Solving Equations

OBJECTIVES

SECTION 5.1
A To determine whether a given number is a solution of an equation
B To solve an equation of the form $x + a = b$
C To solve an equation of the form $ax = b$
D To solve uniform motion problems

SECTION 5.2
A To solve an equation of the form $ax + b = c$
B To solve application problems using formulas

SECTION 5.3
A To solve an equation of the form $ax + b = cx + d$
B To solve an equation containing parentheses
C To solve application problems using formulas

SECTION 5.4
A To solve integer problems
B To translate a sentence into an equation and solve

SECTION 5.5
A To solve value mixture problems
B To solve uniform motion problems

ARE YOU READY?

Take the Chapter 5 Prep Test to find out if you are ready to learn to:

- Solve equations
- Solve problems using formulas
- Solve integer, mixture, and uniform motion problems

PREP TEST

Do these exercises to prepare for Chapter 5.

1. Subtract: $8 - 12$
   $-4$ [3.2B]

2. Multiply: $\frac{-3}{4}\left(\frac{4}{3}\right)$
   $1$ [3.4B]

3. Multiply: $\frac{-5}{8}(16)$
   $-10$ [3.4B]

4. Simplify: $\frac{-3}{-3}$
   $1$ [3.4B]

5. Simplify: $-16 + 7y + 16$
   $7y$ [4.2A]

6. Simplify: $8x - 9 - 8x$
   $-9$ [4.2A]

7. Evaluate $2x + 3$ when $x = -4$.
   $-5$ [4.1A]
Introduction to Equations

**OBJECTIVE A**

To determine whether a given number is a solution of an equation

An **equation** expresses the equality of two mathematical expressions. