarrow	\downarrow	\downarrow
	180 - x	=	$3 \cdot (90 - x) - 38$
	Solve the equivalence $180 - x = 27$	ation. $(0-3x-38)$	
	180 - x = 23	2-3x	
	180 + 2x = 23	2	
	2x = 52		
	x = 26 The measure	of the angle	is 26°.

67. Let x = the measure of the angle.

Then 180 - x = the measure of its supplement, and 90 - x = the measure of its complement. Remember that difference means subtraction.

The				
supplement	minus	complement	is	10°.
\downarrow	\downarrow	\downarrow	\downarrow	\downarrow
(180 - x)	_	3(90-x)	=	10

Solve the equation.

$$180 - x) - 3(90 - x) = 10$$

$$180 - x - 270 + 3x = 10$$

$$2x - 90 = 10$$

$$2x = 100$$

$$x = 50$$

The measure of the angle is 50° . The supplement is $180^{\circ} - 50^{\circ} = 130^{\circ}$ and the complement is $90^{\circ} - 50^{\circ} = 40^{\circ}$. The answer checks since $130^{\circ} - 3(40^{\circ}) = 10^{\circ}$.

68. Let x = the measure of the angle. Then 90 - x = the measure of its complement, and 180 - x = the measure of its supplement. "The sum of the measures of its complement and supplement is 160° " can be written as (90 - x) + (180 - x) = 160. Solve the equation. -2x + 270 = 160 -2x = -110x = 55 The measure of the angle is 55° . The sum of the measures of its complement $(90^{\circ} - 55^{\circ} = 35^{\circ})$ and its supplement $(180^{\circ} - 55^{\circ} = 125^{\circ})$ is 160° .

2.5 Formulas and Additional Applications from Geometry

Classroom Examples, Now Try Exercises

- 1. P = 2L + 2W 126 = 2L + 2(25) Let P = 126 and W = 25. 126 = 2L + 50 76 = 2L Subtract 50. 38 = L Divide by 2.
- N1. P = 2a + 2b 78 = 2(12) + 2b Let P = 78 and a = 12. 78 = 24 + 2b 54 = 2b Subtract 24. 27 = b Divide by 2.
 - 2. The fence will enclose the perimeter of the rectangular field, so use the formula for the perimeter of a rectangle. Find the length of the field by substituting P = 800 and W = L 50 into the formula and solving for *L*. P = 2L + 2W

$$800 = 2L + 2(L - 50)$$

 $800 = 2L + 2L - 100$
 $900 = 4L$
 $225 = L$
Since $L = 225, W = 225 - 50 = 175$. The
dimensions of the field are 225 m by 175 m.

N2. The fence will enclose the perimeter of the rectangular garden, so use the formula for the perimeter of a rectangle. Find the width of the garden by substituting P = 160 and L = 2W - 10 into the formula and solving for *W*. P = 2L + 2W 160 = 2(2W - 10) + 2W 160 = 4W - 20 + 2W 180 = 6W 30 = WSince W = 30, L = 2(30) - 10 = 50. The dimensions of the garden are 50 ft by 30 ft.

2.5 Formulas and Additional Applications from Geometry 139

- 3. Let s = the length of the shortest side, in inches; s+5 = the length of the medium side, and (s+5)+1 = s+6 = the length of the longest side. The perimeter is 32 inches, so s+(s+5)+(s+6) = 32. 3s+11 = 323s = 21s = 7Since s = 7, s+5 = 12 and s+6 = 13. The
 - lengths of the sides are 7, 12, and 13 inches. The perimeter is 7+12+13=32, as required.
- N3. Let s = the length of the medium side, in feet; s+1 = the length of the longest side, and s-7 = the length of the shortest side. The perimeter is 30 feet, so s+(s+1)+(s-7) = 30. 3s-6 = 30 3s = 36 s = 12Since s = 12, s+1 = 13 and s-7 = 5. The
 - lengths of the sides are 5, 12, and 13 feet. The perimeter is 5+12+13=30, as required.
 - 4. Use the formula for the area of a triangle.

1

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

$$120 = \frac{1}{2}b(24) \quad \text{Let } A = 120, h = 24.$$

$$120 = 12b$$

$$10 = b$$

The length of the base is 10 meters.

N4. Use the formula for the area of a triangle.

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

$$77 = \frac{1}{2}(14)h$$
 Let $A = 77, h = 14.$

$$77 = 7h$$

$$11 = h$$

The height is 11 centimeters.

5. The sum of the measures of the two angles is 180° because together they form a straight angle. (6x+29)+(x+11) = 1807x+40 = 180

$$7x = 140$$

 $x = 20$
If $x = 20, 6x + 29 = 6(20) + 29 = 149$ and
 $x + 11 = 20 + 11 = 31$.

The measures of the angles are 149° and 31° .

N5. Since the marked angles are vertical angles, they have equal measures.

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

 $2 = 2x-8$
 $10 = 2x$
 $5 = x$
If $x = 5, 6x+2 = 6(5)+2 = 32$ and
 $8x-8 = 8(5)-8 = 32$.
The measure of the angles is 32° .

6. Solve
$$I = prt$$
 for t .

 $\frac{I}{pr} = \frac{prt}{pr}$ Divide by pr. $\frac{I}{pr} = t, \text{ or } t = \frac{I}{pr}$

N6. Solve W = Fd for F. $\frac{W}{d} = \frac{Fd}{d}$ Divide by d. $\frac{W}{d} = F$, or $F = \frac{W}{d}$

7. Solve
$$S = 2\pi rh + 2\pi r^2$$
 for *h*.
 $S - 2\pi r^2 = 2\pi rh$ Subtract $2\pi r^2$.
 $\frac{S - 2\pi r^2}{2\pi r} = h$, Divide by $2\pi r$.
or $h = \frac{S - 2\pi r^2}{2\pi r}$

N7. Solve
$$Ax + By = C$$
 for A.
 $Ax = C - By$ Subtract By.
 $\frac{Ax}{x} = \frac{C - By}{x}$ Divide by x.
 $A = \frac{C - By}{x}$

8. Solve
$$F = \frac{9}{5}C + 32$$
 for C.
 $F - 32 = \frac{9}{5}C + 32 - 32$ Subtract 32.
 $F - 32 = \frac{9}{5}C$
 $\frac{5}{9}(F - 32) = \frac{5}{9}(\frac{9}{5}C)$ Multiply by $\frac{5}{9}$.
 $\frac{5(F - 32)}{9} = C$
 $C = \frac{5(F - 32)}{9}$, or $C = \frac{5F - 160}{9}$

N8. Solve
$$S = \frac{1}{2}(a+b+c)$$
 for *a*.
 $2S = a+b+c$ Multiply by 2.
 $2S-b-c = a$ Subtract *b* and *c*.
9. (a) Solve $-2x + y = 4$ for *y*.

(a) Solve
$$-2x + y = 4$$
 for y.
 $-2x + y + 2x = 4 + 2x$ Add 2x.
 $y = 2x + 4$

(b) Solve
$$x + 3y = 9$$
 for y.
 $x + 3y - x = 9 - x$ Subtract x.
 $y = \frac{9 - x}{3}$ Divide by 3.
 $y = 3 - \frac{1}{3}x$, or $y = -\frac{1}{3}x + 3$

N9. (a) Solve
$$5x + y = 3$$
 for y.
 $5x + y - 5x = 3 - 5x$ Subtract 5x.
 $y = 3 - 5x$

(b) Solve
$$x - 2y = 8$$
 for y.
 $x - 2y - x = 8 - x$ Subtract x.
 $y = \frac{8 - x}{-2}$ Divide by -2.
 $y = -4 + \frac{1}{2}x$, or $y = \frac{1}{2}x - 4$

Exercises

- 1. Carpeting for a bedroom covers the surface of the bedroom floor, so area would be used.
- **2.** Sod for a lawn covers the surface of the lawn, so area would be used.
- **3.** To measure fencing for a yard, use perimeter since you would need to measure the lengths of the sides of the yard.

- **4.** The baseboards for a living room go around the edges of the room. The amount of baseboard needed will be the sum of the lengths of the sides of the room, so perimeter would be used.
- **5.** Tile for a bathroom covers the surface of the bathroom floor, so area would be used.
- **6.** Fertilizer for a garden covers the surface of the garden, so area would be used.
- 7. To determine the cost of replacing a linoleum floor with a wood floor, use area since you need to know the measure of the surface covered by the wood.
- 8. Determining the cost of planting rye grass in a lawn for the winter requires finding the amount of surface to be covered, so area would be used.

9.
$$P = 2L + 2W; L = 8, W = 5$$

 $P = 2L + 2W$
 $= 2(8) + 2(5)$
 $= 16 + 10$
 $P = 26$

10. P = 2L + 2W; L = 6, W = 4 P = 2L + 2W = 2(6) + 2(4) = 12 + 8 P = 20**11.** $A = \frac{1}{2}bh$; b = 8, h = 16

$$A = \frac{1}{2}bh$$
$$A = \frac{1}{2}bh$$
$$= \frac{1}{2}(8)(16)$$
$$A = 64$$

12.
$$A = \frac{1}{2}bh; b = 10, h = 14$$

 $A = \frac{1}{2}bh$
 $= \frac{1}{2}(10)(14)$
 $= (5)(14)$

A = 70

13.
$$P = a + b + c$$
; $P = 12$, $a = 3$, $c = 5$
 $P = a + b + c$
 $12 = 3 + b + 5$
 $12 = b + 8$
 $4 = b$

14.
$$P = a + b + c$$
; $P = 15$, $a = 3$, $b = 7$
 $P = a + b + c$
 $15 = 3 + 7 + c$
 $15 = 10 + c$
 $5 = c$

15. d = rt; d = 252, r = 45d = rt252 = 45t $\frac{252}{45} = \frac{45t}{45}$ 5.6 = t

16.
$$d = rt; d = 100, t = 2.5$$

 $d = rt$
 $100 = r(2.5)$
 $100 = 2.5r$
 $\frac{100}{2.5} = \frac{2.5r}{2.5}$

40 = r

17.
$$A = \frac{1}{2}h(b+B); A = 91, h = 7, b = 12$$

 $A = \frac{1}{2}h(b+B)$
 $91 = \frac{1}{2}(7)(12+B)$
 $182 = (7)(12+B)$
 $12+B = \frac{1}{7}(182)$
 $B = 26-12 = 14$
18. $A = \frac{1}{2}h(b+B) = A = 75, b = 10, B = 2$

18.
$$A = \frac{1}{2}h(b+B); A = 75, b = 19, B = 31$$

 $A = \frac{1}{2}h(b+B)$
 $75 = \frac{1}{2}h(19+31)$
 $150 = h(50)$
 $h = \frac{150}{50} = 3$
19. $C = 2\pi r; C = 16.328, \pi = 3.14$

 $C = 2\pi r$ 16.328 = 2(3.14)r16.328 = 6.28r2.6 = r

20.
$$C = 2\pi r$$
; $C = 8.164$, $\pi = 3.14$
 $C = 2\pi r$
 $8.164 = 2(3.14)r$
 $8.164 = 6.28r$
 $1.3 = r$
21. $C = 2\pi r$; $C = 20\pi$
 $C = 2\pi r$
 $10 = r$ Divide by 2π .
22. $C = 2\pi r$; $C = 100\pi$
 $C = 2\pi r$
 $100\pi = 2\pi r$
 $50 = r$ Divide by 2π .
23. $A = \pi r^2$; $r = 4$, $\pi = 3.14$
 $A = \pi r^2$
 $= 3.14(16)$
 $A = 50.24$
24. $A = \pi r^2$; $r = 12$, $\pi = 3.14$
 $A = \pi r^2$
 $= 3.14(12)^2$
 $= 3.14(12)^2$
 $= 3.14(12)^2$
 $= 3.14(144)$
 $A = 452.16$
25. $S = 2\pi rh$; $S = 120\pi$, $h = 10$
 $S = 2\pi rh$
 $120\pi = 2\pi r (10)$
 $120\pi = 2\pi r (10)$
 $120\pi = 2\pi r (30)$
 $720\pi = 60\pi r$
 $12 = r$ Divide by 20π .
27. $V = LWH$; $L = 10$, $W = 5$, $H = 3$
 $V = LWH$
 $= (10)(5)(3)$

$$V = 150$$

28.
$$V = LWH$$
; $L = 12$, $W = 8$, $H = 4$
 $V = LWH$
 $= (12)(8)(4)$
 $V = 384$
29. $V = \frac{1}{3}Bh$; $B = 12$, $h = 13$
 $V = \frac{1}{3}Bh$
 $= \frac{1}{3}(12)(13)$
 $V = 52$
30. $V = \frac{1}{3}Bh$; $B = 36$, $h = 4$
 $V = \frac{1}{3}Bh$
 $= \frac{1}{3}(36)(4)$
 $V = 48$
31. $V = \frac{4}{3}\pi r^3$; $r = 12$, $\pi = 3.14$
 $V = \frac{4}{3}\pi r^3$
 $= \frac{4}{3}(3.14)(12)^3$
 $= \frac{4}{3}(3.14)(1728)$
 $V = 7234.56$
32. $V = \frac{4}{3}\pi r^3$; $r = 6$, $\pi = 3.14$
 $V = \frac{4}{3}\pi r^3$
 $= \frac{4}{3}(3.14)(6)^3$
 $= \frac{4}{3}(3.14)(216)$
 $V = 904.32$
33. $I = prt$; $p = \$7500$, $r = 4\%$, $t = 2$ yr
 $I = prt$
 $= (\$7500)(0.04)(2)$
 $= \$600$
34. $I = prt$; $p = \$3600$, $r = 3\%$, $t = 4$ yr
 $I = prt$
 $= (\$3600)(0.03)(4)$
 $= \$432$

35.
$$I = prt; I = \$33, r = 2\%, t = 3$$
 yr
 $I = prt$
 $\$33 = p(0.02)(3)$
 $\$33 = (p)(0.06)$
 $\$550 = p$
36. $I = prt; I = \$270, r = 5\%, t = 6$ yr
 $I = prt$
 $\$270 = (p)(0.05)(6)$
 $\$270 = (p)(0.3)$
 $\$900 = p$
37. $I = prt; I = \$180, p = \$4800, r = 2.5\%$
 $I = prt$
 $\$180 = (\$4800)(0.025)(t)$
 $\$180 = (\$120)(t)$
 1.5 yr = t
38. $I = prt; I = \$162, p = \$2400, r = 1.5\%$
 $I = prt$
 $\$162 = (\$2400)(0.015)(t)$
 $\$162 = (\$2400)(0.015)(t)$
 $\$162 = (\$36)(t)$
 4.5 yr = t
39. $P = 2L + 2W$
 $54 = 2(W + 9) + 2W$ Let $L = W + 9$.
 $54 = 2W + 18 + 2W$
 $54 = 4W + 18$
 $36 = 4W$
 $9 = W$
The width is 9 inches and the length is
 $9 + 9 = 18$ inches.
40. $P = 2L + 2W$
 $62 = 2L + 2(L - 3)$ Let $W = L - 3$.
 $62 = 2L + 2L - 6$
 $62 = 4L - 6$
 $68 = 4L$
 $17 = L$
The length is 17 feet and the width is
 $17 - 3 = 14$ feet.

41. P = 2L + 2W 36 = 2(3W + 2) + 2W Let L = 3W + 2. 36 = 6W + 4 + 2W 36 = 8W + 4 32 = 8W 4 = WThe width is 4 meters and the length is 3(4) + 2 = 14 meters. 42. P = 2L + 2W36 = 2L + 2(2L - 18) Let W = 2L - 18.

36 = 2L + 4L - 36 36 = 6L - 36 72 = 6L 12 = LThe length is 12 yards and the width is 2(12) - 18 = 6 yards.

43. Let s = the length of the shortest side, in inches; s + 2 = the length of the medium side, and s + 3 = the length of the longest side. The perimeter is 20 inches, so s + (s + 2) + (s + 3) = 20. 3s + 5 = 20

$$3s = 15$$
$$s = 5$$

Since s = 5, s + 2 = 7 and s + 3 = 8. The lengths of the sides are 5, 7, and 8 inches. The perimeter is 5+7+8=20, as required.

44. Let s = the length of the shortest side, in feet. s + 4 = the length of the medium side, and 2s = the length of the longest side. The perimeter is 28 feet, so s + (s + 4) + (2s) = 28. 4s + 4 = 28 4s = 24s = 6

Since s = 6, s + 4 = 10 and 2s = 12. The lengths of the sides are 6, 10, and 12 feet. The perimeter is 6+10+12=28, as required.

- **45.** Let *s* = the length of the two sides that have equal length, in meters, and 2s - 4 = the length of the third side. The perimeter is 24 meters, so s + s + (2s - 4) = 24. 4s - 4 = 244s = 28s = 7
 - Since s = 7, 2s 4 = 10. The lengths of the sides are 7, 7, and 10 meters. The perimeter is 7+7+10=24, as required.
- **46.** Let s = the length of the shortest side, in yards; 2s = the length of the medium side, and 3s - 7 = the length of the longest side. The perimeter is 47 yards, so s + 2s + (3s - 7) = 47. 6s - 7 = 47

$$6s = 54$$

$$s = 9$$

Since s = 9, 2s = 18 and 3s - 7 = 20. The lengths of the sides are 9, 18, and 20 yards. The perimeter is 9+18+20=47, as required.

47. The page is a rectangle with length 1.5 m and width 1.2 m, so use the formulas for the perimeter and area of a rectangle. P = 2L + 2W

$$= 2(1.5) + 2(1.2)$$

$$=3+2.4$$

P = 5.4 meters

$$A = LW$$

$$=(1.5)(1.2)$$

- A = 1.8 square meters
- **48.** Since the sand painting is a square with side 12.24 m, use the formulas for the perimeter and area of a square. P = 4s

$$= 43$$

= 4(12.24)

$$P = 48.96$$
 meters

$$A = s^2$$

$$=(12.24)^{2}$$

A = 149.8176 square meters

To the nearest hundredth of a square meter, the area is 149.82 square meters.

49. Use the formula for the area of a triangle with A = 70 and b = 14.

$$A = \frac{1}{2}bh$$
$$70 = \frac{1}{2}(14)h$$
$$70 = 7h$$

$$10 = h$$

The height of the sign is 10 feet.

50. Use the formula for the area of a triangle with A = 96 and h = 12.

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

$$96 = \frac{1}{2}b(12)$$

$$96 = 6b$$

$$16 = b$$

The base of the banner is 16 feet.

51. The diameter of the circle is 443 feet, so its radius is $\frac{443}{2} = 221.5$ ft. Use the area of a

2 circle formula to find the enclosed area.

$$A = \pi r^2$$

$$=\pi(221.5)^2$$

$$\approx 154,133.6 \text{ ft}^2$$
,

or about 154,000 ft². (If 3.14 is used for π , the value is 154,055.465.)

52. The diameter of the circular dome is 630 feet,

so its radius is $\frac{630}{2} = 315$ ft. Use the circumference of a circle formula. $C = 2\pi r$

- $=2\pi(315)$
- ≈1979.2 ft

If we use 3.14 for π , the answer is 1978.2 ft, or about 1978 ft.

53. To find the area of the drum face, use the formula for the area of a circle, $A = \pi r^2$.

$$A = \pi r^{2}$$

 $\approx (3.14)(7.87)^{2}$
 $= (3.14)(61.9369)$
 $A \approx 194.48$
The area of the drum face is about
194.48 square feet.

Use the circumference of a circle formula. $C \approx 2(3.14)(7.87)$ = 49.4236 The circumference is about 49.42 feet.

54. To find the area of the drum face, use the

formula for the area of a circle,
$$A = \pi r^2$$
.
 $A = \pi r^2$

$$\approx (3.14)(6.5)^2$$

= (3.14)(42.25)

A = 132.665

The area of the drum face is about

132.665 square feet.

Use the circumference of a circle formula.

 $C = 2\pi r$

 $= 2\pi(6.5)$

≈ 40.84 ft

If we use 3.14 for π , the answer is about 40.82 feet.

55. Use the formula for the area of a trapezoid with B = 115.80, b = 171.00, and h = 165.97.

$$A = \frac{1}{2}(B+b)h$$

= $\frac{1}{2}(115.80+171.00)(165.97)$
= $\frac{1}{2}(286.80)(165.97)$
= 23,800.098

To the nearest hundredth of a square foot, the combined area of the two lots is 23,800.10 square feet.

56. Let A = the area of Lot A. Use the formula for the area of a trapezoid with B = 82.05, b = 26.84, and h = 165.97.

$$A = \frac{1}{2}(B+b)h$$

= $\frac{1}{2}(82.05+26.84)(165.97)$
= 9036.23665

To the nearest hundredth of a square foot, the area is 9036.24 square feet.

57. The girth is $4 \cdot 18 = 72$ inches. Since the length plus the girth is 108, we have L+G = 108 L+72 = 108L = 36 in.

2.5 Formulas and Additional Applications from Geometry 145

The volume of the box is V = LWH $\alpha \alpha \alpha \alpha \alpha$

$$=(36)(18)(18)$$

$$= 11,664 \text{ in.}^3$$

58. To find the volume of the sandwich, use the formula for the volume of a rectangular solid. V = LWH

$$= (12)(12) \left(1\frac{11}{24} \right)$$
$$= \frac{\frac{6}{12}}{1} \cdot \frac{\frac{1}{12}}{1} \cdot \frac{\frac{35}{24}}{\frac{2}{12}} \cdot \frac{35}{\frac{24}{12}}$$

The volume of the sandwich was 210 cubic feet.

59. The two angles are supplementary, so the sum of their measures is 180°.

$$(x+1) + (4x-56) = 180$$

$$5x-55 = 180$$

$$5x = 235$$

$$x = 47$$

Since $x = 47, x+1 = 47+1 = 48$ and

$$4x-56 = 4(47) - 56 = 132.$$

The measures of the angles are 48° and 132° .

60. In the figure, the two angles are supplementary, so their sum is 180°. (10x+7) + (7x+3) = 180

17x + 10 = 18017x = 170x = 10

Since x = 10, 10x + 7 = 10(10) + 7 = 107 and 7x + 3 = 7(10) + 3 = 73.

The two angle measures are 107° and 73° .

61. In the figure, the two angles are complementary, so their sum is 90°. (8x-1) + 5x = 9013x - 1 = 9013x = 91x = 7Since x = 7, 8x - 1 = 8(7) - 1 = 55 and 5x = 5(7) = 35.

The two angle measures are 55° and 35° .

- **62.** In the figure, the two angles are complementary, so their sum is 90°. 4x + (3x + 13) = 907x + 13 = 907x = 77x = 11Since x = 11, 4x = 4(11) = 44 and 3x + 13 = 3(11) + 13 = 46.The two angle measures are 44° and 46° .
- 63. The two angles are vertical angles, which have equal measures. Set their measures equal to each other and solve for *x*. 5x - 129 = 2x - 213x - 129 = -213x = 108x = 36Since x = 36, 5x - 129 = 5(36) - 129 = 51 and

$$2x - 21 = 2(36) - 21 = 51.$$

The measure of each angle is 51°.

- 64. The two angles are vertical angles, which have equal measures. Set their measures equal to each other and solve for *x*. 7x + 5 = 3x + 45
 - 4x + 5 = 454x = 40x = 10The measure of the first angle is $7(10) + 5 = 75^{\circ}$; the measure of the second angle is 3(10) + 45, which is also 75° .
- 65. The angles are vertical angles, so their measures are equal. 12x - 3 = 10x + 15
 - 2x 3 = 152x = 18x = 9Since x = 9, 12x - 3 = 12(9) - 3 = 105 and 10x + 15 = 10(9) + 15 = 105.The measure of each angle is 105°.

66. The angles are vertical angles, which have equal measures. Set 11x - 37 equal to 7x + 27and solve. 11x - 37 = 7x + 274x - 37 = 274x = 64x = 16Since x = 16, 11x - 37 = 11(16) - 37 = 139 and 7x + 27 = 7(16) + 27 = 139.The angles both measure 139°. **67.** Solve d = rt for t. $\frac{d}{r} = \frac{rt}{r}$ Divide by r. $\frac{d}{r} = t$, or $t = \frac{d}{r}$ **68.** Solve d = rt for r. $\frac{d}{t} = \frac{rt}{t}$ Divide by t. $\frac{d}{t} = r$, or $r = \frac{d}{t}$ **69.** Solve A = bh for b. $\frac{A}{h} = \frac{bh}{h}$ Divide by h. $\frac{A}{h} = b$, or $b = \frac{A}{h}$ **70.** Solve A = LW for *L*. $\frac{A}{W} = \frac{LW}{W}$ Divide by W. $\frac{A}{W} = L$, or $L = \frac{A}{W}$ 71. Solve $C = \pi d$ for d. $\frac{C}{\pi} = \frac{\pi d}{\pi}$ Divide by π . $\frac{C}{\pi} = d$, or $d = \frac{C}{\pi}$ 72. Solve P = 4s for s. $\frac{P}{4} = \frac{4s}{4}$ Divide by 4. $\frac{P}{4} = s$, or $s = \frac{P}{4}$ **73.** Solve V = LWH for *H*. $\frac{V}{LW} = \frac{LWH}{LW}$ Divide by LW. $\frac{V}{LW} = H$, or $H = \frac{V}{LW}$

74. Solve
$$V = LWH$$
 for W .

$$\frac{V}{LH} = \frac{LWH}{LH}$$
 Divide by LH .

$$\frac{V}{LH} = W$$
, or $W = \frac{V}{LH}$
75. Solve $I = prt$ for r .

$$\frac{I}{pt} = \frac{prt}{pt}$$
 Divide by pt .

$$\frac{I}{pt} = r$$
, or $r = \frac{I}{pt}$
76. $I = prt$ for p .

$$\frac{I}{rt} = \frac{prt}{rt}$$
 Divide by rt .

$$\frac{I}{rt} = p$$
, or $p = \frac{I}{rt}$
77. Solve $A = \frac{1}{2}bh$ for h .
 $2A = 2\left(\frac{1}{2}bh\right)$ Multiply by 2.
 $2A = bh$
 $\frac{2A}{b} = bh$ Divide by b .
 $\frac{2A}{b} = h$, or $h = \frac{2A}{b}$
78. Solve $A = \frac{1}{2}bh$ for b .
 $2A = 2\left(\frac{1}{2}bh\right)$ Multiply by 2.
 $2A = bh$
 $\frac{2A}{b} = bh$ Divide by h .
 $\frac{2A}{h} = bh$ or $b = \frac{2A}{h}$
79. Solve $V = \frac{1}{3}\pi r^2 h$ for h .
 $3V = 3\left(\frac{1}{3}\right)\pi r^2 h$ Multiply by 3.
 $3V = \pi r^2 h$
 $\frac{3V}{\pi r^2} = h$, or $h = \frac{3V}{\pi r^2}$

- 80. Solve $V = \pi r^2 h$ for h. $\frac{V}{\pi r^2} = \frac{\pi r^2 h}{\pi r^2}$ Divide by πr^2 . $\frac{V}{\pi r^2} = h$, or $h = \frac{V}{\pi r^2}$
- 81. Solve P = a+b+c for b. P-a-c = a+b+c-a-c Subtract a and c. P-a-c = b, or b = P-a-c
- 82. Solve P = a+b+c for a. P-b-c = a+b+c-b-c Subtract b and c. P-b-c = a, or a = P-b-c
- 83. Solve P = 2L + 2W for W. P - 2L = 2L + 2W - 2L Subtract 2L. P - 2L = 2W $\frac{P - 2L}{2} = \frac{2W}{2}$ Divide by 2. $\frac{P - 2L}{2} = W$, or $W = \frac{P - 2L}{2}$
- 84. Solve A = p + prt for r. A - p = p + prt - p Subtract p. A - p = prt $\frac{A - p}{pt} = \frac{prt}{pt}$ Divide by pt. $\frac{A - p}{pt} = r$, or $r = \frac{A - p}{pt}$
- **85.** Solve y = mx + b for *m*.

$$y-b = mx+b-b$$
 Subtract b.

$$y-b = mx$$

$$\frac{y-b}{x} = \frac{mx}{x}$$
 Divide by x.

$$\frac{y-b}{x} = m, \text{ or } m = \frac{y-b}{x}$$

86. Solve y = mx + b for *x*.

$$y-b = mx+b-b$$
 Subtract b.

$$y-b = mx$$

$$\frac{y-b}{m} = \frac{mx}{m}$$
 Divide by m.

$$\frac{y-b}{m} = x, \text{ or } x = \frac{y-b}{m}$$

87. Solve
$$Ax + By = C$$
 for y.
 $By = C - Ax$ Subtract Ax.
 $\frac{By}{B} = \frac{C - Ax}{B}$ Divide by B.
 $y = \frac{C - Ax}{B}$

- **88.** Solve Ax + By = C for x.
 - Ax = C By Subtract By. $\frac{Ax}{A} = \frac{C - By}{A}$ Divide by A. $x = \frac{C - By}{A}$
- **89.** Solve M = C(1+r) for *r*.
 - M = C + Cr Distributive property M - C = Cr Subtract C. $\frac{M - C}{C} = \frac{Cr}{C}$ Divide by C. $\frac{M - C}{C} = r, \text{ or } r = \frac{M - C}{C}$ Alternative solution: M = C(1+r) $\frac{M}{C} = 1 + r$ Divide by C. $\frac{M}{C} - 1 = r$ Subtract 1.
- **90.** Solve A = p(1+rt) for *t*.

$$A = p + prt$$

$$A - p = p + prt - p$$

$$A - p = prt$$

$$\frac{A - p}{pr} = \frac{prt}{pr}$$

$$\frac{A - p}{pr} = t, \text{ or } t = \frac{A - p}{pr}$$

91. Solve P = 2(a+b) for *a*. P = 2a+2b Distributive property P-2b = 2a Subtract 2*b*. $\frac{P-2b}{2} = \frac{2a}{2}$ Divide by 2. $\frac{P-2b}{2} = a$

92. Solve
$$P = 2(a+b)$$
 for b.

$$\frac{P}{2} = \frac{2(a+b)}{2}$$
Divide by 2.

$$\frac{P}{2} = a+b$$

$$\frac{P}{2} - a = b$$
Subtract a.

$$\frac{P}{2} - a = b, \text{ or } b = \frac{P-2a}{2}$$

The second form of the answer results from first using the distributive property, then subtracting 2a, and then dividing by 2—similar to the method used in Exercise 91.

93. Solve
$$S = \frac{1}{2}(a+b+c)$$
 for b.
 $2S = a+b+c$ Multiply by 2.
 $2S-a-c=b$ Subtract a and c.

94. Solve
$$S = \frac{1}{2}(a+b+c)$$
 for *c*.
 $2S = a+b+c$ Multiply by 2.
 $2S-a-b=c$ Subtract *a* and *b*.

95. Solve
$$C = \frac{5}{9}(F - 32)$$
 for *F*.
 $C = \frac{5}{9}(F - 32)$
 $\frac{9}{5}C = \frac{9}{5} \cdot \frac{5}{9}(F - 32)$
 $\frac{9}{5}C = F - 32$
 $\frac{9}{5}C + 32 = F - 32 + 32$
 $\frac{9}{5}C + 32 = F$

96. Solve
$$A = \frac{1}{2}h(b+B)$$
 for b .
 $A = \frac{1}{2}h(b+B)$
 $2A = 2\left(\frac{1}{2}h(b+B)\right)$
 $2A = hb + hB$ Distributive Prop.
 $2A - hB = hb + hB - hB$ Subtract hB .
 $\frac{2A - hB}{h} = \frac{hb}{h}$ Divide by h .
 $\frac{2A - hB}{h} = b$

- **97.** Solve 6x + y = 4 for y. 6x + y - 6x = 4 - 6x Subtract 6x. y = 4 - 6x
- **98.** Solve 3x + y = 6 for y. 3x + y - 3x = 6 - 3x Subtract 3x. y = 6 - 3x

99. Solve
$$5x - y = 2$$
 for y.
 $5x - y - 5x = 2 - 5x$ Subtract 5x.
 $\frac{-y}{2} - \frac{2 - 5x}{5}$ Divide by -1

$$\frac{1}{-1} = \frac{1}{-1}$$
 Divide by -1.
y = -2+5x, or y = 5x-2

100. Solve 4x - y = 1 for *y*.

$$4x - y - 4x = 1 - 4x$$
 Subtract 4x.
$$\frac{-y}{-1} = \frac{1 - 4x}{-1}$$
 Divide by -1.
$$y = -1 + 4x$$
, or $y = 4x - 1$

101. Solve -3x + 5y = -15 for y. -3x + 5y + 3x = -15 + 3x Add 3

$$\frac{5y}{5} = \frac{-15+3x}{5} \quad \text{Add } 3x.$$

$$\frac{5y}{5} = \frac{-15+3x}{5} \quad \text{Divide by 5.}$$

$$y = -3 + \frac{3}{5}x, \quad \text{or} \quad y = \frac{3}{5}x - 3$$

102. Solve
$$-2x + 3y = -9$$
 for y.
 $-2x + 3y + 2x = -9 + 2x$ Add 2x.
 $\frac{3y}{3} = \frac{-9 + 2x}{3}$ Divide by 3.
 $y = -3 + \frac{2}{3}x$, or $y = \frac{2}{3}x - 3$

103. Solve x - 3y = 12 for *y*. x - 3y - x = 12 - x Subtract *x*.

$$\frac{-3y}{-3} = \frac{12 - x}{-3}$$
 Divide by -3.
$$y = -4 + \frac{1}{3}x, \text{ or } y = \frac{1}{3}x - 4$$

104. Solve
$$x - 5y = 10$$
 for y.

$$x-5y-x = 10-x$$
 Subtract x.
 $\frac{-5y}{-5} = \frac{10-x}{-5}$ Divide by -5.
 $y = -2 + \frac{1}{5}x$, or $y = \frac{1}{5}x - 2$

2.6 Ratio, Proportion, and Percent

Classroom Examples, Now Try Exercises

- 1. (a) To find the ratio of 3 days to 2 weeks, first convert 2 weeks to days. 2 weeks = $2 \cdot 7 = 14$ days The ratio of 3 days to 2 weeks is then $\frac{3 \text{ days}}{2 \text{ weeks}} = \frac{3 \text{ days}}{14 \text{ days}} = \frac{3}{14}$.
 - (b) 4 days = $4 \cdot 24 = 96$ hours The ratio of 12 hr to 4 days is then $\frac{12 \text{ hr}}{4 \text{ days}} = \frac{12 \text{ hr}}{96 \text{ hr}} = \frac{12}{96} = \frac{1}{8}.$
- N1. (a) The ratio of 7 inches to 4 inches is $\frac{7 \text{ inches}}{4 \text{ inches}} = \frac{7}{4}.$

(**b**) 45 seconds
$$=\frac{45}{60}=\frac{3}{4}$$
 minute
The ratio of 45 seconds to 2 minutes is then

 $\frac{45 \text{ seconds}}{2 \text{ minutes}} = \frac{3}{4} \div 2 = \frac{3}{4} \cdot \frac{1}{2} = \frac{3}{8}.$

2. The results in the following table are rounded to the nearest thousandth.

Size	Unit Cost (dollars per oz)
12 oz	$\frac{\$1.89}{12} = \0.158
24 oz	$\frac{\$2.79}{24} = \0.116
36 oz	$\frac{\$3.89}{36} = \$0.108 \ (*)$

Because the 36-oz size produces the lowest unit cost, it is the best buy. The unit cost, to the nearest thousandth, is \$0.108 per oz. **N2.** The results in the following table are rounded to the nearest thousandth.

SizeUnit Cost (dollars per oz)75 oz
$$\frac{\$8.94}{75} = \$0.119$$
 (*)100 oz $\frac{\$13.97}{100} = \0.140 150 oz $\frac{\$19.97}{150} = \0.133

Because the 75-oz size produces the lowest unit cost, it is the best buy. The unit cost, to the nearest thousandth, is \$0.119 per oz.

3. (a) $\frac{21}{15} = \frac{62}{45}$

Compare the cross products. $21 \cdot 45 = 945$

$$15.62 = 930$$

The cross products are *different*, so the proportion is *false*.

(b) $\frac{13}{17} = \frac{91}{119}$

Check to see whether the cross products are equal. $13 \cdot 119 = 1547$ $17 \cdot 91 = 1547$ The error products are equal so the

The cross products are *equal*, so the proportion is *true*.

- N3. (a) $\frac{1}{3} = \frac{33}{100}$ Compare the cross products.
 - $1 \cdot 100 = 100$
 - $3 \cdot 33 = 99$

The cross products are *different*, so the proportion is *false*.

(b)
$$\frac{4}{13} = \frac{16}{52}$$

Check to see whether the cross products are equal.

$$4 \cdot 52 = 208$$

13.16 = 208

The cross products are *equal*, so the proportion is *true*.

4.
$$\frac{x}{6} = \frac{35}{42}$$

$$42x = 6 \cdot 35$$
 Cross products
$$x = \frac{6 \cdot 35}{42}$$
 Divide by 42.
$$= \frac{6 \cdot 5 \cdot 7}{6 \cdot 7}$$
 Factor.
$$= 5$$
 Cancel.

The solution set is $\{5\}$.

Note: We could have multiplied 6.35 to get 210 and then divided 210 by 42 to get 5. This may be the best approach if you are doing these calculations on a calculator. The factor and cancel method is preferable if you're not using a calculator.

N4. $\frac{9}{7} = \frac{x}{56}$ 7x = 9.56 Cross products $x = \frac{9.56}{7}$ Divide by 7. $= \frac{9.7.8}{7}$ Factor. = 72 Cancel.

The solution set is $\{72\}$.

Note: We could have multiplied 9.56 to get 504 and then divided 504 by 7 to get 72. This may be the best approach if you are doing these calculations on a calculator. The factor and cancel method is preferable if you're not using a calculator.

5. $\frac{x+6}{2} = \frac{2}{5}$

5(x+6) = 2(2) Cross products 5x+30 = 4 Distributive property 5x = -26 Subtract 30. $x = -\frac{26}{5}$ Divide by 5. The solution set is $\left\{-\frac{26}{5}\right\}$.

N5.
$$\frac{k-3}{6} = \frac{3k+2}{4}$$

$$4(k-3) = 6(3k+2)$$
 Cross products
$$4k-12 = 18k+12$$
 Distributive property
$$-14k-12 = 12$$
 Subtract 18k.
$$-14k = 24$$
 Add 12.
$$k = -\frac{24}{14}$$
 Divide by -14.
$$= -\frac{12}{7}$$
The solution set is $\left\{-\frac{12}{7}\right\}$.

6. Let x = the cost for 16.5 gallons.

 $\frac{\$49.68}{12} = \frac{x}{16.5}$ 12x = 16.5(49.68) Cross products 12x = \$19.72 Multiply. x = 68.31 Divide by 12.
It would cost \\$68.31.

N6. Let x = the cost for 27 gallons.

 $\frac{\$69.80}{20} = \frac{x}{27}$ 20x = 27(69.80) Cross products 20x = 1884.60 Multiply. x = 94.23 Divide by 20.

It would cost \$94.23.

- 7. (a) What is 3% of 80?
 3% ⋅ 80 = 0.03 ⋅ 80 = 2.4
 - (b) 16% of what number is 12? As in Example 7(b), let *n* denote the number. $0.16 \cdot n = 12$ $n = \frac{12}{0.16}$ Divide by 0.16. = 75 Simplify.

(c) What percent of 75 is 90? As in Example 7(c), let *p* denote the percent. $90 = p \cdot 75$ $p = \frac{90}{75} = 1.2 = 120\%$ 90 is 120% of 75.

N7. (a) What is 20% of 70? $20\% \cdot 70 = 0.20 \cdot 70 = 14$

(b) 40% of what number is 130?As in Example 7(b), let *n* denote the number.

$$0.40 \cdot n = 130$$

$$n = \frac{130}{0.40}$$
 Divide by 0.40.
= 325 Simplify.

40% of 325 is 130.

(c) 121 is what percent of 484? As in Example 7(c), let p denote the percent. $121 = p \cdot 484$

$$p = \frac{121}{484} = 0.25 = 25\%$$

121 is 25% of 484.

8. We can think of this problem as "What percent of \$3800 is \$912?"

Let *p* denote the number. $p \cdot 3800 = 912$

$$p = \frac{912}{3800}$$
 Divide by 3800.
= 0.24 = 24% Simplify.

Mark's rent is 24% of his monthly income.

N8. We can think of this problem as "48 is what percent of 120?" Let p denote the percent. $48 = p \cdot 120$

$$p = \frac{48}{120} = 0.40 = 40\%$$

The coat costs 40% of the regular price, so the savings is 100% - 40% = 60% of the regular price.

Exercises

1. (a) 75 to 100 is
$$\frac{75}{100} = \frac{3}{4}$$
, or 3 to 4.
The answer is C.

- (**b**) 5 to 4, or $\frac{5}{4} = \frac{5 \cdot 3}{4 \cdot 3} = \frac{15}{12}$, or 15 to 12. The answer is D.
- (c) $\frac{1}{2} = \frac{1 \cdot 50}{2 \cdot 50} = \frac{50}{100}$, or 50 to 100. The answer is B.
- (d) 4 to 5, or $\frac{4}{5} = \frac{4 \cdot 20}{5 \cdot 20} = \frac{80}{100}$, or 80 to 100. The answer is A.

2. Since there are 14 days in 2 weeks, the ratio of 4 days to 2 weeks can be represented by $\frac{4}{14}$,

choice C, or $\frac{2}{7}$, choice E.

- 3. The ratio of 40 miles to 30 miles is $\frac{40 \text{ miles}}{30 \text{ miles}} = \frac{40}{30} = \frac{4}{3}.$
- 4. The ratio of 60 feet to 70 feet is $\frac{60 \text{ feet}}{70 \text{ feet}} = \frac{60}{70} = \frac{6}{7}.$
- 5. The ratio of 120 people to 90 people is $\frac{120 \text{ people}}{90 \text{ people}} = \frac{4 \cdot 30}{3 \cdot 30} = \frac{4}{3}.$
- 6. The ratio of 72 dollars to 220 dollars is $\frac{72 \text{ dollars}}{220 \text{ dollars}} = \frac{72}{220} = \frac{18 \cdot 4}{55 \cdot 4} = \frac{18}{55}.$
- 7. To find the ratio of 20 yards to 8 feet, first convert 20 yards to feet. 20 yards = 20 yards $\cdot \frac{3 \text{ feet}}{1 \text{ yard}} = 60 \text{ feet}$

The ratio of 20 yards to 8 feet is then $\frac{60 \text{ feet}}{8 \text{ feet}} = \frac{60}{8} = \frac{15 \cdot 4}{2 \cdot 4} = \frac{15}{2}.$

- 8. First convert 8 feet to inches. 8 feet = $8 \cdot 12 = 96$ inches The ratio of 30 inches to 8 feet is then $\frac{30 \text{ inches}}{96 \text{ inches}} = \frac{30}{96} = \frac{5 \cdot 6}{16 \cdot 6} = \frac{5}{16}.$
- 9. Convert 2 hours to minutes.

2 hours = 2 hours $\cdot \frac{60 \text{ minutes}}{1 \text{ hour}}$ = 120 minutes The ratio of 24 minutes to 2 hours is then $\frac{24 \text{ minutes}}{120 \text{ minutes}} = \frac{24}{120} = \frac{1 \cdot 24}{5 \cdot 24} = \frac{1}{5}.$

10. To find the ratio of 16 minutes to 1 hour, first convert 1 hour to minutes. 1 hour = 60 minutes The ratio of 16 minutes to 1 hour is then $\frac{16 \text{ minutes}}{60 \text{ minutes}} = \frac{16}{60} = \frac{4 \cdot 4}{15 \cdot 4} = \frac{4}{15}.$

- 11. 2 yards = $2 \cdot 3 = 6$ feet 6 feet = $6 \cdot 12 = 72$ inches The ratio of 60 inches to 2 yards is then $\frac{60 \text{ inches}}{72 \text{ inches}} = \frac{5 \cdot 12}{6 \cdot 12} = \frac{5}{6}.$
- 12. 1 hour = 3600 seconds The ratio of 720 seconds to 1 hour is then $\frac{720 \text{ seconds}}{3600 \text{ seconds}} = \frac{1 \cdot 720}{5 \cdot 720} = \frac{1}{5}.$
- **13.** Find the unit price for each size.

Size	Price	Unit Cost (dollars per lb)
4 lb	\$3.29	$\frac{\$3.29}{4} = \0.823
10 lb	\$7.49	$\frac{\$7.49}{10} = \$0.749 (*)$

The 10-lb size is the best buy.

14. Find the unit price for each size.

Size	Price	Unit Cost (dollars per lb)
23 oz	\$1.99	$\frac{\$1.99}{23} \approx \0.087
48 oz	\$3.49	$\frac{\$3.49}{48} \approx \0.073 (*)

The 48-oz size is the best buy.

15. Find the unit price for each size.

Size	Price	Unit Cost (dollars per lb)
64 oz	\$2.99	$\frac{\$2.99}{64} \approx \0.047 (*)
89 oz	\$4.79	$\frac{\$4.79}{89} \approx \0.054
128 oz	\$6.49	$\frac{\$6.49}{128} \approx \0.051

The 64-oz size is the best buy.

16. Find the unit price for each size.

Size	Price	Unit Cost (dollars per lb)
8 oz	\$1.69	$\frac{\$1.69}{8} \approx \0.211
16 oz	\$1.97	$\frac{\$1.97}{16} \approx \$0.123 (*)$
36 oz	\$5.99	$\frac{\$5.99}{36} \approx \0.166

The 16-oz size is the best buy.

17. Find the unit price for each size.

Size	Price	Unit Cost (dollars per lb)
8.5 oz	\$5.79	$\frac{\$5.79}{8.5} \approx \0.681
12.5 oz	\$7.99	$\frac{\$7.99}{12.5} \approx \0.639
32 oz	\$16.99	$\frac{\$16.99}{32} \approx \$0.531 (*)$

The 32-oz size is the best buy.

18. Find the unit price for each size.

Size	Price	Unit Cost (dollars per lb)
16.9 oz	\$3.39	$\frac{\$3.39}{16.9} \approx \0.201
33.8 oz	\$3.49	$\frac{\$3.49}{33.8} \approx \$0.103 (*)$
50.7 oz	\$5.29	$\frac{\$5.29}{50.7} \approx \0.104

The 33.8-oz size is the best buy.

19. Find the unit price for each size.

Size	Price	Unit Cost (dollars per lb)
32 oz	\$1.79	$\frac{\$1.79}{32} \approx \$0.056 (*)$
36 oz	\$2.69	$\frac{\$2.69}{36} \approx \0.075
40 oz	\$2.49	$\frac{\$2.49}{40} \approx \0.062
64 oz	\$4.38	$\frac{\$4.38}{64} \approx \0.068

The 32-oz size is the best buy.

20. Find the unit price for each size.

Size	Price	Unit Cost (dollars per lb)
12 oz	\$1.05	$\frac{\$1.05}{12} \approx \0.088
18 oz	\$1.73	$\frac{\$1.73}{18} \approx \0.096
32 oz	\$1.84	$\frac{\$1.84}{32} \approx \0.058 (*)
48 oz	\$2.88	$\frac{\$2.88}{48} = \0.06

The 32-oz size is the best buy.

Size	Price	Unit Cost (dollars per lb)		
87 oz	\$7.88	$\frac{\$7.88}{87} \approx \0.091		
131 oz	\$10.98	$\frac{\$10.98}{131} \approx \0.084		
263 oz	\$19.96	$\frac{\$19.96}{263} \approx \$0.076 (*)$		

21. Find the unit price for each size.

The 263-oz size is the best buy.

22. Find the unit price for each size.

Size	Price	Unit Cost (dollars per lb)		
14 oz	\$1.79	$\frac{\$1.79}{14} \approx \0.128		
24 oz	\$1.77	$\frac{\$1.77}{24} \approx \$0.074 (*)$		
48 oz	\$3.65	$\frac{\$3.65}{48} \approx \0.076		

The 24-oz size is the best buy.

- **23.** Check to see whether the cross products are equal. $5 \cdot 56 = 280$
 - $35 \cdot 8 = 280$

The cross products are *equal*, so the proportion is *true*.

24. Check to see whether the cross products are equal.4 · 21 = 84

 $12 \cdot 7 = 84$

The cross products are *equal*, so the proportion is *true*.

25. Check to see whether the cross products are equal. $120 \cdot 10 = 1200$

$$82 \cdot 7 = 574$$

The cross products are *different*, so the proportion is *false*.

26. Check to see whether the cross products are equal.27.110 = 2970

160.18 = 2880The cross products are *different*, so the

proportion is *false*.

27. Check to see whether the cross products are equal.

$$\frac{1}{2} \cdot 10 = 5$$

$$5 \cdot 1 = 5$$

The cross

The cross products are *equal*, so the proportion is *true*.

28. Check to see whether the cross products are equal.

$$\frac{1}{3} \cdot 18 = 6$$
$$6 \cdot 1 = 6$$

The cross products are *equal*, so the proportion is *true*.

29. 20k = 4(175) Cross products 20k = 700 $\frac{20k}{20} = \frac{700}{20}$ Divide by 20. k = 35

The solution set is $\{35\}$.

30. $\frac{x}{6} = \frac{18}{4}$

 $6 \quad 4$ $x \cdot 4 = 6 \cdot 18 \quad \text{Cross products}$ 4x = 108 $\frac{4x}{4} = \frac{108}{4} \quad \text{Divide by 4.}$ x = 27The set of (27)

- The solution set is $\{27\}$.
- 31. $\frac{49}{56} = \frac{z}{8}$ 56z = 49(8) Cross products 56z = 392 $\frac{56z}{56} = \frac{392}{56}$ Divide by 56. z = 7

The solution set is $\{7\}$.

32.
$$\frac{20}{100} = \frac{z}{80}$$

 $100 \cdot z = 20 \cdot 80$ Cross products are equal.
 $100z = 1600$
 $\frac{100z}{100} = \frac{1600}{100}$ Divide by 100.
 $z = 16$
The solution set is {16}.

33.
$$\frac{x}{24} = \frac{15}{16}$$

 $16x = 24(15)$ Cross products
 $16x = 360$
 $\frac{16x}{16} = \frac{360}{16}$ Divide by 16.
 $x = \frac{45 \cdot 8}{2 \cdot 8} = \frac{45}{2}$
The solution set is $\left\{\frac{45}{2}\right\}$.

34. $\frac{x}{4} = \frac{12}{30}$

$$30x = 4(12) Cross products
30x = 48
$$\frac{30x}{30} = \frac{48}{30} Divide by 30.
x = \frac{8 \cdot 6}{5 \cdot 6} = \frac{8}{5}$$$$

The solution set is $\left\{\frac{8}{5}\right\}$.

35.
$$\frac{z}{2} = \frac{z+1}{3}$$

 $3z = 2(z+1)$ Cross products
 $3z = 2z+2$ Distributive property
 $z = 2$ Subtract $2z$.

The solution set is $\{2\}$.

36.
$$\frac{m}{5} = \frac{m-2}{2}$$

 $2m = 5(m-2)$ Cross products
 $2m = 5m-10$ Distributive property
 $-3m = -10$ Subtract $5m$.
 $m = \frac{10}{3}$ Divide by -3 .
The solution set is $\left\{\frac{10}{3}\right\}$.

37.
$$\frac{3y-2}{5} = \frac{6y-5}{11}$$

11(3y-2) = 5(6y-5) Cross products
33y-22 = 30y-25 Distributive property
3y-22 = -25 Subtract 30y.
3y = -3 Add 22.
y = -1 Divide by 3.

The solution set is $\{-1\}$.

38.
$$\frac{2r+8}{4} = \frac{3r-9}{3}$$
3(2r+8) = 4(3r-9) Cross products
6r+24 = 12r-36 Distributive property
-6r+24 = -36 Subtract 12r.
-6r = -60 Subtract 24.
r = 10 Divide by - 6.
The solution set is {10}.
39.
$$\frac{5k+1}{6} = \frac{3k-2}{3}$$
3(5k+1) = 6(3k-2) Cross products
15k+3 = 18k-12 Distributive property
-3k+3 = -12 Subtract 18k.
-3k = -15 Subtract 3.
k = 5 Divide by -3.

The solution set is $\{5\}$.

40.
$$\frac{x+4}{6} = \frac{x+10}{8}$$

$$8(x+4) = 6(x+10)$$
 Cross products
$$8x+32 = 6x+60$$
 Distributive property
$$2x+32 = 60$$
 Subtract 6x.
$$2x = 28$$
 Subtract 32.
$$x = 14$$
 Divide by 2.

The solution set is $\{14\}$.

41.
$$\frac{2p+7}{3} = \frac{p-1}{4}$$

$$4(2p+7) = 3(p-1)$$
 Cross products
$$8p+28 = 3p-3$$
 Distributive property
$$5p+28 = -3$$
 Subtract 3p.
$$5p = -31$$
 Subtract 28.
$$p = -\frac{31}{5}$$
 Divide by 5.
The solution set is $\left\{-\frac{31}{5}\right\}$.

42. $\frac{3m-2}{5} = \frac{4-m}{3}$ 3(3m-2) = 5(4-m) Cross products 9m - 6 = 20 - 5m Distributive property 14m - 6 = 20Add 5*m*. 14m = 26Add 6. $m = \frac{26}{14} = \frac{13}{7}$ Divide by 14. The solution set is $\left\{\frac{13}{7}\right\}$. **43.** $\frac{2(x-4)}{3} = \frac{4(x-3)}{5}$ $\frac{2x-8}{3} = \frac{4x-12}{5}$ Distributive property 5(2x-8) = 3(4x-12) Cross products 10x - 40 = 12x - 36Dist. prop. -40 = 2x - 36Subtract 10x. -4 = 2xAdd 36. $x = \frac{-4}{2} = -2$ Divide by 2.

The solution set is $\{-2\}$.

44.
$$\frac{9(x-3)}{6} = \frac{6(x-2)}{2}$$

$$\frac{9x-27}{6} = \frac{6x-12}{2}$$
 Distributive property

$$2(9x-27) = 6(6x-12)$$
 Cross products

$$18x-54 = 36x-72$$
 Dist. prop.

$$-54 = 18x-72$$
 Subtract 18x.

$$18 = 18x$$
 Add 72.

$$x = 1$$
 Divide by 18.

The solution set is $\{1\}$.

45. Let x = the cost of 24 candy bars. Set up a proportion. $\frac{x}{24} = \frac{\$20.00}{16}$ 16x = 24(20)16x = 480x = 30The cost of 24 candy bars is \$30.00. **46.** Let x = the cost of 8 ring tones. Set up a proportion. $\frac{x}{8} = \frac{\$30.00}{12}$ 12x = 8(30)12x = 240x = 20The cost of 8 ring tones is \$20.00. 47. Let x = the cost of 5 quarts of oil. Set up a proportion. $\frac{x}{5} = \frac{\$14.00}{8}$ 8x = 5(14)8x = 70x = 8.75The cost of 5 quarts of oil is \$8.75. **48.** Let x = the cost of 7 tires. Set up a proportion. $\frac{x}{7} = \frac{\$398.00}{4}$ 4x = 7(398)4x = 2786x = 696.50The cost of 7 tires is \$696.50. **49.** Let x = the cost of 5 pairs of jeans. $\frac{9 \text{ pairs}}{\$121.50} = \frac{5 \text{ pairs}}{x}$

$$9x = 5(121.50)$$

$$9x = 607.5$$

$$\frac{9x}{9} = \frac{607.5}{9}$$

$$x = 67.5$$
The cost of 5 pairs is \$67.50.

50. Let x = the cost of 11 shirts. $\frac{7 \text{ shirts}}{\$87.50} = \frac{11 \text{ shirts}}{x}$ 7x = 11(87.50) 7x = 962.5 $\frac{7x}{7} = \frac{962.5}{7}$ x = 137.5The cost of 11 shirts is \$137.50.

- 51. Let x = the cost for filling a 15-gallon tank. Set up a proportion. $\frac{x \text{ dollars}}{\$22.56} = \frac{15 \text{ gallons}}{6 \text{ gallons}}$ 6x = 15(22.56)6x = 338.4x = 56.4It would cost \$56.40 to completely fill a 15-gallon tank.
- **52.** Let x = the sales tax on a \$120.00 DVD player.

$$\frac{\$1.32}{\$x} = \frac{\$16}{\$120}$$
$$\frac{1.32}{x} = \frac{16}{120}$$
$$16x = 120(1.32)$$
$$16x = 158.4$$
$$x = 9.90$$

The sales tax on a \$120 DVD player would be \$9.90.

53. Let x = the number of fish in North Bay. Set up a proportion with one ratio involving the sample and the other involving the total number of fish.

$$\frac{7 \text{ fish}}{700 \text{ fish}} = \frac{500 \text{ fish}}{x \text{ fish}}$$
$$7x = (700)(500)$$
$$7x = 350,000$$
$$x = 50,000$$

We estimate that there are 50,000 fish in North Bay.

54. Let x = the number of fish in West Okoboji Lake.

Set up a proportion with one ratio involving the sample and the other involving the total number of fish.

$$\frac{18 \text{ fish}}{1000 \text{ fish}} = \frac{840 \text{ fish}}{x \text{ fish}}$$
$$18x = (1000)(840)$$
$$18x = 840,000$$
$$x = 46,666.\overline{6}$$

The approximate fish population of West Okoboji Lake, to the nearest hundred, is 46,700 fish.

55. Let *x* = the distance between Memphis and Philadelphia on the map (in feet). Set up a proportion with one ratio involving map distances and the other involving actual distances.

$$\frac{x \text{ feet}}{2.4 \text{ feet}} = \frac{1000 \text{ miles}}{600 \text{ miles}}$$
$$\frac{x}{2.4} = \frac{1000}{600}$$
$$600x = (2.4)(1000)$$
$$600x = 2400$$
$$x = 4$$

The distance on the map between Memphis and Philadelphia would be 4 feet.

56. Let *x* = the number of inches between Mexico City and Cairo on the map. Set up a proportion.

$$\frac{11 \text{ inches}}{x \text{ inches}} = \frac{3300 \text{ miles}}{7700 \text{ miles}}$$

$$\frac{11}{x} = \frac{3300}{7700}$$

$$3300x = 11(7700)$$

$$3300x = 84,700$$

$$x = \frac{84,700}{3300}$$

$$= \frac{847}{33} = \frac{77}{3}, \text{ or } 25\frac{2}{3}$$
Mexico City and Cairo are $25\frac{2}{3}$ inches apart

on the map.

57. Let x = the number of inches between St. Louis and Des Moines on the map. Set up a proportion. $\frac{8.5 \text{ inches}}{x \text{ inches}} = \frac{1040 \text{ miles}}{333 \text{ miles}}$ 1040x = 8.5(333)1040x = 2830.5 $x \approx 2.72$ St. Louis and Des Moines are about 2.7 inches apart on the map. **58.** Let *x* = the number of inches between Milwaukee and Seattle on the map. Set up a proportion.

$$\frac{8.0 \text{ inches}}{x \text{ inches}} = \frac{912 \text{ miles}}{1940 \text{ miles}}$$
$$912x = 8.0(1940)$$
$$912x = 15,520$$
$$x \approx 17.0$$

Milwaukee and Seattle are about 17.0 inches apart on the map.

59. Let *x* = the number of inches between Moscow and Berlin on the globe. Set up a proportion.

 $\frac{12.4 \text{ inches}}{x \text{ inches}} = \frac{10,080 \text{ km}}{1610 \text{ km}}$ 10,080x = 12.4(1610)10,080x = 19,964

 $x \approx 1.98$

Moscow and Berlin are about 2.0 inches apart on the globe.

60. Let *x* = the number of inches between Paris and Stockholm on the globe. Set up a proportion.

$$\frac{21.5 \text{ inches}}{x \text{ inches}} = \frac{17,615 \text{ km}}{1605 \text{ km}}$$
$$17,615x = 21.5(1605)$$
$$17,615x = 34,507.5$$
$$x \approx 1.96$$

Paris and Stockholm are about 2.0 inches apart on the globe.

61. Let *x* = the number of cups of cleaner. Set up a proportion with one ratio involving the number of cups of cleaner and the other involving the number of gallons of water.

$$\frac{x \operatorname{cups}}{\frac{1}{4} \operatorname{cup}} = \frac{10\frac{1}{2} \text{ gallons}}{1 \text{ gallons}}$$
$$x \cdot 1 = \frac{1}{4} \left(10\frac{1}{2} \right)$$
$$x = \frac{1}{4} \left(\frac{21}{2} \right) = \frac{21}{8}$$

The amount of cleaner needed is $2\frac{5}{8}$ cups.

62. Let *x* = the number of cups of cleaner. Set up a proportion with one ratio involving the number of cups of cleaner and the other involving the number of gallons of water.

$$\frac{x \text{ cups}}{\frac{1}{2} \text{ cup}} = \frac{15\frac{1}{2} \text{ gallons}}{1 \text{ gallons}}$$
$$x \cdot 1 = \frac{1}{2} \left(15\frac{1}{2}\right)$$
$$x = \frac{1}{2} \left(\frac{31}{2}\right) = \frac{31}{4}$$

The amount of cleaner needed is $7\frac{3}{4}$ cups.

63. Let x = the number of U.S. dollars Ashley exchanged. Set up a proportion. $\frac{\$1.3492}{x \text{ dollars}} = \frac{1 \text{ euro}}{300 \text{ euros}}$ $x \cdot 1 = 1.3492(300)$ x = 404.76She exchanged \$404.76.

64. Let x = the number of pesos that can be obtained for \$65. Set up a proportion. $\frac{103.0 \text{ pesos}}{x \text{ pesos}} = \frac{8 \text{ dollars}}{65 \text{ dollars}}$ $x \cdot 8 = 103.0(65)$ 8x = 6695

$$x = 836.875$$

To the nearest tenth, one can obtain 836.9 pesos for \$65.

65.
$$\frac{x}{12} = \frac{3}{9}$$

 $9x = 12 \cdot 3 = 36$
 $x = 4$
Other possibilities for the proportion are
 $\frac{12}{x} = \frac{9}{3}, \quad \frac{x}{12} = \frac{5}{15}, \text{ and } \frac{12}{x} = \frac{15}{5}.$
66.
$$\frac{6}{x} = \frac{8}{12}$$

 $8x = 6 \cdot 12$
 $8x = 72$
 $x = 9$
Other possibilities for the proportion are
 $\frac{6}{x} = \frac{4}{6}, \quad \frac{x}{6} = \frac{6}{4}, \text{ and } \frac{x}{6} = \frac{12}{8}.$

67.
$$\frac{x}{2} = \frac{12}{3}$$

 $3x = 2 \cdot 12 = 24$
 $x = 8$
68. $\frac{x}{4} = \frac{6}{8}$
 $8x = 4 \cdot 6 = 24$
 $x = 3$
69. $\frac{x}{15} = \frac{12}{8}$
 $8x = 15(12) = 180$
 $x = 22.5$
70. $\frac{x}{6} = \frac{7}{14}$
 $14x = 7 \cdot 6 = 42$
 $x = 3$
71. (a)
x
Chair
x
Chair
x
Shadow
Shadow
Shadow

(**b**) These two triangles are similar, so their sides are proportional.

$$\frac{x}{12} = \frac{18}{4}$$

$$4x = 18(12)$$

$$4x = 216$$

$$x = 54$$
The chair is 54 feet tall.

72. (a) x Candle 5 2 Shadow Shadow

(b) These two triangles are similar, so their sides are proportional. $\frac{x}{32} = \frac{5}{2}$ 2x = 5(32)2x = 160x = 80The candle was 80 feet tall. **73.** Let x = the 2001 price of electricity. 1999 price 2001 price $\overline{1999 \text{ index}} = \overline{2001 \text{ index}}$ $\frac{225}{166.6} = \frac{x}{177.1}$ 166.6x = 225(177.1) $x = \frac{225(177.1)}{166.6} \approx \239 The 2001 price would be about \$239. 74. Let x = the 2003 price of electricity. $\frac{1999 \text{ price}}{2003 \text{ price}} = \frac{2003 \text{ price}}{2003 \text{ price}}$ 1999 index 2003 index $\frac{225}{166.6} = \frac{x}{184.0}$ 166.6x = 225(184.0) $x = \frac{225(184.0)}{166.6} \approx \248

The 2003 price would be about \$248.

75. Let
$$x =$$
 the 2007 price of electricity.

$$\frac{1999 \text{ price}}{1999 \text{ index}} = \frac{2007 \text{ price}}{2007 \text{ index}}$$

$$\frac{225}{166.6} = \frac{x}{207.3}$$

$$166.6x = 225(207.3)$$

$$x = \frac{225(207.3)}{166.6} \approx $280$$
The 2007 price would be about \$280.

76. Let x = the 2011 price of electricity. $\frac{1999 \text{ price}}{1999 \text{ index}} = \frac{2011 \text{ price}}{2011 \text{ index}}$ $\frac{225}{166.6} = \frac{x}{224.9}$ 166.6x = 225(224.9) $x = \frac{225(224.9)}{166.6} \approx \304 The 2011 price would be about \$304.

77. (a) Find the total amount of medication by multiplying.(375 mg/day)(7 days) = 2625 mg

(**b**) Let x = the number of mL of suspension.

 $\frac{\text{mg of Amoxil}}{\text{mL of suspension}} = \frac{\text{total mg of Amoxil}}{\text{total mL of suspension}}$ 125 mg = 2625 mg

$$\frac{125 \text{ mg}}{5 \text{ mL}} = \frac{2625 \text{ mg}}{x}$$

(c) Solve the proportion. $\frac{125 \text{ mg}}{5 \text{ mL}} = \frac{2625 \text{ mg}}{x}$ 125x = 5(2625)

$$x = \frac{5(2625)}{125} = 105 \text{ mI}$$

Logan's pharmacist will make 105 mL of Amoxil suspension for the total course of treatment.

- 78. (a) Find the total amount of medication by multiplying.(900 mg/day)(10 days) = 9000 mg
 - (b) Let x = the number of mL of suspension. $\frac{\text{mg of Amoxil}}{\text{mL of suspension}} = \frac{\text{total mg of Amoxil}}{\text{total mL of suspension}}$

 $\frac{250 \text{ mg}}{5 \text{ mL}} = \frac{9000 \text{ mg}}{x}$

(c) Solve the proportion.

$$\frac{250 \text{ mg}}{5 \text{ mL}} = \frac{9000 \text{ mg}}{x}$$

$$250x = 5(9000)$$

$$x = \frac{5(9000)}{250} = 180 \text{ mL}$$

Ava's pharmacist will make 180 mL of Amoxil suspension for the total course of treatment.

- **79.** What is 18% of 780? 18% ⋅ 780 = 0.18 ⋅ 780 = 140.4
- **80.** What is 23% of 480? 23% ⋅ 480 = 0.23 ⋅ 480 = 110.4

81. 42% of what number is 294? As in Example 7(b), let *n* denote the number. $0.42 \cdot n = 294$

$$n = \frac{294}{0.42}$$
 Divide by 0.42.
= 700 Simplify.

42% of 700 is 294.

82. 18% of what number is 108? As in Example 7(b), let *n* denote the number. $0.18 \cdot n = 108$

$$n = \frac{108}{0.18}$$
 Divide by 0.18.
= 600 Simplify.

18% of 600 is 108.

83. 120% of what number is 510? As in Example 7(b), let *n* denote the number. $1.20 \cdot n = 510$

$$n = \frac{510}{1.20}$$
 Divide by 1.20.
= 425 Simplify.

120% of 425 is 510.

84. 140% of what number is 315? As in Example 7(b), let *n* denote the number. $1.40 \cdot n = 315$

$$n = \frac{315}{1.40}$$
 Divide by 1.40.
= 225 Simplify.

140% of 225 is 315.

85. 4 is what percent of 50? As in Example 7(c), let p denote the percent. $4 = p \cdot 50$ $n = \frac{4}{2} = 0.08 = 8\%$

$$p = \frac{1}{50} = 0.08 = 8\%$$

4 is 8% of 50.

86. 8 is what percent of 64? As in Example 7(c), let p denote the percent. $8 = p \cdot 64$

$$p = \frac{8}{64} = 0.125 = 12.5\%$$

8 is 12.5% of 64.

87. What percent of 30 is 36? As in Example 7(c), let p denote the percent. $36 = p \cdot 30$

$$p = \frac{36}{30} = 1.2 = 120\%$$

36 is 120% of 30.

- 88. What percent of 48 is 96? As in Example 7(c), let p denote the percent. $96 = p \cdot 48$ $p = \frac{96}{48} = 2 = 200\%$
 - 96 is 200% of 48.
- 89. 48 is what percent of 60? As in Example 7(c), let p denote the percent. $48 = p \cdot 60$

 $p = \frac{48}{60} = 0.08 = 80\%$

He earned 80% of the total points.

90. 63 is what percent of 75? As in Example 7(c), let p denote the percent. $63 = p \cdot 75$ $p = \frac{63}{75} = 0.84 = 84\%$

She scored 84% of the total points.

91. Find the amount of the savings. \$700 - \$504 = \$196What percent of \$700 is \$196? As in Example 7(b), let *n* denote the number. $n \cdot 700 = 196$ 196

$$n = \frac{150}{700}$$
 Divide by 700.
= 0.28 Simplify.
 $0.28 = 28(0.01) = 28 \cdot 1\% = 28\%$

92. Find the amount of the savings. \$980 - \$833 = \$147What percent of \$980 is \$147? As in Example 7(b), let *n* denote the number. $n \cdot 980 = 147$

$$n = \frac{147}{980}$$
 Divide by 980.
= 0.15 Simplify.

 $0.15 = 15(0.01) = 15 \cdot 1\% = 15\%$

93. What percent of \$1500 is \$480? As in Example 7(b), let *n* denote the number. $n \cdot 1500 = 480$

$$n = \frac{480}{1500}$$
 Divide by 1500.
= 0.32 Simplify.

 $0.32 = 32(0.01) = 32 \cdot 1\% = 32\%$

Tyler pays 32% of his income in rent.

94. What percent of \$2200 is \$154? As in Example 7(b), let *n* denote the number. $n \cdot 2200 = 154$

$$n = \frac{154}{2200}$$
 Divide by 2200.
= 0.07 Simplify.

 $0.07 = 7(0.01) = 7 \cdot 1\% = 7\%$

Lily budgeted 7% of her income for entertainment.

95. 65% of what number is 1950? As in Example 7(b), let *n* denote the number. $0.65 \cdot n = 1950$

> $n = \frac{1950}{0.65}$ Divide by 0.65. = 3000 Simplify.

She needs \$3000 for the car.

96. 70% of what number is 525? As in Example 7(b), let *n* denote the number. $0.70 \cdot n = 525$ 525

$$n = \frac{525}{0.70}$$
 Divide by 0.70.
= 750 Simplify.

She needs \$750 for the apartment deposit.

2.7 Further Applications of Linear Equations

Classroom Examples, Now Try Exercises

1. (a) The amount of pure acid in 40 L of a 16% acid solution is

40 L	×	0.16	= 6.4 L.
\uparrow		\uparrow	\uparrow
Amount		Rate	Amount
of		of	of pure
solution		concentration	acid

(b) If \$5000 is invested for one year at 4% simple interest, the amount of interest earned is $$5000 \times 0.04 = $200.$

1	\uparrow	\uparrow				
D''' 1	Interest	Interest				
Principal	rate	earned				
N1.	(a) Th	e amou	nt of	pure alco	ohol in	70 L of a
--------	-------------------	------------------------	--------------	---------------	--------------	------------------
	20	% alcoh	nol se	olution is		
	,	70L	Х	0.20		=14 L.
		↑		\uparrow		\uparrow
	Aı	mount		Rate		Amount
		of		of		of pure
	so	lution		concentra	tion	alcohol
	(b) If S	\$3200 is	s inv	ested for	one ye	ear at 2%
	sin	nple int	erest	, the amo	unt of	interest
	ear	rned is				
	\$	63200	Х	0.02	=\$6	64.
		\uparrow		\uparrow	\uparrow	
	D			Interest	Inter	est
	Pr	incipal		rate	earn	ed
2.	Let x	= the n	umb	er of kilo	grams	of metal that
	is 40%	b coppe	r.		0	
	Then	x + 80 =	the	number (of kilo	grams of
	metal	that is 5	0%	copper.		
Copp	per in	_	cc	pper in		copper in
40%	metal	plus	70	% metal	is	50% metal.
		\downarrow		\downarrow	\downarrow	\downarrow
0.4	0x	+	0	70(80)	=	0.05(x+80)
	Solve	the equ	ation			,
	0.40 <i>x</i>	+0.70(3)	80) =	= 0.50x + 100	40	
	Multip	oly by 1	0 to	clear deci	imals.	
	4x + 7	f(80) = 5	5x + 6	400		
	4x +	-560 = 5	5x + 4	400		
		560 = 3	x + 4	00		
		160 = 2	x			
	160 ki	lograms	s of 1	netal that	is 409	% copper is
	Check	1.	0.			
	L S and	$\lambda = 10^{\circ}$	0. fer to	the left i	ide ar	d right side of
	the ori	ginal ec	mati	on.	siuc ai	la right side of
	LS:	0.40(16	(0) +	0.70(80)	= 64 +	56 = 120
	RS:	0.50)(160	(+80) = ().50(24	40) = 120
N2	Let r	– the n	umh	er of our	ces of	seasoning that
1 1 20	is 70%	b salt.	umo		003 01	seasoning that
	Then	x + 30 =	the	number	of oun	ces of
	season	ing that	t is 5	0% salt.		
Salt	in		S	alt in		salt in
709	%			10%		50%

seasoning

 \downarrow

0.70x

plus

 \downarrow

+

seasoning

 \downarrow

0.10(30)

is

 \downarrow

=

2.7 Further Applications of Linear Equations 161 Solve the equation. 0.70x + 0.10(30) = 0.50x + 15Multiply by 10 to clear decimals. 7x + 1(30) = 5x + 1507x + 30 = 5x + 1502x + 30 = 1502x = 120x = 6060 ounces of seasoning that is 70% salt is needed. Check x = 60: LS and RS refer to the left side and right side of the original equation. LS: 0.70(60) + 0.10(30) = 42 + 3 = 45RS: 0.50(60+30) = 0.50(90) = 453. Let x = the number of gallons of 12% indicator solution. Then 10 - x = the number of gallons of 20% indicator solution. 12% 20% 14% solution solution solution. plus is \downarrow \downarrow \downarrow \downarrow \downarrow 0.12*x* + 0.2(10 - x)= 0.14(10) Solve the equation. 0.12x + 0.2(10 - x) = 0.14(10)Multiply by 100 to clear decimals. 12x + 20(10 - x) = 14(10)12x + 200 - 20x = 140-8x + 200 = 140-8x = -60 $x = \frac{60}{8} = \frac{15}{2} = 7\frac{1}{2}$ There needs to be $7\frac{1}{2}$ gallons of the 12% indicator solution. Check $x = 7\frac{1}{2}$: LS and RS refer to the left side and right side of the original equation. LS: $12\left(7\frac{1}{2}\right) + 20\left(10 - 7\frac{1}{2}\right) = 90 + 50 = 140$

RS:
$$14(10) = 140$$

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seasoning.

 \downarrow

0.50(x+30)

N3.	Let $x =$ the number of liters of 25% saline						
	soluti	on.					
	Then	15 - x =	the number of	liters o	of 10%		
	saline	solution	l.				
25%)		10%		15%		
solutio	on	plus	solution	is	solution.		
\downarrow		\downarrow	\downarrow	\downarrow	\downarrow		
0.25.	x	+	0.1(15-x)	=	0.15(15)		
	Solve	the equa	ation.				
	0.25 <i>x</i>	+ 0.1(15	(5-x) = 0.15(15))			
	Multi	ply by 10	00 to clear decin	nals.			
	25x +	10(15-	x) = 15(15)				
	25x	+150-1	0x = 225				
		15x + 1	50 = 225				
		1	5x = 75				
			<i>x</i> = 5				
There needs to be 5 liters of the 25% saline							
solution.							
	Check $x = 5$:						
	LS an	d RS ref	er to the left sid	e and	right side of		
the original equation.							

LS:
$$25(5)+10(15-(5)) = 125+100 = 225$$

RS: $15(15) = 225$

4. Let x = the amount invested at 5%. Then 2x + 3000 = the amount invested at 8%.

Amount Invested (in dollars)	Rate of Interest	Interest for One Year
x	0.05	0.05 <i>x</i>
2x + 3000	0.08	0.08(2x+3000)

Since the total annual interest was \$1710, the equation is 0.05x + 0.08(2x + 3000) = 1710.

Multiply by 100 to eliminate the decimals. 5x + 8(2x + 3000) = 100(1710)

5x + 16x + 24,000 = 171,000

$$21x + 24,000 = 171,000$$

$$21x = 147,000$$

$$x = 7000$$

The engineer invested \$7000 at 5%.

N4. Let x = the amount invested at 3%. Then x + 5000 = the amount invested at 4%.

Amount Invested (in dollars)	Rate of Interest	Interest for One Year
x	0.03	0.03 <i>x</i>
<i>x</i> +5000	0.04	0.04(x+5000)

Since the total annual interest is \$410, the equation is 0.03x + 0.04(x + 5000) = 410. Multiply by 100 to eliminate the decimals. 3x + 4(x + 5000) = 100(410)3x + 4x + 20,000 = 41,0007x + 20,000 = 41,0007x = 21,000x = 3000The financial advisor should invest \$3000 at

The financial advisor should invest \$3000 at 3% and \$8000 at 4%.

5. Let x = the number of quarters.

 \downarrow

0.10*x*

Then $x+9 =$	the r	number of nic	kels.		
The value	nlus	the value	is	\$2.55	
of quarters	pius	of nickels	15	φ2.55.	
\downarrow	\downarrow	\downarrow	\downarrow	\downarrow	
0.25x	+	0.05(x+9)	=	2.55	
Multiply by	100 to	eliminate the	e dec	imals.	
25x + 5(x + 9)	9) = 25	55			
25x + 5x + 4	45 = 25	55			
30x + 45 = 255					
30x = 210					
<i>x</i> = 7					
Since $x = 7$,	x + 9 = 100	=16.			
The man has	s 16 ni	ckels and 7 qu	uarte	ers.	
N5. Let $x =$ the	numt	per of dimes.			
Then $x+10$	= the	number of qu	arte	rs.	
The value	plue	the value	ic	\$5.65	
of dimes	pius	of quarters	15	<i>ф3</i> .03.	

 \downarrow

+

 \downarrow

0.25(x+10) = \$5.65

 $\downarrow \qquad \downarrow$

Multiply by 100 to eliminate the decimals. 10x + 25(x+10) = 565 10x + 25x + 250 = 565 35x + 250 = 565 35x = 315 x = 9Since x = 9, x + 10 = 19.

Clayton has 19 quarters and 9 dimes.

6.
$$r = \frac{d}{t} = \frac{100 \text{ meters}}{9.63 \text{ seconds}} \approx 10.3842$$

His rate was about 10.38 meters per second.

N6.
$$r = \frac{d}{t} = \frac{400 \text{ miles}}{6 \text{ hours}} \approx 66.6667$$

The rate was about 66.67 miles per hour.

7. Let t = the time it takes for the planes to be 3290 miles apart. Use the formula d = rt.

$$d_{\text{faster}} + d_{\text{slower}} = d_{\text{total}}$$

$$530t + 410t = 3290$$

$$940t = 3290$$

$$t = \frac{3290}{940} = 100$$

It will take 3.5 hours for the planes to be 3290 miles apart.

3.5

N7. Let t = the time it takes for the bicyclists to be 5 miles apart. Use the formula d = rt.

$$d_{\text{faster}} - d_{\text{slower}} = d_{\text{total}}$$

$$20t - 18t = 5$$

$$2t = 5$$

$$t = \frac{5}{2} = 2.5$$

It will take 2.5 hours for the bicyclists to be 5 miles apart.

8. Let x = the rate of the slower bus. Then x+10 = the rate of the faster bus. Use the formula d = rt and the fact that each bus travels for $\frac{1}{5}$ hour.

$$d_{\text{slower}} + d_{\text{faster}} = d_{\text{total}}$$
$$(x+10)\left(\frac{1}{5}\right) + x\left(\frac{1}{5}\right) = 12$$
$$\frac{1}{5}x + 2 + \frac{1}{5}x = 12$$
$$\frac{2}{5}x + 2 = 12$$
$$\frac{2}{5}x = 10$$
$$\frac{5}{2}\left(\frac{2}{5}x\right) = \frac{5}{2}(10)$$
$$x = 25$$

Since x = 25, x + 10 = 35. The slower bus had a rate of 25 mph and the faster bus had a rate of 35 mph.

Check: The slower bus traveled

$$25\left(\frac{1}{5}\right) = 5$$
 miles and the faster bus traveled
 $35\left(\frac{1}{5}\right) = 7$ miles. The total miles traveled is

5+7=12, as required.

N8. Let x = the rate of the slower car. Then x + 6 = the rate of the faster car. Use the formula d = rt and the fact that each car travels for $\frac{1}{4}$ hour. $d_{\text{slower}} + d_{\text{faster}} = d_{\text{total}}$ $(x+6)\left(\frac{1}{2}\right) + x\left(\frac{1}{2}\right) = 35$

$$(x+6)\left(\frac{1}{4}\right) + x\left(\frac{1}{4}\right) = 35$$
$$\frac{1}{4}x + \frac{3}{2} + \frac{1}{4}x = \frac{70}{2}$$
$$\frac{2}{4}x + \frac{3}{2} = \frac{70}{2}$$
$$\frac{1}{2}x = \frac{67}{2}$$
$$\frac{2}{1}\left(\frac{1}{2}x\right) = \frac{2}{1}\left(\frac{67}{2}\right)$$
$$x = 67$$

Since x = 67, x + 6 = 73. The slower car had a rate of 67 mph and the faster car had a rate of 73 mph.

Check: The slower car traveled

$$67\left(\frac{1}{4}\right) = \frac{67}{4}$$
 miles and the faster car traveled
 $73\left(\frac{1}{4}\right) = \frac{73}{4}$ miles. The total miles traveled is
 $\frac{67}{4} + \frac{73}{4} = \frac{140}{4} = 35$, as required.

Exercises

- 1. The amount of pure alcohol in x liters of a 75% alcohol solution is 0.75 times the volume of solution, or 0.75x liters. So choice A is the correct answer.
- 2. Each quarter is worth 0.25. The value of x quarters is 0.25x dollars. So choice C is the correct answer.
- 3. Use d = rt, where r = 55 and t is the number of hours. d = (55)t = 55t miles. So choice C is the correct answer.
- Use d = rt, where t = 6 and r is the rate of the car. d = r(6) = 6r miles.
 So choice D is the correct answer.
- 5. The concentration of the new solution could not be more than the strength of the stronger of the original solutions, so the correct answer is D, since 32% is stronger than both 20% and 30%.
- 6. Because pure alcohol (100% concentration) is to be added, the new solution must be stronger than the original one. Therefore, the concentration of the new solution must be greater than 24%, so the correct answer is A, 22%.
- 7. To estimate the average rate of the trip, round 405 to 400 and 8.2 to 8.

Use
$$r = \frac{d}{t}$$
 with $d = 405$ and $t = 8.2$.
 $r = \frac{d}{t} = \frac{405}{8.2} \approx 49.4$

The best estimate is choice A, 50 mph.

8. The distance traveled cannot be found by multiplying 45 and 30 because the rate is given in miles per hour, while the time is given in minutes. To find the correct distance, start by converting the time to hours.

30 minutes =
$$\frac{1}{2}$$
 hour
 $d = rt$
 $= 45\left(\frac{1}{2}\right)$
 $= 22.5$
The car traveled 22.5 (or $22\frac{1}{2}$) miles.

9. The amount of pure alcohol in 150 liters of a 30% alcohol solution is

150	Х	0.30	= 45 liters.
\uparrow		\uparrow	\uparrow
Amount		Rate	Amount
of		of	of pure
solution		concentration	alcohol

10. The amount of pure acid in 250 milliliters of a 14% acid solution is

250	× 0.14	= 35 milliliters.
\uparrow	\uparrow	\uparrow
Amount	Rate	Amount
of	of	of pure
solution	concentration	acid

11. If \$25,000 is invested at 3% simple interest for one year, the amount of interest earned is

\$25,000	×	0.03	×	1	=\$750.
\uparrow		\uparrow		\uparrow	\uparrow
Duin ain al		Interest		Time	Interest
Principal		rate		Time	earned

12. If \$10,000 is invested for one year at 3.5% simple interest, the amount of interest earned is \$10,000 \times 0.035 = \$350.

+-0,000 /(0.000	+
\uparrow	\uparrow	\uparrow
D'' 1	Interest	Interest
Principal	rate	earned

13. The monetary value of 35 half-dollars is $35 \times \$0.50 = \$17.50.$

I	I	I
Number	Denomination	Monetary
of coins		value

14.	The monetary value of 283 nickels is				
	283	×	\$0.05	= \$14.15.	
	\uparrow		\uparrow	\uparrow	
	Number		Denomination	Monetary	
	of coins			value	

15. Step 2

Let x = the number of liters of 25% acid solution to be used. Step 3

Use the box diagram in the textbook to write the equation.

Pure acid pure acid pure acid in 25% in 40% in 30% solution plus solution is solution. \downarrow ↓ \downarrow \downarrow \downarrow 0.25x+ 0.40(80)0.30(x+80)= Step 4 Multiply by 100 to clear decimals. 25x + 40(80) = 30(x + 80)25x + 3200 = 30x + 240025x + 800 = 30x800 = 5x160 = xStep 5 160 liters of 25% acid solution must be added. Step 6 25% of 160 liters plus 40% of 80 liters is 40 liters plus 32 liters, or 72 liters, of pure acid; which is equal to 30% of (160+80) liters. [0.30(240) = 72]16. Step 2 Let x = the number of gallons of 50% solution needed.

Then x + 80 = the number of gallons of 40% solution.

```
Step 3
```

Use the box diagram in the textbook to write the equation.

Pure		pure		pure	
antifreeze		antifreeze		antifreeze	
in 50%	plus	in 20%	ic	in 40%	
solution	I ····	solution	15	solution.	
\downarrow	4	\downarrow	\checkmark	\downarrow	
0.50 <i>x</i>	+	0.20(80)	=	0.40(x+80)	
Step	4				
Solve the equation.					

0.50x + 0.20(80) = 0.40(x + 80)

Multiply by 10 to clear decimals. 5x + 2(80) = 4(x + 80)5x + 160 = 4x + 320x + 160 = 320x = 160Step 5 160 gallons of 50% antifreeze is needed. Step 6 50% of 160 gallons plus 20% of 80 gallons is 80 gallons plus 16 gallons, or 96 gallons, of pure antifreeze, which is equal to 40% of (160+80) gallons. [0.40(240) = 96]17. Let x = the number of liters of 5% drug solution. Pure drug pure drug pure drug in 10% in 5% in 8% solution solution solution. plus is \downarrow \downarrow \downarrow \downarrow \downarrow 0.10(20)0.05x+ = 0.08(x+20)Solve the equation. 0.10(20) + 0.05x = 0.08(x + 20)10(20) + 5x = 8(x + 20)200 + 5x = 8x + 160200 = 3x + 16040 = 3x

$$x = \frac{40}{3} = 13\frac{1}{3}$$

The pharmacist needs $13\frac{1}{3}$ liters of 5% drug solution.

oration.

Check $x = 13\frac{1}{3}$:

LS and RS refer to the left side and right side of the original equation.

LS: $0.10(20) + 0.05\left(13\frac{1}{3}\right) = 2\frac{2}{3}$ RS: $0.08\left(13\frac{1}{3} + 20\right) = 2\frac{2}{3}$

18. Let <i>x</i>	c = the r	number of kilo	grams	of metal that
is 20 ⁴	% tin.			
Then	x + 80 =	= the number of	of kilo	grams of
metal	l that is \sharp	50% tin.		-
Tin in		tin in		tin in
20% metal	plus	70% metal	is	50% metal.
\downarrow	\downarrow	\downarrow	\downarrow	\downarrow
0.20 <i>x</i>	+	0.70(80)	=	0.50(x+80)
Solve	e the equ	ation.		
0.20.	x + 0.70((80) = 0.50x + 4	40	
Mult	iply by 1	0 to clear deci	mals.	
2 <i>x</i> +	7(80) =	5x + 400		
2x	+ 560 =	5x + 400		
	560 =	3x + 400		
	160 =	3 <i>x</i>		
	<i>x</i> =	$\frac{160}{3} = 53\frac{1}{3}$		
$53\frac{1}{3}$	kilograi	ns of metal tha	at is 20	0% tin is

needed.

Check $x = 53\frac{1}{3}$:

LS and RS refer to the left side and right side of the original equation.

LS:
$$0.20\left(53\frac{1}{3}\right) + 0.70(80) = 66\frac{2}{3}$$

RS: $0.50\left(53\frac{1}{3} + 80\right) = 66\frac{2}{3}$

19. Let x = the number of liters of the 20% alcohol solution.Complete the table.

StrengthLiters of SolutionLiters of Pure Alcohol 12% 12 $0.12(12) = 1.44$ 20% x $0.20x$		
Strength	Liters of Solution	Liters of Pure Alcohol
12%	12	0.12(12) = 1.44
20%	x	0.20 <i>x</i>
14%	<i>x</i> +12	0.14(x+12)

From the last column, we can formulate an equation that compares the number of liters of pure alcohol. The equation is 1.44 + 0.20x = 0.14(x+12). Solve the equation. 1.44 + 0.20x = 0.14(x+12)1.44 + 0.20x = 0.14(x+12)1.44 + 0.20x = 0.14x + 1.680.06x = 0.24

$$x = 4$$

4 L of the 20% alcohol solution is needed.

20. Let x = the number of liters of the 10% solution.

	borunion			
	Strength	Liters of Solution	P	Liters of Pure Alcohol
	10%	x		0.10 <i>x</i>
	50%	40	0	.50(40) = 20
	40%	<i>x</i> +40	(0.40(x+40)
Alcoho	1	alcohol		alcohol
in 10%		in 50%		in 40%
solutior	n plus	solution	is	solution.
\downarrow	\downarrow	\downarrow	\downarrow	\downarrow
0.10 <i>x</i>	+	20	=	0.40(x+40)

Multiply by 10 to clear decimals.

$$1x + 200 = 4(x + 40)$$

x + 200 = 4x + 160
$$-3x = -40$$

$$x = \frac{-40}{-3} = \frac{40}{3}$$
, or $13\frac{1}{3}$

 $13\frac{1}{3}$ L of 10% alcohol solution should be added.

21. Let x = the amount of water to be added. Then 20 + x = the amount of 2% solution. There is no minoxidil in water.

Pure		pure		pure
minoxidil		minoxidil		minoxidil
in x mL		in 4%		in 2%
solution	plus	solution	is	solution.
\downarrow	\downarrow	\downarrow	\downarrow	\downarrow
O(x)	+	0.04(20)	=	0.02(20 + x)
Solve	the equa	ation.		
0x + 0	0.04(20)	= 0.02(20 + x)	;)	
	4(20)	= 2(20 + x)		
	80	=40+2x		
	40	=2x		
	20	= x		
20 mi	lliliters o	of water shoul	d be u	ised.
Check	k x = 20	:		
LS:	0(20)	+0.04(20) = 0	0.8	
RS:	0.0	2(20+20) = 0	0.8	

This answer should make common sense—that is, equal amounts of 0% and 4% solutions should produce a 2% solution.

22.	Let x solution	the n	umber of mill	iliters	of 4%
Pu	re		pure		pure
minoz	xidil		minoxidil		minoxidil
in 1	%		in 4%		in 2%
solut	ion	plus	solution	is	solution.
\downarrow		\downarrow	\downarrow	\downarrow	\downarrow
0.01((50)	+	0.04 <i>x</i>	=	0.02(50+x)
	Multip 1(50) -	bly by $10 + 4x = 2$	0 to clear deci (50 + x)	mals.	
	50-	+4x = 1	00 + 2x		
	50-	x = 1	00		
		2x = 5	0		
		x = 2	5		
	The pl	narmaci	st must add 2	5 milli	liters of 4%
	Check	r = 25			
	LS:	n = 25	(50) + 0.04(25)	=1.5	
	RS:	0.01(0.02(50+25)	=1.5	
23.	Let x	= the n	umber of liter	s of 6	0% acid
	solutio	on.			
	Then 2 solutio	20 - x = on.	the number	of lite	rs of 75% acid
Pure	acid		pure acid		pure acid
in 60)%		in 75%		in 72%
solut	ion	plus	solution	i	s solution.
\downarrow		\downarrow	\downarrow		$\downarrow \downarrow$
0.6	$\Im x$	+	0.75(20-x)) =	= 0.72(20)
	Solve $0.60x$	the equation the equation the	ation. $(20 - x) = 0.72$	(20)	
	60	x + 750	2(0-x) = 72(2)	.0)	
	60.	x + 1500	-75x = 1440)	
		1500	-15x = 1440)	
			-15x = -60		
			x = 4		
	4 liters Check	x = 4:	b acid solutior	n must	be used.
	LS:	0.60(4	4) + 0.75(20 -	4) = 1	4.4
	RS		0.72(2	(0) = 1	44

24. Let .	x = the $x = $ the	number of gallo	ns of :	50% juice
fruit	drink.			
Ther	12 - x =	= the number of	f gallo	ons of 20%
juice	fruit dri	nk.		
Juice in		juice in		juice in
50% drink	plus	20% drink	is	40% drink
\downarrow	\downarrow	\downarrow	\downarrow	\downarrow
0.5x	+	0.20(12 - x)	=	0.40(12)
Mult	iply by	10 to clear decin	nals.	
5x +	2(12 - x)	= 4(12)		
5x	+24-2.	x = 48		
	3x + 2x	4 = 48		
	3.	x = 24		
	-	x = 8		
8 gal adde	lons of t d.	he 50% juice fr	uit dri	nk must be
Chec	x = 8:			
LS:	0.5(8)	+0.20(12-8) =	4.8	
RS:		0.4(12) =	4.8	

25. Let x = the amount invested at 5% (in dollars). Then x - 1200 = the amount invested at 4% (in dollars).

Amount Invested (in dollars)	Rate of Interest	Interest for One Year
x	0.05	0.05 <i>x</i>
x-1200	0.04	0.04(x-1200)

Since the total annual interest was \$141, the equation is 0.05x + 0.04(x - 1200) = 141.

5x + 4(x - 1200) = 100(141) 5x + 4x - 4800 = 14,100 9x - 4800 = 14,100 9x = 18,900 x = 2100Since x = 2100, x - 1200 = 900. Arlene invested \$2100 at 5% and \$900 at 4%.

Then $x + 3000 =$	the amount in	nvested at 3%.
Amount Invested	Rate of	Interest for
(in dollars)	Interest	One Year

26. Let x = the amount invested at 2%.

(in dollars)	Interest	One Year
X	0.02	0.02 <i>x</i>
x + 3000	0.03	0.03(x+3000)

Since the total annual interest was \$390, the equation is 0.02x + 0.03(x + 3000) = 390. Multiply by 100 to clear decimals. 2x + 3(x + 3000) = 39,0002x + 3x + 9,000 = 39,000

5x + 9,000 = 39,0005x = 30,000x = 6000Since x = 6000, x + 3000 = 9000.

Margaret deposited \$6000 at 2% and \$9000 at 3%.

27. Let x = the amount invested at 6%. Then 3x + 6000 = the amount invested at 5%. 0.06x + 0.05(3x + 6000) = 825

$$6x + 5(3x + 6000) = 100(825)$$

$$6x + 15x + 30,000 = 82,500$$

$$21x + 30,000 = 82,500$$

$$21x = 52,500$$

$$x = 2500$$

Since $x = 2500, 3x + 6000 = 13,500$.
The artist invested \$2500 at 6% and \$13,500

28. Let x = the amount invested at 3%. Then 2x + 30,000 = the amount invested at 4%. 0.03x + 0.04(2x + 30,000) = 56003x + 4(2x + 30,000) = 100(5600)3x + 8x + 120,000 = 560,000

The

at 5%.

11x + 120,000 = 560,000

$$11x = 440,000$$

x = 40,000

Since x = 40,000, 2x + 30,000 = 110,000. The actor invested \$40,000 at 3% and \$110,000 at 4%.

29. Let x = the amount Jamal invested at 8%. Then 2500 - x = the amount invested at 2%. 0.08x + 0.02(2500 - x) = 152

$$8x + 2(2500 - x) = 15,200$$

$$8x + 5000 - 2x = 15,200$$

$$6x + 5000 = 15,200$$

$$6x = 10,200$$

$$x = 1700$$
Since $x = 1700, 2500 - x = 800$.
Jamal invested \$1700 at 8% and \$800 at 2%.

30. Let x = the amount Carter invested at 1%. Then 9000 - x = the amount invested at 4%. 0.01x + 0.04(9000 - x) = 285

1x + 4(9000 - x) = 28,500x + 36,000 - 4x = 28,500-3x + 36,000 = 28,500-3x = -7500x = 2500Since x = 2500, 9000 - x = 6500. Carter invested \$2500 at 1% and \$6500 at 4%.

31. Let x = the number of nickels. Then x + 2 = the number of dimes. The value the value of nickels of dimes \$1.70. plus is \downarrow \downarrow \downarrow \downarrow \downarrow 0.05x0.10(x+2)1.70 + = 5x + 10(x + 2) = 100(1.70)5x + 10x + 20 = 17015x + 20 = 17015x = 150x = 10The collector has 10 nickels.

32. Let x = the number of \$5 bills.

Then x + 5 = the number of \$20 bills. The value the value of fives plus of twenties \$725. is \downarrow \downarrow \downarrow \downarrow \downarrow 5x+ 20(x+5)= 725 5x + 20x + 100 = 72525x + 100 = 72525x = 625x = 25The teller has twenty-five \$5 bills.

33. Let x = the number of 46-cent stamps. Then 45 - x = the number of 20-cent stamps. The value of the 46-cent stamps is 0.46x and the value of the 20-cent stamps is 0.20(45 - x).

The total value is \$15.50, so 0.46x + 0.20(45 - x) = 15.50

$$46x + 20(45 - x) = 1550$$

$$46x + 900 - 20x = 1550$$

$$26x + 900 = 1550$$

$$26x = 650$$

$$x = 25$$

Since x = 25, 45 - x = 20.

She bought twenty-five 46-cent stamps valued at \$11.50 and twenty 20-cent stamps valued at \$4.00, for a total value of \$15.50.

34. Let x = the number of adult tickets sold. Then 600 - x = the number of children's tickets sold. The value of the adult tickets is 8x and the value of the children's tickets is 5(600 - x). The

total value was \$4116, so

8x + 5(600 - x) = 4116.

$$8x + 3000 - 5x = 4116$$

 $3x + 3000 = 4116$
 $3x = 1116$
 $x = 372$

Since x = 372, 600 - x = 228.

There were 372 adult tickets valued at \$2976 and 228 children's tickets valued at \$1140, for a total value of \$4116.

35. Let x = the number of pounds of Colombian Decaf beans.

Then 2x = the number of pounds of Arabian Mocha beans.

	Number of Pounds	Cost per Pound	Total Value (in \$)
Colombian Decaf	x	\$8.00	8 <i>x</i>
Arabian Mocha	2x	\$8.50	8.5(2 <i>x</i>)

The total value is \$87.50, so 8x + 8.5(2x) = 87.50. 8x + 17x = 87.50 25x = 87.50 x = 3.5Since x = 3.5, 2x = 7.

She can buy 3.5 pounds of Colombian Decaf and 7 pounds of Arabian Mocha.

36. Let x = the number of pounds of Italian Espresso beans. Then 4x = the number of pounds of Kona

Deluxe beans. x = 1 for humber of pounds of Kona

	Number of Pounds	Cost per Pound	Total Value (in \$)
Italian Espresso	x	\$9.00	9.00 <i>x</i>
Kona Deluxe	4x	\$11.50	11.50(4x)

The sum of the values of the Kona Deluxe beans and the Italian Espresso beans must equal the value of the mixture, so

9.00x + 11.50(4x) = 247.5090x + 115(4x) = 247590x + 460x = 2475550x = 2475x = 4.5

Since x = 4.5, 4x = 18.

The customer can buy 4.5 pounds of Italian Espresso beans and 18 pounds of Kona Deluxe beans.

- **37.** Use the formula d = rt with r = 53 and t = 10. d = rt
 - =(53)(10)

= 530

The distance between Memphis and Chicago is 530 miles.

- **38.** Use d = rt with r = 164 and t = 2.
 - d = rt

=164(2)

= 328

The distance from Warsaw to Rome is 328 miles.

39. Use
$$d = rt$$
 with $d = 500$ and $r = 187.433$.
 $d = rt$
 $500 = 187.433t$
 $t = \frac{500}{187.433} \approx 2.668$

His time was about 2.668 hours.

40. Use d = rt with d = 400 and r = 153.485.
d = rt
400 = 153.485t

$$t = \frac{400}{153.485} \approx 2.606$$

His time was about 2.606 hours.

41.
$$r = \frac{d}{t} = \frac{200 \text{ meters}}{21.88 \text{ seconds}} \approx 9.14$$

Her rate was about 9.14 meters per second.

42.
$$r = \frac{d}{t} = \frac{400 \text{ meters}}{49.55 \text{ seconds}} \approx 8.07$$

Her rate was about 8.07 meters per second.

43.
$$r = \frac{d}{t} = \frac{110 \text{ meters}}{12.92 \text{ seconds}} \approx 8.51$$

His rate was about 8.51 meters per second.

44.
$$r = \frac{d}{t} = \frac{200 \text{ meters}}{19.32 \text{ seconds}} \approx 10.35$$

His rate was about 10.35 meters per second.

45. Let *t* = the number of hours Marco and Celeste traveled.

	Make a	chart	using	the	formula	d	=	rt.
--	--------	-------	-------	-----	---------	---	---	-----

	r	t	d	
Marco	10	t	10 <i>t</i>	
Celeste	12	t	12 <i>t</i>	
Marco's		Celeste'	S	I
distance	minus	distance	e is	15.
\downarrow	\downarrow	\downarrow	\downarrow	\downarrow
12 <i>t</i>	_	10 <i>t</i>	=	15
Solve the eq	uation.			
12t - 10t = 1	3			
2t = 1	5			
$t = \frac{1}{2}$	$\frac{5}{2}$ or $7\frac{2}{2}$	$\frac{1}{2}$		

They will be 15 miles apart in $7\frac{1}{2}$ hours.

46. Let t = the number of hours until the steamboats will be 9 miles apart. Make a chart using the formula d = rt.

			r	t		d]
Slower Boa	t		18	t		18 <i>t</i>	
Faster Boat	er Boat		24 t			24 <i>t</i>	1
Distance		distance					-
traveled by			tr	aveled by			
faster boat	mi	nus	sle	ower boat		is	9.
\downarrow	``	L		\downarrow		\downarrow	\downarrow
24 <i>t</i>	-	F		18 <i>t</i>		=	9
Solve the equation $24t - 18t = 9$	tior	1.					
6t = 9							
$t = \frac{3}{2}$	or	$1\frac{1}{2}$					

In $1\frac{1}{2}$ hours, the steamboats will be 9 miles apart.

47. Let t = the number of hours until John and Pat meet.The distance John travels and the distance Pat travels total 440 miles

	Juli 440	nines.		
John's		Pat's		total
distance	and	distance	is	distance.
\downarrow	\downarrow	\downarrow	\downarrow	\downarrow
60 <i>t</i>	+	28 <i>t</i>	=	440
Solve the $60t + 28$	e equation $t = 440$	on.		
88	t = 440			
	<i>t</i> = 5			

It will take 5 hours for them to meet.

48. Let t = the time each plane travels. Use the chart in the text to help write the equation.

Distance		distance		distance
of plane		of plane		between
leaving		leaving		Portland
Portland	plus	St. Louis	is	and St. Louis.
\downarrow	\downarrow	\downarrow	\downarrow	\downarrow
90 <i>t</i>	+	116 <i>t</i>	=	2060

Solve the equation. 90t + 116t = 2060 206t = 2060 $t = \frac{2060}{206}$ t = 10

It will take the planes 10 hours to meet.

49. Let t = the number of hours until the trains are 315 kilometers apart.

Distance of		distance of		
northbound		southbound		total
train	plus	train	is	distance.
\downarrow	\downarrow	\downarrow	\downarrow	\downarrow
85 <i>t</i>	+	95 <i>t</i>	=	315
Solve the solution $85t + 92$	he equation $5t = 315$	on.		
18	0t = 315			
	$t = \frac{315}{180} =$	$=\frac{7}{4}$		
It will t	ake $1\frac{3}{4}$ h	ours for the t	rains to	be
315 kil	ometers a	part.		

50. Let t = the number of hours until the steamers are 110 miles apart. Each steamer will travel 22*t* miles and the total distance traveled will be 110 miles. 22t + 22t = 11044t = 110

$$t = \frac{110}{44} = \frac{5}{2}$$

It will take $2\frac{1}{2}$ hours for the steamers to be 110 miles apart.

51. Let x = the rate of the westbound plane.

Then x-150 = the rate of the eastbound plane. Using the formula d = rt and the chart in the text, we see that

$$d_{west} + d_{east} = d_{total}$$

x(3) + (x - 150)(3) = 2250
3x + 3x - 450 = 2250
6x = 2700
x = 450
Since x = 450, x - 150 = 300.

The rate of the westbound plane is 450 mph and the rate of the eastbound plane is 300 mph.

52. Let x = the rate of the northbound train. Then x + 20 = the rate of the southbound train. Using the formula d = rt and the chart in the text, we see that

$$d_{north} + d_{south} = d_{total}$$
$$x(2) + (x + 20)(2) = 280$$
$$2x + 2x + 40 = 280$$
$$4x = 240$$
$$x = 60$$

Since x = 60, x + 20 = 80. The rate of the northbound train is 60 mph and the rate of the southbound train is 80 mph.

53. Let x = the rate of the slower car. Then x + 20 = the rate of the faster car. Use the formula d = rt and the fact that each car travels for 4 hours.

$$d_{\text{faster}} + d_{\text{slower}} = d_{\text{total}}$$

(x + 20)(4) + (x)(4) = 400
 $4x + 80 + 4x = 400$
 $8x = 320$
 $x = 40$

The rate of the slower car is 40 mph and the rate of the faster car is 60 mph.

54. Let x = the rate of the faster car. Then x-15 = the rate of the slower car. Use the formula d = rt and the fact that each car travels for 2 hours.

$$d_{\text{faster}} + d_{\text{slower}} = d_{\text{total}}$$

x(2) + (x-15)(2) = 230
2x + 2x - 30 = 230
4x = 260
x = 65
Since x = 65, x-15 = 50.

The rate of the faster car is 65 km per hour and the rate of the slower car is 50 km per hour.

55. Let x = Bob's current age.

Then 3x = Kevin's current age. Three years ago, Bob's age was x-3 and Kevin's age was 3x-3, and this sum was 22. (x-3) + (3x-3) = 22 4x-6 = 22 4x = 28 x = 7Bob is 7 years old and Kevin is 3(7) = 21 years old. 56. Let x = the number of pint cartons. Then 6x = the number of quart cartons.

Since 1 quart = 2 pints, 1 pint = $\frac{1}{2}$ quart, and $\frac{1}{2}x$ is the number of quarts contained in pint cartons. The total number of quarts is 39, so

$$\frac{1}{2}x + 6x = 39.$$

$$\frac{1}{2}x + \frac{12}{2}x = 39$$

$$\frac{13}{2}x = 39$$

$$\frac{2}{13}\left(\frac{13}{2}x\right) = \frac{2}{13}(39)$$

$$x = 6$$

There are 6 pint cartons and 6(6) = 36 quart cartons.

57. Let w = the width of the table. Then 3w = the length of the table. If we subtract 3 feet from the length (3w-3) and add 3 feet to the width (w+3), then the length and the width would be equal. 3w-3 = w+3

$$3w = w + 6$$
$$2w = 6$$
$$w = 3$$
The width is 3 feet

- 3(3) = 9 feet.
- **58.** Let x = the number of hours worked. Her gross pay (pay before deductions) is 8x. gross pay – deduction = take-home pay

and the length is

75

650

$$8x - 0.25(8x) = 450$$
$$8x - 2x = 450$$
$$6x = 450$$
$$x = \frac{450}{6} = 450$$

She must work 75 hours to take home \$450.

59. Let *x* = her gross pay (pay before deductions). gross pay – deduction = take-home pay

$$x - 0.10(x) = 585$$
$$0.90x = 585$$
$$x = \frac{585}{0.90} = 585$$

She was paid \$650 before deductions.

60. Let x = the amount of the sales.
sales + tax = total

$$x + 0.05x = 2394$$

 $1.05x = 2394$
 $x = \frac{2394}{1.05} = 2280$

The amount of sales was \$2280.

2.8 Solving Linear Inequalities

Classroom Examples, Now Try Exercises

 (a) The statement x≥3 says that x can represent any number greater than or equal to 3. The interval is written as [3,∞) (the

parenthesis at ∞ shows that ∞ is *not* part of the graph). To graph the inequality, place a bracket at 3 and draw an arrow extending to the right.

- (b) The statement -4 > x is the same as x < -4. The interval is written as (-∞, -4). Graph this inequality by placing a parenthesis at -4 on a number line and drawing an arrow to the left.
- N1. (a) The statement *x* < −1 says that *x* can represent any number less than −1. The interval is written as (−∞, −1). Graph this inequality by placing a parenthesis at −1 on a number line and drawing an arrow to the left.

(b) The statement $-2 \le x$ is the same as $x \ge -2$. The interval is written as $[-2, \infty)$.

Graph this inequality by placing a bracket at -2 on a number line and drawing an arrow to the right.

$$-3 - 2 - 1 \quad 0 \quad 1 \quad 2 \quad 3$$

2.
$$-1+8x < 7x + 2$$

 $-1+8x+1 < 7x + 2 + 1$ Add 1.
 $8x < 7x + 3$
 $8x - 7x < 7x + 3 - 7x$ Subtract 7x.
 $x < 3$

Graph the solution set $(-\infty, 3)$.

To graph this inequality, place a parenthesis at 3 on a number line and draw an arrow to the left.

Graph the solution set $[-2,\infty)$.

To graph this inequality, place a bracket at -2 on a number line and draw an arrow to the right.

$$-4 -3 -2 -1 \quad 0 \quad 1 \quad 2$$

3. $-2r > -12$
 $\frac{-2r}{-2} < \frac{-12}{-2}$ Divide by -2 .
 $r < 6$

Graph the solution set $(-\infty, 6)$.

9

N3. $-5k \ge 15$ $\frac{-5k}{5} \le \frac{15}{5}$ Divide by -5.

$$-5$$
 -5
 $k \le -3$
Graph the solution set $(-\infty, -3]$.

4.
$$5x - x + 2 < 7x - 5$$

 $4x + 2 < 7x - 5$
 $4x + 2 < 7x - 5 - 7x$ Subtract 7x.
 $-3x + 2 < -5$
 $-3x + 2 - 2 < -5 - 2$ Subtract 2.
 $-3x < -7$
 $\frac{-3x}{-3} > \frac{-7}{-3}$ Divide by -3.
 $x > \frac{7}{3}$
Graph the solution set $\left(\frac{7}{3}, \infty\right)$.
 $\frac{7}{3}$
 $-1 \ 0 \ 1 \ 2 \ 3 \ 4 \ 5$
N4. $6 - 2t + 5t \le 8t - 4$
 $3t + 6 - 8t \le 8t - 4 - 8t$ Subtract 8t.
 $-5t + 6 \le -4$
 $-5t + 6 \le 4 - 4$
 $5t + 6 \le 4 - 4$
 $-5t + 6 - 6 \le -4 - 6$ Subtract 6.
 $-5t \le -10$
 $\frac{-5t}{-5} \ge \frac{-10}{-5}$ Divide by -5.
 $t \ge 2$
Graph the solution set $[2, \infty)$.
 $\frac{1}{-1} + \frac{1}{-1} + \frac{1}{-5} - \frac{1}{-5}$

x > -4Graph the solution set $(-4, \infty)$.

$$\begin{array}{c|c} + + & + + + + \\ -6 & -4 & -2 & 0 & 1 \end{array}$$

7. Let
$$x = Maggie's$$
 score on the fourth test.

The average is at least 90.

$$\downarrow \qquad \downarrow \qquad \downarrow \qquad \downarrow$$

 $\frac{98+86+88+x}{4} \ge 90$

Solve the inequality. Combine like terms in the numerator, and multiply by 4 to eliminate the fraction.

$$4\left(\frac{272+x}{4}\right) \ge 4(90)$$
$$272+x \ge 360$$

 $272 + x - 272 \ge 360 - 272$ Subtract 272.

She must score 88 or more on the fourth test to have an average of *at least* 90.

N7. Let x = Will's score on the third test.

 $x \ge 88$

The average is at least 90.

$$\downarrow \qquad \downarrow \qquad \downarrow$$

 $\frac{98+85+x}{3} \geq 90$

Solve the inequality. Combine like terms in the numerator, and multiply by 3 to eliminate the fraction.

$$3\left(\frac{183+x}{3}\right) \ge 3(90)$$
$$183+x \ge 270$$

 $183 + x - 183 \ge 270 - 183$ Subtract 183.

 $x \ge 87$ Combine terms. He must score 87 or more on the third test to have an average of *at least* 90.

8. The statement $2 < x \le 4$ says that x can represent any number between 2 and 4, excluding 2 and including 4. To graph the inequality, place a parenthesis at 2 and a bracket at 4 and draw a line segment between them. The interval is written as (2, 4].

N8. The statement $0 \le x < 2$ says that x can represent any number between 0 and 2, including 0 and excluding 2. To graph the inequality, place a bracket at 0 and a parenthesis at 2 and draw a line segment between them. The interval is written as [0, 2).

Exercises

 When graphing an inequality, use a parenthesis if the inequality symbol is ≥ or ≤. Use a square bracket if the inequality symbol is ≥ or ≤.

Examples:

A parenthesis would be used for the inequalities x < 2 and x > 3. A square bracket would be used for the inequalities $x \le 2$ and $x \ge 3$.

- 2. *False*. A parenthesis is always used with the symbols $-\infty$ and ∞ .
- **3.** In interval notation, the set $\{x \mid x > 0\}$ is

written $(0, \infty)$.

- In interval notation, the set of all real numbers is (-∞,∞).
- 5. The set of numbers graphed corresponds to the inequality x > -4.

- 6. The set of numbers graphed corresponds to the inequality $x \ge -4$.
- 7. The set of numbers graphed corresponds to the inequality $x \le 4$.
- 8. The set of numbers graphed corresponds to the inequality x < 4.
- 9. The statement $z \le 4$ says that z can represent any number less than or equal to 4. The interval is written as $(-\infty, 4]$. To graph the inequality, place a square bracket at 4 (to show that 4 is part of the graph) and draw an arrow extending to the left.

- 10. The statement $x \le 3$ can be written as $(-\infty, 3]$.
- 11. The statement x < -3 says that x can represent any number less than -3. The interval is written as $(-\infty, -3)$. To graph the inequality, place a parenthesis at -3 (to show that -3 is *not* part of the graph) and draw an arrow extending to the left.

12. The statement r < -11 says that r can represent any number less than -11. The interval is written $(-\infty, -11)$. To graph the inequality, place a parenthesis at -11 (to show that -11 is *not* part of the graph) and draw an arrow extending to the left.

13. The statement t > 4 says that t can represent any number greater than 4. The interval is written $(4, \infty)$. To graph the inequality, place a parenthesis at 4 (to show that 4 is *not* part of the graph) and draw an arrow extending to the right.

14. The statement m > 5 can be written as $(5, \infty)$.



15. The statement $0 \ge x$ (or $x \le 0$) says that x can represent any number less than or equal to 0. The interval is written as $(-\infty, 0]$. To graph the inequality, place a bracket at 0 (to show that 0 is part of the graph) and draw an arrow extending to the left.

16. The statement $1 \ge x$ (or $x \le 1$) says that x can represent any number less than or equal to 1. The interval is written as $(-\infty, 1]$. To graph the inequality, place a bracket at 1 (to show that 1 is part of the graph) and draw an arrow extending to the left.

17. The statement $-\frac{1}{2} \le x$ (or $x \ge -\frac{1}{2}$) says that x can represent any number greater than or equal

to
$$-\frac{1}{2}$$
. The interval is written $\left[-\frac{1}{2},\infty\right)$. To

graph the inequality, place a bracket at $-\frac{1}{2}$ (to

show that $-\frac{1}{2}$ is part of the graph) and draw an arrow extending to the right.

$$\begin{array}{c} -\frac{1}{2} \\ + + + \frac{1}{1} \\ -1 \end{array}$$

18. The statement $-\frac{3}{4} \le x \left(\text{ or } x \ge -\frac{3}{4} \right)$ says that x can represent any number greater than or equal to $-\frac{3}{4}$. The interval is written $\left[-\frac{3}{4}, \infty \right)$. To graph the inequality, place a bracket at $-\frac{3}{4}$ (to show that $-\frac{3}{4}$ is part of the graph) and draw an arrow extending to the right. $-\frac{3}{4}$ $+\frac{1}{4}$ $+\frac{1}{4}$ -1 = 019. $z - 8 \ge -7$ $z - 8 + 8 \ge -7 + 8$ Add 8. $z \ge 1$

Graph the solution set $[1, \infty)$. ++++

$$p-3+3 \ge -11+3 \quad \text{Add } 3.$$

$$p \ge -8$$
Graph the solution set $[-8, \infty)$.

$$1 = \begin{bmatrix} 1 \\ 1 \\ 1 \\ -8 \end{bmatrix} = \begin{bmatrix} -8 \\ 0 \end{bmatrix}$$
21. $2k+3 \ge k+8$
 $2k+3-k \ge k+8-k$ Subtract $k.$
 $k+3 \ge 8$
 $k+3-3 \ge 8-3$ Subtract $3.$
 $k \ge 5$
Graph the solution set $[5, \infty)$.
 $1 + 1 + 1 = \begin{bmatrix} 1 \\ 1 \\ -8 \end{bmatrix} = \begin{bmatrix} 5 \\ \infty \end{bmatrix}$.
22. $3x+7 \ge 2x+11$
 $3x+7-2x \ge 2x+11-2x$ Subtract $2x.$
 $x+7 \ge 11$
 $x+7-7 \ge 11-7$ Subtract $7.$
 $x \ge 4$
Graph the solution set $[4, \infty)$.
 $1 + 1 + 1 = \begin{bmatrix} 1 \\ -7 \end{bmatrix} = \begin{bmatrix} 1 \\ -7 \end{bmatrix}$
 $0 = \begin{bmatrix} 4 \\ -7 \end{bmatrix}$.
 $1 + 1 = \begin{bmatrix} 1 \\ -7 \end{bmatrix} = \begin{bmatrix} 1 \\ -7 \end{bmatrix}$
 $1 + 1 = \begin{bmatrix} 1 \\ -7 \end{bmatrix} = \begin{bmatrix} 1 \\ -7 \end{bmatrix}$
24. $5x-2 \le 4x-5$
 $5x-2-4x \le 4x-5-4x$ Subtract $4x.$
 $x-2 \le -5$
 $x-2+2 \le -5+2$ Add $2.$
 $x \le -3$

20.

 $p - 3 \ge -11$

Graph the solution set $(-\infty, -3)$.

25. The inequality symbol must be reversed when one is multiplying or dividing by a negative number.

26. For choice A, the second part of the multiplication property of inequality states that when both sides of an inequality are multiplied by a negative number, the inequality symbol is reversed. Since r is negative, this statement is false.

Look at choice B. Both sides of the inequality p < q have been multiplied by the negative

number r and the inequality symbol has been reversed, so this statement is true.

Look at choice C. By the addition property of inequality, this statement is true. When the same number is added to both sides of an inequality, the inequality symbol is not reversed.

Look at choice D. When the same number is subtracted from both sides of an inequality, the inequality symbol is not reversed. The statement is true.

Therefore, only statement A is false.

27.
$$3x < 18$$

$$\frac{3x}{3} < \frac{18}{3}$$
 Divide by 3.
 $x < 6$

Graph the solution set $(-\infty, 6)$.

28. 5x < 355x < 35 Divide by 5

$$\frac{-}{5} < \frac{-}{5}$$

$$x < 7$$

Graph the solution set $(-\infty, 7)$.

0 7 29.
$$2y \ge -20$$

$$\frac{2y}{2} \ge \frac{-20}{2}$$
 Divide by 2.
 $y \ge -10$

Graph the solution set $[-10, \infty)$.

30. $6m \ge -24$ $\frac{6m}{6} \ge \frac{-24}{6}$ Divide by 6. $m \ge -4$

Graph the solution set $[-4, \infty)$. -4 0

36. Multiply by
$$-\frac{8}{7}$$
, the reciprocal of $-\frac{7}{8}$, and
reverse the inequality symbol.
 $-\frac{7}{8}t < -14$
 $\left(-\frac{8}{7}\right)\left(-\frac{7}{8}t\right) > \left(-\frac{8}{7}\right)(-14)$
 $t > 16$
Graph the solution set $(16, \infty)$.
 $++++++\frac{1}{6}$
37. $-0.02x \le 0.06$
 $-0.02x \ge 0.06$
 $-0.02x \ge 0.02$ Divide by -0.02 .
 $x \ge -3$
Graph the solution set $[-3, \infty)$.
 $+++\frac{1}{-3}$
38. $-0.03v \ge -0.12$
 $-0.03v \le -0.12$
 $\frac{-0.03v}{-0.03} \le \frac{-0.12}{-0.03}$ Divide by -0.03 .
 $v \le 4$
Graph the solution set $(-\infty, 4]$.
 $++++\frac{1}{-3}$
40. $6x + 9 \le -15$
 $8x \le -24$ Subtract 9.
 $\frac{8x}{8} \le \frac{-24}{8}$ Divide by 8.
 $x \le -3$
Graph the solution set $(-\infty, -3]$.
 $++++\frac{1}{-3}$
40. $6x + 7 \le -17$
 $6x \le -24$ Subtract 7.
 $\frac{6x}{6} \le \frac{-24}{6}$ Divide by 6.
 $x \le -4$
Graph the solution set $(-\infty, -4]$.

41. -4*x* - 3 < 1 -4x < 4 Add 3. $\frac{-4x}{-4} > \frac{4}{-4}$ Divide by -4. x > -1Graph the solution set $(-1, \infty)$. -1 0 **42.** -5x - 4 < 6-5x < 10 Add 4. $\frac{-5x}{-5} > \frac{10}{-5}$ Divide by -5. x > -2Graph the solution set $(-2, \infty)$. $\begin{array}{c} + \begin{array}{c} + \end{array} \\ -2 \end{array} 0 \end{array}$ **43.** $5r+1 \ge 3r-9$ $2r+1 \ge -9$ Subtract 3r. $2r \ge -10$ Subtract 1. $r \ge -5$ Divide by 2. Graph the solution set $[-5, \infty)$. -5 0 **44.** 6*t* + 3 < 3*t* + 12 3t + 3 < 12 Subtract 3t. 3t < 9Subtract 3. r < 3 Divide by 3. Graph the solution set $(-\infty, 3)$. \leftrightarrow **45.** $5x - 2 \le -x + 10$ $6x - 2 \le 10$ Add x. $6x \le 12$ Add 2. $x \le 2$ Divide by 6. Graph the solution set $(-\infty, 2]$.

46. $3x - 9 \ge -2x + 6$ $5x-9 \ge 6$ Add 2x. $5x \ge 15$ Add 9. $x \ge 3$ Divide by 5. Graph the solution set $[3,\infty)$. 0 1 2 3 **47.** -7x + 4 > -3x - 24 > 4x - 2 Add 7x. 6 > 4x Add 2. $\frac{6}{4} > x$ Divide by 4. $\frac{3}{2} > x$ $x < \frac{3}{2}$ Graph the solution set $\left(-\infty, \frac{3}{2}\right)$. **48.** -8x + 1 < -4x + 111 < 4x + 11 Add 8x. -10 < 4xSubtract 11. $-\frac{10}{4} < x$ Divide by 4. $x > -\frac{5}{2}$ Graph the solution set $\left(-\frac{5}{2},\infty\right)$. $-\frac{5}{2}$ $-\frac{1}{2}$ $-3 -2 \quad 0 \quad 1$ **49.** 6x + 3 + x < 2 + 4x + 47x + 3 < 4x + 6Combine like terms. 3x + 3 < 6Subtract 4*x*. 3*x* < 3 Subtract 3. *x* < 1 Divide by 3. Graph the solution set $(-\infty, 1)$. <+++) + + +≻ 0 1

 $5w + 12 \ge 2w + 9$ Combine terms. $3w+12 \ge 9$ Subtract 2w. $3w \ge -3$ Subtract 12. $w \ge -1$ Divide by 3. Graph the solution set $[-1, \infty)$. ++[++++> -1 0 **51.** $-x + 4 + 7x \le -2 + 3x + 6$ $6x + 4 \le 4 + 3x$ $3x + 4 \leq 4$ $3x \le 0$ $x \le 0$ Graph the solution set $(-\infty, 0]$. + + +≻ **52.** 14x - 6 + 7x > 4 + 10x - 1021x - 6 > 10x - 611x - 6 > -611x > 0x > 0Graph the solution set $(0, \infty)$. **53.** 5(t-1) > 3(t-2)5t - 5 > 3t - 62t - 5 > -62t > -1 $t > -\frac{1}{2}$ Graph the solution set $\left(-\frac{1}{2},\infty\right)$.

50. $-4w + 12 + 9w \ge w + 9 + w$

54.
$$7(m-2) < 4(m-4)$$

 $7m-14 < 4m-16$
 $3m-14 < -16$
 $3m < -2$
 $m < -\frac{2}{3}$
Graph the solution set $\left(-\infty, -\frac{2}{3}\right)$.
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63.
$$4x - (6x + 1) \le 8x + 2(x - 3)$$

 $4x - 6x - 1 \le 8x + 2x - 6$
 $-2x - 1 \le 10x - 6$
 $-12x \le -5$
 $\frac{-12x}{-12} \ge \frac{-5}{-12}$ Divide by -12 .
 $x \ge \frac{5}{12}$
Graph the solution set $\left[\frac{5}{12}, \infty\right]$.
 $4x - (4z + 3) \ge 6z + 3(z + 4)$
 $2z - (4z + 3) \ge 6z + 3(z + 4)$
 $2z - 4z - 3 \ge 6z + 3z + 12$
 $-2z - 3 \ge 9z + 12$
 $-11z \ge 15$
 $\frac{-11z}{-11} < \frac{15}{-11}$ Divide by -11 .
 $z < -\frac{15}{11}$
Graph the solution set $\left(-\infty, -\frac{15}{11}\right)$.
 $4x - 3 > 12$
 $-10k + 15 - 2k + 16 \ge 6k + 12 + k - 2$
 $10k + 15 - 2k + 16 \ge 6k + 12 + k - 2$
 $8k + 31 \ge 7k + 10$
 $k + 31 \ge 10$
 $k > -21$
Graph the solution set $(-21, \infty)$.
 $4x - 21$
Graph the solution set $(-21, \infty)$.
 $4x - 21$
 -21
 -21
 -25
 -25
Graph the solution set $[-25, \infty)$.
 -25
 -25
 $-5 = 0$

- 67. The statement "You must be at least 18 yr old to vote" translates as $x \ge 18$.
- **68.** The statement "Less than 1 in. of rain fell" translates as x < 1.
- **69.** The statement "Chicago received more than 5 in. of snow" translates as x > 5.
- 70. The statement "A full-time student must take at least 12 credits" translates as $x \ge 12$.
- 71. The statement "Tracy could spend at most \$20 on a gift" translates as $x \le 20$.
- 72. The statement "The car's rate exceeded 60 mph" translates as x > 60.
- **73.** Let x = the score on the third test.

The average
of the is at least
three tests

$$\downarrow$$
 \downarrow \downarrow \downarrow
 $76+81+x$

$$\frac{76+81+x}{3} \ge 80$$

Then solve the inequality.

$$\frac{157 + x}{3} \ge 80$$

$$3\left(\frac{157 + x}{3}\right) \ge 3(80)$$

$$157 + x \ge 240$$

$$x \ge 83$$

In order to average at least 80, Christy's score on her third test must be 83 or greater.

74. Let x = the score on the third test.

The average of the is at least 90. three tests $\downarrow \qquad \downarrow \qquad \downarrow \qquad \downarrow$ $\frac{96+86+x}{3} \geq 90$ Then solve the inequality. 182+x

$$\frac{182+x}{3} \ge 90$$

$$3\left(\frac{182+x}{3}\right) \ge 3(90)$$

$$182+x \ge 270$$

$$x \ge 88$$

In order to average at least 90, Joseph's score on his third test must be 88 or greater.

75. Let x = the amount of precipitation in December. The average precipitation \downarrow \downarrow \downarrow \downarrow $\frac{5.7+4.3+x}{3} > 4.6$ Then solve the inequality. $\frac{10+x}{3} > 4.6$

$$3\left(\frac{10+x}{3}\right) > 3(4.6)$$
$$10+x > 13.8$$
$$x > 3.8$$

In order for the average monthly precipitation to exceed 4.6 in., more than 3.8 in. must fall in December.

76. Let x = the amount of precipitation in August. The average exceeds 6.7 in.

$$3\left(\frac{13.8+x}{3}\right) > 3(6.7)$$

13.8+x > 20.1

x > 6.3

In order for the average monthly precipitation to exceed 6.7 in., more than 6.3 in. must fall in August.

77. Let n = the number.

"When 2 is added to the difference between six times a number and 5, the result is greater than 13 added to five times the number" translates to (6n-5)+2 > 5n+13.

Solve the inequality.

$$6n-5+2 > 5n+13$$

$$6n-3 > 5n+13$$

 $n-3 > 13$ Subtract 5n.

$$n > 16$$
 Add 3.

All numbers greater than 16 satisfy the given condition.

78. Let n = the number.

"When 8 is subtracted from the sum of three times a number and 6, the result is less than 4 more than the number" translates to (3n+6)-8 < n+4.

Solve the inequality.

3n

$$+6-8 < n+4$$

 $3n-2 < n+4$
 $2n-2 < 4$ Subtract *n*.
 $2n < 6$ Add 2.
 $n < 3$ Divide by 2

All numbers less than 3 satisfy the given condition.

79. The Fahrenheit temperature must correspond to a Celsius temperature that is greater than or equal to -25° .

$$C = \frac{5}{9}(F - 32) \ge -25$$

$$\frac{9}{5} \left[\frac{5}{9}(F - 32) \right] \ge \frac{9}{5}(-25)$$

$$F - 32 \ge -45$$

$$F \ge -13$$

The temperature in Minneapolis on a certain winter day is never less than -13° Fahrenheit.

80. The Celsius temperature must give a Fahrenheit temperature that is less than or equal to 122° .

$$F = \frac{9}{5}C + 32 \le 122$$
$$\frac{9}{5}C \le 90$$
$$\frac{5}{9}\left(\frac{9}{5}C\right) \le \frac{5}{9}(90)$$
$$C \le 50$$

The temperature of Phoenix has never exceeded 50° Celsius.

81. $P = 2L + 2W; P \ge 400$

From the figure, we have L = 4x + 3 and W = x + 37. Thus, we have the inequality $2(4x + 3) + 2(x + 37) \ge 400$. Solve this inequality. $8x + 6 + 2x + 74 \ge 400$ $10x + 80 \ge 400$ $10x \ge 320$

$$x \ge 32$$

The rectangle will have a perimeter of at least 400 if the value of x is 32 or greater.

82. $P = a + b + c; P \ge 72$

From the figure, we have a = x, b = x+11, and c = 2x+5. Thus, we have the inequality $x + (x+11) + (2x+5) \ge 72$. Solve this inequality. $4x+16 \ge 72$ $4x \ge 56$ $x \ge \frac{56}{4} = 14$

The triangle will have a perimeter of at least 72 if the value of x is 14 or greater.

83.
$$2 + 0.30x \le 5.60$$

 $10(2+0.30x) \le 10(5.60)$

$$20 + 3x \le 56$$

 $3x \le 36$

 $x \le 12$

Alan can use the phone for a maximum of 12 minutes.

84. Let x = the number of gallons.

The amount she spends can be represented by \$3+\$3.60x. This must be less than or equal to \$48.00.

$$3+3.6x \le 48$$

 $3.6x \le 45$ Subtract 3.
 $\frac{3.6x}{3.6} \le \frac{45}{3.6}$ Divide by 3.6.
 $x \le 12.5$

She can purchase 12.5 gallons of gasoline.

- 85. "Revenue from the sales of the DVDs is \$5 per DVD less sales costs of \$100" translates to R = 5x - 100, where *x* represents the number of DVDs to be produced.
- **86.** "Production costs are \$125 plus \$4 per DVD" translates to C = 125 + 4x.

87.
$$P = R - C$$

$$=(5x-100)-(125+4x)$$

=5x-100-125-4x

$$= x - 225$$

We can use this expression for P to solve the inequality.

$$P > 0$$
$$x - 225 > 0$$
$$x > 225$$

88. To make a profit, more than 225 DVDs must be produced and sold.

- **89.** The graph corresponds to the inequality -1 < x < 2, excluding both -1 and 2.
- **90.** The graph corresponds to the inequality $-1 \le x < 2$.
- **91.** The graph corresponds to the inequality $-1 < x \le 2$, excluding -1 but including 2.
- **92.** The graph corresponds to the inequality $-1 \le x \le 2$.
- **93.** The statement $8 \le x \le 10$ says that *x* can represent any number between 8 and 10, including 8 and 10. To graph the inequality, place brackets at 8 and 10 (to show that 8 and 10 are part of the graph) and draw a line segment between the brackets. The interval is written as [8, 10].

94. The statement $3 \le x \le 5$ can be written as [3, 5].

95. The statement $0 < y \le 10$ says that y can represent any number between 0 and 10, excluding 0 and including 10. To graph the inequality, place a parenthesis at 0 and a bracket at 10 and draw a line segment between them. The interval is written as (0, 10].

96. The statement $-3 \le x < 0$ can be written as [-3, 0).

$$+\underbrace{[++)}_{-3}+++++ \rightarrow 5$$

97. The statement 4 > x > -3 can be written as -3 < x < 4. Graph the solution set (-3, 4).

98. The statement $6 \ge x \ge -4$ can be written as $-4 \le x \le 6$. Graph the solution set [-4, 6].

99.

 $-8 < 4x \le 4$

104. $-8 \le 3r - 1 \le -1$ $-7 \leq 3r \leq 0$ Add 1. $-\frac{7}{2} \le r \le 0$ Divide by 3. Graph the solution set $\left| -\frac{7}{3}, 0 \right|$. $++\frac{-\frac{i}{3}}{4}$ **105.** -4 < -2x < 12 $\frac{-4}{-2} > \frac{-2x}{-2} > \frac{12}{-2}$ Divide by -2. 2 > x > -6-6 < x < 2Graph the solution set (-6, 2). $\begin{array}{c|c} \hline (++++++) \\ \hline -6 & 0 & 2 \end{array}$ **106.** 9 < -3x < 15 $\frac{9}{-3} > \frac{-3x}{-3} > \frac{15}{-3}$ Divide by -3. -3 > x > -5-5 < x < -3Graph the solution set (-5, -3). ++ (+) ++++ \rightarrow -5 -3 05 < 1 - 6m < 12107. 5-1 < 1-6m-1 < 12-1 Subtract 1. 4 < -6*m* <11 $\frac{4}{-6} > \frac{-6m}{-6} > \frac{11}{-6}$ Divide by -6. $-\frac{2}{3}$ > m > $-\frac{11}{6}$ $-\frac{11}{6} < m < -\frac{2}{3}$ Graph the solution set $\left(-\frac{11}{6}, -\frac{2}{3}\right)$. $-\frac{11}{6} - \frac{2}{3} + \frac{1}{6} + \frac{$

108. $-1 < 1 - 5q \le 16$ $-1-1 \le 1-5q-1 \le 16-1$ Subtract 1. $-2 \leq -5q \leq 15$ $\frac{-2}{-5} \ge \frac{-5q}{-5} \ge \frac{15}{-5} \quad \text{Divide by} - 5.$ $\frac{2}{5} \ge q \ge -3$ $-3 \le q \le \frac{2}{5}$ Graph the solution set $\left[-3, \frac{2}{5}\right]$. +**109.** $6 \le 3(x-1) < 18$ $6 \leq 3x - 3 < 18$ Distributive prop. $6+3 \le 3x-3+3 < 18+3$ Add 3. $9 \leq 3x < 21$ $\frac{9}{3} \le \frac{3x}{3} < \frac{21}{3}$ Divide by 3. 3≤ < 7 Graph the solution set [3, 7). $-4 < 2(x+1) \le 6$ 110. $-4 < 2x + 2 \le 6$ Distributive prop. $-4-2 < 2x+2-2 \le 6-2$ Subtract 2. $-6 < 2x \leq 4$ $\frac{-6}{2} < \frac{2x}{2} \le \frac{4}{2}$ Divide by 2. -3< Graph the solution set (-3, 2]. **111.** $-12 \le \frac{1}{2}z + 1 \le 4$ Multiply by 2. $2(-12) \le 2\left(\frac{1}{2}z+1\right) \le 2(4)$ $-24 \leq z+2 \leq 8$ Dist. prop. $-24 - 2 \le z + 2 - 2 \le 8 - 2$ Subtract 2. $-26 \le z \le 6$

Note: We could have started this solution by subtracting 1 from each part. Graph the solution set [-26, 6]. $\begin{array}{c|c} -26 & 6 \\ \hline & -1 & -1 & -1 \\ -30 & -20 & -10 & 0 & 10 \end{array}$ $-6 \le \frac{1}{3}x + 3 \le 5$ 112. $-6-3 \le \frac{1}{3}x+3-3 \le 5-3$ Subtract 3. $-9 \leq \frac{1}{3}x \leq 2$ $3(-9) \le 3\left(\frac{1}{3}x\right) \le 3(2)$ Multiply by 3. -27 ≤ x ≤ 6 Note: We could have started this solution by multiplying each part by 3. Graph the solution set [-27, 6]. -10^{-10} $+10^{-10}$ $+10^{-10}$ $+10^{-10}$ $1 \le 3 + \frac{2}{3}p \le 7$ 113. $3(1) \le 3\left(3 + \frac{2}{3}p\right) \le 3(7)$ Multiply by 3. $3 \le 9 + 2p \le 21$ Dist. prop. $3-9 \le 9+2p-9 \le 21-9$ Subtract 9. $-6 \leq 2p \leq 12$ Divide by 2. -3≤ ≤6 р Graph the solution set [-3, 6]. -3 0 6 $2 < 6 + \frac{3}{4}x < 12$ 114. $4(2) < 4\left(6 + \frac{3}{4}x\right) < 4(12)$ Multiply by 4. 8 < 24 + 3x < 48 Distributive prop. -16 < 3x < 24Subtract 24. $-\frac{16}{3}$ < x < 8 Divide by 3. Graph the solution set $\left(-\frac{16}{3}, 8\right)$.

115.
$$-7 \le \frac{5}{4}r - 1 \le -1$$

 $-7 + 1 \le \frac{5}{4}r - 1 + 1 \le -1 + 1$ Add 1.
 $-6 \le \frac{5}{4}r \le 0$
 $\frac{4}{5}(-6) \le \frac{4}{5}\left(\frac{5}{4}r\right) \le \frac{4}{5}(0)$ Multiply by $\frac{4}{5}$.
 $-\frac{24}{5} \le r \le 0$
Graph the solution set $\left[-\frac{24}{5}, 0\right]$.
 $-\frac{24}{5}$
 $-12 \le \frac{3}{7}x + 2 \le -4$
 $7(-12) \le 7\left(\frac{3}{7}x + 2\right) \le 7(-4)$ Multiply by 7
 $-84 \le 3x + 14 \le -28$ Dist. prop.
 $-98 \le 3x \le -42$ Subtract 14.
 $-\frac{98}{3} \le x \le -14$ Divide by 3.
To graph the solution set $\left[-\frac{98}{3}, -14\right]$, note
that $-\frac{98}{3} = -32\frac{2}{3}$.
 $-\frac{98}{3} = -32\frac{2}{3}$.
 $-\frac{98}{3} = -14$
 $-12 \le 34 + 56 - 78$
118. $3x + 2 > 14$
 $3x > 12$
 $x > 4$
Solution set: $(4, \infty)$
 $+1 + 4 + 1 + 1 \Rightarrow$
 $1 \ge 3 + 4 5 - 6 - 78$

119.
$$3x+2 < 14$$

 $3x < 12$
 $x < 4$
Solution set: $(-\infty, 4)$
 $< + + + >$
 $1 \ 2 \ 3 \ 4 \ 5 \ 6 \ 7$

120. If you were to graph all the solutions from Exercises 117–120 on the same number line, the graph would be the complete number line, that is, all real numbers.

Chapter 2 Review Exercises

1. x-5=1x=6 Add 5. The solution set is {6}.

2. x + 8 = -4

x = -12 Subtract 8. The solution set is $\{-12\}$.

- **3.** 3t+1=2t+8
 - t+1=8 Subtract 2t. t=7 Subtract 1.

The solution set is $\{7\}$.

4.
$$5z = 4z + \frac{2}{3}$$

 $z = \frac{2}{3}$ Subtract 4z.

The solution set is $\left\{\frac{2}{3}\right\}$.

5.
$$(4r-2)-(3r+1) = 8$$

 $(4r-2)-1(3r+1) = 8$
 $4r-2-3r-1 = 8$ Distributive property
 $r-3 = 8$
 $r = 11$ Add 3.
The solution set is {11}.

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

$$6x-15 = 2+5x$$
 Distributive property

$$x-15 = 2$$
 Subtract 5x.

$$x = 17$$
 Add 15.

The solution set is {17}.

7. 7x = 35

6.

x = 5 Divide by 7. The solution set is $\{5\}$. **8.** 12r = -48

r = -4 Divide by 12. The solution set is $\{-4\}$.

9.
$$2p-7p+8p=15$$

 $3p=15$
 $p=5$ Divide by 3.

The solution set is {5}.

10. $\frac{x}{12} = -1$ x = -12 Multiply by 12.

The solution set is $\{-12\}$.

11.
$$\frac{5}{8}q = 8$$
$$\frac{8}{5}\left(\frac{5}{8}q\right) = \frac{8}{5}(8) \quad \text{Multiply by } \frac{8}{5}.$$
$$q = \frac{64}{5}$$
The solution set is $\left\{\frac{64}{5}\right\}.$

12. 12m + 11 = 5912m = 48 Subtract 11. m = 4 Divide by 12.

The solution set is {4}.

13.
$$3(2x+6)-5(x+8) = x-22$$

 $6x+18-5x-40 = x-22$
 $x-22 = x-22$
This is a true statement, so the

This is a true statement, so the solution set is {all real numbers}.

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

 $5x+9-2x+3 = 2x-7$
 $3x+12 = 2x-7$
 $x+12 = -7$
 $x = -19$

The solution set is $\{-19\}$.

15.
$$\frac{1}{2}r - \frac{r}{3} = \frac{r}{6}$$
$$6\left(\frac{1}{2}r\right) - 6\left(\frac{r}{3}\right) = 6\left(\frac{r}{6}\right)$$
 Multiply by 6.
$$3r - 2r = r$$
$$r = r$$

This is a true statement, so the solution set is {all real numbers}.

16. Multiply by 10 to clear decimals.

$$10[0.1(x+80)+0.2x] = 10(14)$$

 $(x+80)+2x = 140$ Dist. prop.
 $3x+80 = 140$
 $3x = 60$
 $x = 20$

The solution set is $\{20\}$.

17.
$$3x - (-2x+6) = 4(x-4) + x$$

 $3x + 2x - 6 = 4x - 16 + x$
 $5x - 6 = 5x - 16$
 $-6 = -16$
This statement is folce, so that

This statement is false, so there is no solution set, symbolized by \emptyset .

18. Multiply both sides by 6 to eliminate fractions.

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

$$6\left\lfloor \frac{1}{2}(x+3) \right\rfloor - 6\left\lfloor \frac{2}{3}(x-2) \right\rfloor = 18$$

$$3(x+3) - 4(x-2) = 18$$

$$3x+9 - 4x + 8 = 18$$

$$-x+17 = 18$$

$$-x = 1$$

$$x = -1$$

The solution set is $\{-1\}$.

19. Let x represent the number. 5x+7 = 3x 7 = -2x Subtract 5x. $-\frac{7}{2} = x$ Divide by -2.

The number is $-\frac{7}{2}$.

20. *Step 2*

Let x = the number of Republicans. Then x + 24 = the number of Democrats. Step 3 x + (x + 24) = 118Step 4 2x + 24 = 118 2x = 94x = 47

Step 5

Since x = 47, x + 24 = 71. There were 71 Democrats and 47 Republicans. *Step 6* There are 24 more Democrats than Republicans and the total is 118.

21. *Step 2*

Let x = the land area of Rhode Island. Then x+5213 = the land area of Hawaii. Step 3 The areas total 7637 square miles, so x+(x+5213) = 7637. Step 4 2x+5213 = 7637 2x = 2424 x = 1212Step5 Since x = 1212, x+5213 = 6425.

The land area of Rhode Island is 1212 square miles and that of Hawaii is 6425 square miles. *Step 6*

The land area of Hawaii is 5213 square miles greater than the land area of Rhode Island and the total is 7637 square miles.

22. *Step 2*

Let x = the height of Twin Falls. Then $\frac{5}{2}x =$ the height of Seven Falls. Step 3 The sum of the heights is 420 feet, so $x + \frac{5}{2}x = 420$. Step 4 $2\left(x + \frac{5}{2}x\right) = 2(420)$ 2x + 5x = 840 7x = 840 x = 120Step 5 Since $x = 120, \frac{5}{2}x = \frac{5}{2}(120) = 300$. The height of Twin Falls is 120 feet and that of Seven Falls is 300 feet.

Step 6 The height of Seven Falls is $\frac{5}{2}$ the height of Twin Falls and the sum is 420. 23. Step 2

Let x = the measure of the angle. Then 90 - x = the measure of its complement and 180 - x = the measure of its supplement. Step 3 180 - x = 10(90 - x)Step 4 180 - x = 900 - 10x9x + 180 = 9009x = 720x = 80Step5 The measure of the angle is 80°. Its complement measures $90^{\circ} - 80^{\circ} = 10^{\circ}$, and its supplement measures $180^\circ - 80^\circ = 100^\circ$. Step 6 The measure of the supplement is 10 times the measure of the complement. **24.** *Step 2*

Let x = lesser odd integer. Then x+2 = greater odd integer. Step 3 x+2(x+2) = (x+2)+24Step 4 x+2x+4 = x+26 3x+4 = x+26 2x+4 = 26 2x = 22 x = 11Step 5 Since x = 11, x+2 = 13. The consecutive odd numbers are 11 and 13. Step 6 The lesser plus twice the greater is

11+2(13) = 37, which is 24 more than the greater.

25. Solve for *h*.

$$A = \frac{1}{2}bh$$
$$44 = \frac{1}{2}(8)h$$
$$44 = 4h$$
$$11 = h$$

26. Solve for *A*. $A = \frac{1}{2}h(b+B)$ $A = \frac{1}{2}(8)(3+4)$ $=\frac{1}{2}(8)(7)$ =(4)(7)*A* = 28 **27.** Solve for *r*. $C = 2\pi r$ 29.83 = 2(3.14)r29.83 = 6.28r29.83 _ 6.28r 6.28 6.28 4.75 = r28. Solve for V. $V = \frac{4}{3}\pi r^3$ $=\frac{4}{3}(3.14)(6)^3$ $=\frac{4}{3}(3.14)(216)$ $\frac{4}{-}(678.24)$

$$=\frac{-(678.24)}{3}$$

V = 904.32

- 29. Solve for *h*. $\frac{A}{b} = \frac{bh}{b}$ Divide by *b*. $\frac{A}{b} = h, \text{ or } h = \frac{A}{b}$
- **30.** Solve for *h*.

$$2A = 2\left[\frac{1}{2}h(b+B)\right] \qquad \text{Multiply by 2.}$$
$$2A = h(b+B)$$
$$\frac{2A}{(b+B)} = \frac{h(b+B)}{(b+B)} \qquad \text{Divide by } b+B.$$
$$\frac{2A}{b+B} = h, \text{ or } h = \frac{2A}{b+B}$$

31. Solve for *y*.
$$x + y = 11$$

 $y = -x + 11$

- 32. Solve for y. 3x - 2y = 12 -2y = -3x + 12 $y = \frac{3}{2}x - 6$
- **33.** Because the two angles are supplementary, (8x-1)+(3x-6) = 180. 11x-7 = 180 11x = 187 x = 17Since x = 17, 8x-1 = 135, and 3x-6 = 45.

The measures of the two angles are 135° and 45° .

34. The angles are vertical angles, so their measures are equal. 3x+10 = 4x - 2010 = x - 2030 = x

> Since x = 30, 3x + 10 = 100 and 4x - 20 = 100. Each angle has a measure of 100° .

- **35.** Let W = the width of the rectangle. Then W + 12 = the length of the rectangle. "The perimeter of the rectangle is 16 times the width" can be written as 2L + 2W = 16W since the perimeter is 2L + 2W. Because L = W + 12, we have 2(W + 12) + 2W = 16W. 2W + 24 + 2W = 16W 4W + 24 = 16W -12W + 24 = 0 -12W = -24 W = 2
 - The width is 2 cm and the length is 2+12 = 14 cm.
- **36.** The sum of the three marked angles in the triangle is 180°.

$$45^{\circ} + (x+12.2)^{\circ} + (3x+2.8)^{\circ} = 180^{\circ}$$
$$4x + 60 = 180$$
$$4x = 120$$
$$x = 30$$
Since $x = 30, (x+12.2)^{\circ} = 42.2^{\circ}$ and $(3x+2.8)^{\circ} = 92.8^{\circ}$.

37. The ratio of 60 centimeters to 40 centimeters is $\frac{60 \text{ cm}}{40 \text{ cm}} = \frac{3 \cdot 20}{2 \cdot 20} = \frac{3}{2}.$ **38.** To find the ratio of 90 inches to 10 feet, first convert 10 feet to inches. 10 feet = $10 \cdot 12 = 120$ inches Thus, the ratio of 90 inches to 10 feet is $\frac{90}{120} = \frac{3 \cdot 30}{4 \cdot 30} = \frac{3}{4}$.

39.
$$\frac{p}{21} = \frac{5}{30}$$

 $30p = 105$ Cross products
 $\frac{30p}{30} = \frac{105}{30}$ Divide by 30.
 $p = \frac{105}{30} = \frac{7 \cdot 15}{2 \cdot 15} = \frac{7}{2}$
The solution set is $\left\{\frac{7}{2}\right\}$.

- 40. $\frac{5+x}{3} = \frac{2-x}{6}$ 6(5+x) = 3(2-x) Cross products 30+6x = 6-3x Distributive property 30+9x = 6 Add 3x. 9x = -24 Subtract 30. $x = \frac{-24}{9} = -\frac{8}{3}$ The solution set is $\left\{-\frac{8}{3}\right\}$.
- **41.** Let *x* = the tax on a \$36.00 item. Set up a proportion with one ratio involving sales tax and the other involving the costs of the items.

$$\frac{x \text{ dollars}}{\$2.04} = \frac{\$36}{\$24}$$
$$24x = (2.04)(36) = 73.44$$
$$x = \frac{73.44}{24} = 3.06$$

The sales tax on a \$36.00 item is \$3.06.

42. Let *x* = the actual distance between the second pair of cities (in kilometers). Set up a proportion with one ratio involving map distances and the other involving actual distances.

$$\frac{x \text{ kilometers}}{150 \text{ kilometers}} = \frac{80 \text{ centimeters}}{32 \text{ centimeters}}$$
$$32x = (150)(80) = 12,000$$
$$x = \frac{12,000}{32} = 375$$

The cities are 375 kilometers apart.

43. Let x = the number of gold medals earned by Italy.

$$\frac{x \text{ gold medals}}{28 \text{ medals}} = \frac{2 \text{ gold medals}}{7 \text{ medals}}$$
$$7x = 2(28) = 56$$
$$x = 8$$

At the 2012 Olympics, 8 gold medals were earned by Italy.

44. To find the best buy, divide the price by the number of units to get the unit cost. Each result was found by using a calculator and rounding the answer to three decimal places. The best buy (based on price per unit) is the smallest unit cost. The results in the following table are rounded to the nearest thousandth.

Size	Price	Unit Cost (dollar per oz)
9 oz	\$3.49	$\frac{\$3.49}{9} \approx \0.388
14 oz	\$3.99	$\frac{\$3.99}{14} = \0.285
18 oz	\$4.49	$\frac{\$4.49}{18} \approx \0.249 (*)

Because the 18-oz size produces the lowest unit cost, it is the best buy. The unit cost, to the nearest thousandth, is \$0.249 per oz.

- 45. What percent of 12 is 21? Let *p* denote the percent. $21 = p \cdot 12$ $p = \frac{21}{12} = 1.75 = 175\%$ 21 is 175% of 12.
- **46.** 36% of what number is 900? Let *n* denote the number. $0.36 \cdot n = 900$

$$n = \frac{900}{0.36}$$
 Divide by 0.36.
= 2500 Simplify.

- Thus, 36% of 2500 is 900.
- **47.** Let x = the number of liters of the 60% solution to be used. Then x+15 = the number of liters of the 20% solution.

10%		60%		20%
solution	plus	solution	is	solution.
\downarrow	\downarrow	\downarrow	\downarrow	\downarrow
0.10(15)	+	0.60(x)	=	0.20(x+15)

Multiply by 10 to clear decimals. 1(15) + 6x = 2(x+15) 15 + 6x = 2x + 30 15 + 4x = 304x = 15

$$x = \frac{15}{4} = 3.75$$

3.75 liters of 60% solution are needed.

48. Let x = the amount invested at 5%.

Then 10,000 - x = the amount invested at 3%.

Interest		interest		
at 5%	plus	at 3%	equals	\$400.
\downarrow	\downarrow	\downarrow	\downarrow	\downarrow
0.05 <i>x</i>	+	0.03(10,000 - x)	=	400
So 5x	blve the $x + 3(10, 0)$ 5x + 30, 0	equation. 000 - x) = 100(400) 000 - 3x = 40,000		
Ro 10	obert inv), 000 – 5	2x = 10,000 x = 5000 ested \$5000 at 5% a 000 = \$5000 at 3%.	nd	
49. Us	se the for	rmula $d = rt$ or $r =$	$\frac{d}{d}$.	

19. Use the formula
$$d = rt$$
 or $r = -\frac{d}{t}$

$$r = \frac{d}{t} = \frac{3150}{384} \approx 8.203$$

Rounded to the nearest tenth, the *Yorkshire's* average rate was 8.2 mph.

50. Let t = the number of hours until the planes are 1925 miles apart.

The	the distance			the	
distance		the other			
one plane		plane		between	
flies north	plus	flies south	equals	the planes.	
\downarrow	\downarrow	\downarrow	\downarrow	\downarrow	
350 <i>t</i>	+	420 <i>t</i>	=	1925	
Solve 350 <i>t</i>	Solve the equation. 350t + 420t = 1925				
	770t =	=1925			
$t = \frac{1925}{770} = \frac{5}{2} = 2\frac{1}{2}$					
The p	lanes w	vill be 1925 m	iles apart	in	
$2\frac{1}{2}$ ł	nours.				

- 51. The statement $x \ge -4$ can be written as $[-4, \infty)$. -4
- 52. The statement x < 7 can be written as $(-\infty, 7)$. $(-\infty, 7)$.
- 53. The statement $-5 \le x < 6$ can be written as [-5, 6].

- 54. By examining the choices, we see that $-4x \le 36$ is the only inequality that has a negative coefficient of *x*. Thus, B is the only inequality that requires a reversal of the inequality symbol when it is solved.
- **55.** $x + 6 \ge 3$

$$x \ge -3$$
 Subtract 6.

Graph the solution set $[-3, \infty)$.

$$\begin{array}{c|c} + & \hline \\ -3 & 0 \end{array}$$

56. 5x < 4x + 2x < 2 Subtract 4x.

Graph the solution set $(-\infty, 2)$.

$$\leftrightarrow$$

57.
$$-6x \le -18$$

 $\frac{-6x}{-6} \ge \frac{-18}{-6}$ Divide by -6.
 $x \ge 3$

Graph the solution set $[3, \infty)$.

58.
$$8(x-5) - (2+7x) \ge 4$$

 $8x - 40 - 2 - 7x \ge 4$
 $x - 42 \ge 4$
 $x \ge 46$
Graph the solution set [46, ∞).
 $+ + + + + = = =$
0 10 40 46

59.
$$4x - 3x > 10 - 4x + 7x$$

 $x > 10 + 3x$
 $-2x > 10$
 $\frac{-2x}{-2} < \frac{10}{-2}$ Divide by -2.
 $x < -5$
Graph the solution set $(-\infty, -5)$.
 $<+++++++++ > -5$
 $60. \quad 3(2x+5) + 4(8+3x) < 5(3x+7)$
 $6x+15+32+12x < 15x+35$
 $18x+47 < 15x+35$
 $3x+47 < 35$
 $3x < -12$
 $x < -4$
Graph the solution set $(-\infty, -4)$.
 $<++++++ > -4$
 $61. \quad -3 \le 2x+1 \le 4$
 $-4 \le 2x \le 3$ Subtract 1.
 $-2 \le x \le \frac{3}{2}$ Divide by 2.
Graph the solution set $\left[-2, \frac{3}{2}\right]$.
 $<++++++ = -4$
 $62. \quad 9 < 3x+5 \le 20$
 $4 < 3x \le 15$ Subtract 5.
 $\frac{4}{3} < x \le 5$ Divide by 3.
Graph the solution set $\left(\frac{4}{3}, 5\right]$.
 $<++++++ = -4$
 $61. \quad -3 \le 2x+1 \le 4$
 $-2 \le x \le \frac{3}{2}$ Divide by 3.
 $= -2$
 $62. \quad 9 < 3x+5 \le 20$
 $4 < 3x \le 15$ Subtract 5.
 $\frac{4}{3} < x \le 5$ Divide by 3.
 $= -2$
 $63. \quad 5 = -2$
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 $4 < 3x \le 5$ Divide by 3.
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63. Let x = the score on the third test.

The average

of the is at least 90.
three tests

$$\downarrow$$
 \downarrow \downarrow \downarrow
 $\frac{94+88+x}{3} \ge 90$
 $\frac{182+x}{3} \ge 90$
 $3\left(\frac{182+x}{3}\right) \ge 3(90)$
 $182+x \ge 270$
 $x \ge 88$
In order to average at least 90,
Awilda's score on her third test must
be 88 or more.
64. Let $n =$ the number.

"If nine times a number is added to 6, the result is at most 3" can be written as $9n + 6 \le 3$. Solve the inequality. $9n + 6 \le 3$ $9n \le -3$ Subtract 6

$$n \le \frac{-3}{9}$$
 Divide by 9.
 $n \le -\frac{1}{3}$

All numbers less than or equal to $-\frac{1}{3}$ satisfy

the given condition.

Chapter 2 Mixed Review Exercises

1.
$$\frac{x}{7} = \frac{x-5}{2}$$

$$2x = 7(x-5)$$
 Cross products

$$2x = 7x-35$$

$$-5x = -35$$

$$x = 7$$

The solution set is $\{7\}$.

2. Solve I = prt for r.

$$\frac{I}{pt} = \frac{prt}{pt}$$
 Divide by pt .
$$\frac{I}{pt} = r$$
, or $r = \frac{I}{pt}$

3. -2x > -4 $\frac{-2x}{-2} < \frac{-4}{-2}$ Divide by -2. x < 2The solution set is $(-\infty, 2)$.

4. 2k-5 = 4k+13-2k-5 = 13 Subtract 4k.

-2k = 18 Add 5. k = -9 Divide by -2.The solution set is $\{-9\}.$

5. 0.05x + 0.02x = 4.9To clear decimals, multiply both sides by 100. 100(0.05x + 0.02x) = 100(4.9)

$$5x + 2x = 490$$
$$7x = 490$$
$$x = 70$$

The solution set is {70}.

6.
$$2-3(x-5) = 4+x$$
$$2-3x+15 = 4+x$$
$$17-3x = 4+x$$
$$17-4x = 4$$
$$-4x = -13$$
$$x = \frac{-13}{-4} = \frac{13}{4}$$
The solution set is $\left\{\frac{13}{4}\right\}$.

7.
$$9x - (7x + 2) = 3x + (2 - x)$$

 $9x - 7x - 2 = 3x + 2 - x$
 $2x - 2 = 2x + 2$
 $-2 = 2$

Because -2 = 2 is a false statement, the given equation has no solution, symbolized by \emptyset .

8.
$$\frac{1}{3}s + \frac{1}{2}s + 7 = \frac{5}{6}s + 5 + 2$$

 $\frac{1}{3}s + \frac{1}{2}s = \frac{5}{6}s$ Subtract 7

The least common denominator is 6.

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

Because 5s = 5s is a true statement, the solution set is {all real numbers}.

9. Let x = the number of calories a 175-pound athlete can consume.Set up a proportion with one ratio involving calories and the other involving pounds.

$$\frac{x \text{ calories}}{50 \text{ calories}} = \frac{175 \text{ pounds}}{2.2 \text{ pounds}}$$
$$2.2x = 50(175)$$
$$x = \frac{8750}{2.2} \approx 3977.3$$

To the nearest hundred calories, a 175-pound athlete in a vigorous training program can consume 4000 calories per day.

10. Let x = the sales for DiGiorno, in millions of dollars.

Then x - 399.9 the sales for Red Baron, in millions of dollars.

x + (x - 399.9) = 937.52x - 399.9 = 937.52x = 1337.4x = 668.7

Since x = 668.7, x - 399.9 = 268.8.

DiGiorno sold \$668.7 million worth of frozen pizza and Red Baron sold \$268.8 million worth of frozen pizza.

11. The results in the following table are rounded to the nearest thousandth.

Size	Price	Unit Cost (dollar per oz)
50 oz	\$3.99	$\frac{\$3.99}{50} \approx \0.080
100 oz	\$7.29	$\frac{\$7.29}{100} \approx \0.073
160 oz	\$9.99	$\frac{\$9.99}{160} \approx \$0.062 (*)$

Because the 160-oz size produces the lowest unit cost, it is the best buy. The unit cost, to the nearest thousandth, is \$0.062 per oz.

12. The angles make up a right angle, so the sum of their measures is 90°.

$$(3x)^{\circ} + (8x+2)^{\circ} = 90^{\circ}$$

 $11x + 2 = 90$
 $11x = 88$
 $x = 8$

Since x = 8, $(3x)^{\circ} = 24^{\circ}$ and $(8x + 2)^{\circ} = 66^{\circ}$.

13. Use the formula d = rt, or $t = \frac{d}{r}$, where d = 819 and r = 63.

$$t = \frac{d}{r} = \frac{819}{63} = 13$$

It took Janet 13 hours to drive from Louisville to Dallas.

14. Let x = the rate of the slower train. Then x + 30 = the rate of the faster train.

	r	t	d
Slower Train	X	3	3 <i>x</i>
Faster Train	<i>x</i> +30	3	3(x+30)

The sum of the distances traveled by the two trains is 390 miles, so 3x + 3(x+30) = 390.

Solve the equation.

$$3x + 3(x + 30) = 390$$

$$3x + 3x + 90 = 390$$

$$6x + 90 = 390$$

$$6x = 300$$

$$x = 50$$

Since
$$x = 50$$
, $x + 30 = 80$.

The rate of the slower train is 50 miles per hour and the rate of the faster train is 80 miles per hour.

15. Let x = the length of the first side.

Then 2x = the length of the second side. Use the formula for the perimeter of a triangle, P = a+b+c, with perimeter 96 and third side 30.

$$x + 2x + 30 = 96$$
$$3x + 30 = 96$$
$$3x = 66$$
$$x = 22$$

The sides have lengths 22 meters, 44 meters, and 30 meters. The length of the longest side is 44 meters.

16. Let s = the length of a side of the square. The formula for the perimeter of a square is P = 4s.

	cannot be	
The perimeter	greater than	200.
\downarrow	\downarrow	\downarrow
4 <i>s</i>	\leq	200
	$4s \le 200$	
	$s \le 50$	

The length of a side is 50 meters or less.

Chapter 2 Test

1. 5x+9 = 7x+21 -2x+9 = 21 Subtract 7x. -2x = 12 Subtract 9. x = -6 Divide by -2.

The solution set is $\{-6\}$.

2.
$$-\frac{4}{7}x = -12$$
$$\left(-\frac{7}{4}\right)\left(-\frac{4}{7}x\right) = \left(-\frac{7}{4}\right)(-12)$$
$$x = 21$$

The solution set is $\{21\}$.

3.
$$7 - (x - 4) = -3x + 2(x + 1)$$

 $7 - x + 4 = -3x + 2x + 2$
 $-x + 11 = -x + 2$
 $11 = 2$

Because the last statement is false, the equation has no solution set, symbolized by \emptyset .

4. To clear decimals, multiply both sides by 100. 100[0.06(x+20)+0.08(x-10)] = 100(4.6)

$$6(x+20)+8(x-10) = 460$$

$$6x+120+8x-80 = 460$$

$$14x+40 = 460$$

$$14x = 420$$

$$x = 30$$

The solution set is $\{30\}$.

5.
$$-8(2x+4) = -4(4x+8)$$

 $-16x-32 = -16x-32$
Because the last statement is true, the solution set is {all real numbers}.

6.
$$2-3(x-5) = 3 + (x+1)$$

 $2-3x+15 = 3 + x + 1$ Distributive property
 $-3x+17 = 4 + x$
 $17 = 4 + 4x$ Add $3x$.
 $13 = 4x$ Subtract 4.
 $\frac{13}{4} = x$
The solution set is $\left\{\frac{13}{4}\right\}$.

- 7. Let x = the number of games the Cardinals lost. Then 2x-33 = the number of games the Cardinals won. The total number of games played was 162. x + (2x-33) = 1623x-33 = 1623x = 195x = 65Since x = 65, 2x-33 = 97. The Cardinals won 97 games and lost 65 games.
- 8. Let x = the area of Kauai (in square miles). Then x+177 = the area of Maui (in square miles), and (x+177)+3293 = x+3470 = the area of Hawaii. x+(x+177)+(x+3470) = 53003x+3647 = 5300

$$3x + 3047 = 5500$$

 $3x = 1653$
 $x = 551$
Since $x = 551$, $x + 177 = 728$ and $x + 3470 = 4021$.

The area of Hawaii is 4021 square miles, the area of Maui is 728 square miles, and the area of Kauai is 551 square miles.

9. Let x = the measure of the angle. Then 90 - x = the measure of its complement, and 180 - x = the measure of its supplement. 180 - x = 3(90 - x) + 10180 - x = 270 - 3x + 10180 - x = 280 - 3x

$$180 + 2x = 280$$

 $2x = 100$

$$2x = 100$$
$$x = 50$$

The measure of the angle is 50° . The measure of its supplement, 130° , is 10° more than three times its complement, 40° .

10. Step 2 Let x = the lesser even integer. Then x+2 = the greater even integer. Step 3 3x = 20+2(x+2)Step 4 3x = 20+2(x+2) 3x = 20+2x+4 3x = 24+2x x = 24Step 5 Since x = 24, x+2 = 26. The consecutive even numbers are 24 and 26. Step 6 Three times the lesser is 3(24) = 72, and 20

more than twice the greater is 20 + 2(26) = 72.

11. (a) Solve P = 2L + 2W for *W*.

$$\frac{P-2L}{2} = 2W$$

$$\frac{P-2L}{2} = W, \text{ or } W = \frac{P-2L}{2}$$

(**b**) Substitute 116 for *P* and 40 for *L* in the formula obtained in part (a).

$$W = \frac{P - 2L}{2}$$
$$= \frac{116 - 2(40)}{2}$$
$$= \frac{116 - 80}{2} = \frac{36}{2} = 18$$

12.
$$5x-4y = 8$$

 $5x-4y-5x = 8-5x$ Subtract 5x.
 $-4y = 8-5x$
 $\frac{-4y}{-4} = \frac{8-5x}{-4}$ Divide by -4
 $y = -\frac{8-5x}{4}$, or $y = \frac{5}{4}x-2$

(There are other correct forms.)

13. The angles are vertical angles, so their measures are equal. 3x+15 = 4x-5

> 15 = x - 5 20 = xSince x = 20, 3x + 15 = 75 and 4x - 5 = 75. Both angles have measure 75° .

14.
$$\frac{z}{8} = \frac{12}{16}$$

 $16z = 8(12)$ Cross products
 $16z = 96$
 $\frac{16z}{16} = \frac{96}{16}$ Divide by 16.
 $z = 6$
The solution set is $\{6\}$.

15. $\frac{x+5}{3} = \frac{x-3}{4}$ 4(x+5) = 3(x-3) 4x+20 = 3x-9 x+20 = -9 x = -29The solution set is $\{-29\}$.

16. What percent of 65 is 26? Let *p* denote the percent. $26 = p \cdot 65$

$$p = \frac{26}{65} = 0.4 = 40\%$$

26 is 40% of 65.

17. The results in the following table are rounded to the nearest thousandth.

Size	Price	Unit Cost (dollar per oz)
8 oz	\$2.99	$\frac{\$2.99}{8} \approx \0.374
16 oz	\$3.99	$\frac{\$3.99}{16} \approx \$0.249 (*)$
48 oz	\$14.69	$\frac{\$14.69}{48} \approx \0.306

Because the 16-oz size produces the lowest unit cost, it is the best buy. The unit cost, to the nearest thousandth, is \$0.249 per oz.

18. Let x = the actual distance between Seattle and Cincinnati.

$$\frac{x \text{ miles}}{1050 \text{ miles}} = \frac{92 \text{ inches}}{42 \text{ inches}}$$
$$42x = 92(1050) = 96,600$$
$$x = \frac{96,600}{42} = 2300$$

The actual distance between Seattle and Cincinnati is 2300 miles.
19. Let x = the amount invested at 3%. Then x + 6000 = the amount invested at 4.5%

Amount Invested (in dollars)	Rate of Interest	Interest for One Year	
x	0.03	0.03 <i>x</i>	
x + 6000	0.045	0.045(x+6000)	

0.03x + 0.045(x + 6000) = 870To clear decimals, multiply both sides by 1000. 30x + 45x(x + 6000) = 870,00030x + 45x + 270,000 = 870,00075x + 270,000 = 870,00075x = 600,000x = 8000Since x = 8000, x + 6000 = 14,000. Carlos invested \$8000 at 3% and \$14,000 at 4.5%.

20. Use the formula d = rt and let *t* be the number of hours they traveled

011	iours mey u	aveleu.		
		r	t	d
First Car Second Car		50	t	50 <i>t</i>
		65	t	65 <i>t</i>
First car's		second car	total	
distance	and	distance	is	distance.
\downarrow	\downarrow	\downarrow	\downarrow	\downarrow
50 <i>t</i>	+	65 <i>t</i>	=	460
Sol 50 <i>i</i>	ve the equat $t + 65t = 460$	ion.		
	115t = 460)		
	t = 4			
The	e two cars w	ill be 460 i	miles apar	t in
4 h	ours.			

- **21.** (a) The set of numbers graphed corresponds to the inequality x < 0.
 - (b) The set of numbers graphed corresponds to the inequality $-2 < x \le 3$.

22.
$$-3x > -33$$

$$x < 11$$
 Divide by -3 .

Graph the solution set $(-\infty, 11)$.

$$\begin{array}{c|c} \leftarrow & \leftarrow \\ \bullet & \bullet \\ \bullet &$$

23.
$$-10 < 3x - 4 \le 14$$

 $-6 < 3x \le 18$ Add 4.
 $-2 < x \le 6$ Divide by 3.

Graph the solution set (-2, 6].

24.
$$-4x + 2(x-3) \ge 4x - (3+5x) - 7$$

 $-4x + 2x - 6 \ge 4x - 3 - 5x - 7$
 $-2x - 6 \ge -x - 10$
 $-x - 6 \ge -10$
 $-x \ge -4$
 $\frac{-1x}{-1} \le \frac{-4}{-1}$
 $x \le 4$

Graph the solution set $(-\infty, 4]$.

25. Let x = the score on the third test. The average is at

of the three tests \downarrow \downarrow \downarrow \downarrow $\frac{76+81+x}{3} \ge 80$ $\frac{157+x}{3} \ge 80$ $3\left(\frac{157+x}{3}\right) \ge 3(80)$ $157+x \ge 240$ $x \ge 83$

In order to average at least 80, Susan's score on her third test must be 83 or more.

Chapters R–2 Cumulative Review Exercises

1.
$$\frac{5}{6} + \frac{1}{4} - \frac{7}{15} = \frac{50}{60} + \frac{15}{60} - \frac{28}{60}$$

= $\frac{65 - 28}{60}$
= $\frac{37}{60}$

198 Chapter 2 Linear Equations and Inequalities in One Variable

2.
$$\frac{9}{8} \cdot \frac{16}{3} \div \frac{5}{8} = \frac{9}{8} \cdot \frac{16}{3} \cdot \frac{8}{5}$$

= $\frac{3 \cdot 3 \cdot 16 \cdot 8}{8 \cdot 3 \cdot 5}$
= $\frac{48}{5}$

$$3. 4.8 + 12.5 + 16.73 = 34.03$$

- 4. "The difference of half a number and 18" is written $\frac{1}{2}x 18$.
- 5. "The quotient of 6 and 12 more than a number is 2" is written $\frac{6}{x+12} = 2$.

6.
$$\frac{8(7) - 5(6 + 2)}{3 \cdot 5 + 1} \ge 1$$
$$\frac{8(7) - 5(8)}{3 \cdot 5 + 1} \ge 1$$
$$\frac{56 - 40}{15 + 1} \ge 1$$
$$\frac{16}{16} \ge 1$$
$$1 \ge 1$$

The statement is true.

7.
$$\frac{-4(9)(-2)}{-3^2} = \frac{-36(-2)}{-1 \cdot 3^2}$$
$$= \frac{72}{-9}$$
$$= -8$$

8.
$$(-7-1)(-4) + (-4) = (-8)(-4) + (-4)$$
$$= 32 + (-4)$$
$$= 28$$

9.
$$\frac{6(-4) - (-2)(12)}{3^2 + 7^2} = \frac{6(-4) - (-2)(12)}{9 + 19}$$
$$= \frac{-24 - (-24)}{9 + 19}$$
$$= \frac{0}{28} = 0$$

10. Let
$$x = -2$$
, $y = -4$, and $z = 3$.

$$\frac{3x^2 - y^3}{-4z} = \frac{3(-2)^2 - (-4)^3}{-4(3)}$$

$$= \frac{3(4) - (-64)}{-12}$$

$$= \frac{12 + 64}{-12}$$

$$= \frac{76}{-12}$$

$$= -\frac{19}{3}$$

11. 7(p+q) = 7p + 7q

The multiplication of 7 is distributed over the sum, which illustrates the distributive property.

12. 7 + (-7) = 0

A number added to its opposite is equal to 0. This illustrates the inverse property (of addition).

13. 3.5(1) = 3.5

A number multiplied by 1 is equal to itself. This illustrates the identity property (of multiplication).

14.
$$2r-6 = 8r$$

 $-6 = 6r$
 $-1 = r$
Check $r = -1: -8 = -8$ True
The solution set is $\{-1\}$.

15.
$$4-5(s+2) = 3(s+1)-1$$

 $4-5s-10 = 3s+3-1$
 $-5s-6 = 3s+2$
 $-8s-6 = 2$
 $-8s = 8$
 $s = -1$
Check $s = -1$: $-1 = -1$ True
The solution set is $\{-1\}$.

16.
$$\frac{2}{3}x + \frac{3}{4}x = -17$$

$$12\left(\frac{2}{3}x + \frac{3}{4}x\right) = 12(-17) \quad \text{LCD} = 12$$

$$8x + 9x = -204$$

$$17x = -204$$

$$x = -12$$

Check $x = -12$: $-17 = -17$ True
The solution set is $\{-12\}$.

17.
$$\frac{2x+3}{5} = \frac{x-4}{2}$$

$$(2x+3)(2) = (5)(x-4)$$

$$4x+6 = 5x-20$$

$$6 = x-20$$

$$26 = x$$
Check $x = 26: 11 = 11$ True
The solution set is $\{26\}$.

18. Solve
$$3x + 4y = 24$$
 for y.
 $4y = 24 - 3x$
 $y = \frac{24 - 3x}{4}$

19. Solve P = a + b + c + B for *c*. Subtract *a*, *b*, and *B*. P = a + b + c + BP

$$P-a-b-B=c$$

20.
$$6(r-1)+2(3r-5) \le -4$$

 $6r-6+6r-10 \le -4$
 $12r-16 \le -4$
 $12r \le 12$
 $r \le 1$
Graph the solution set $(-\infty, 1]$.

21. $-18 \le -9z < 9$ $2 \ge z > -1$ Divide; reverse the symbols.

or $-1 < z \le 2$

Graph the solution set
$$(-1, 2]$$
.

- **22.** Let x = the length of the middle-sized piece. Then 3x = the length of the longest piece, and x-5 = the length of the shortest piece. x + 3x + (x - 5) = 405x - 5 = 405x = 45x = 9The length of the middle-sized piece is 9 centimeters, that of the longest piece is 27 centimeters, and that of the shortest piece is 4 centimeters.
- **23.** Let r = the radius and use 3.14 for π . Using the formula for circumference, $C = 2\pi r$, and C = 78, we have $2\pi r = 78$ $r = \frac{78}{2\pi} \approx 12.4204$

To the nearest hundredth, the radius is 12.42 cm.

24. Let x = the rate of the slower car. Then x + 20 = the rate of the faster car. Use the formula d = rt.

$$d_{slower} + d_{faster} = d_{total}$$
(x)(4) + (x + 20)(4) = 400
4x + 4x + 80 = 400
8x + 80 = 400
8x = 320
x = 40
The rates are 40 mph and 60

25. (a) The segment of the circle representing white cars is 19% of the circle. What is 19% of 2.8 million? $19\% \cdot 2.8 = 0.19 \cdot 2.8 = 0.532$ 0.532 million cars, or 532,000 cars, are white.

mph.

- (**b**) The segment of the circle representing silver cars is 18% of the circle. What is 18% of 2.8 million? $18\% \cdot 2.8 = 0.18 \cdot 2.8 = 0.504$ 0.504 million cars, or 504,000 cars, are silver.
- (c) The segment of the circle representing red cars is 12% of the circle. What is 12% of 2.8 million? $12\% \cdot 2.8 = 0.12 \cdot 2.8 = 0.336$ 0.336 million cars, or 336,000 cars, are red.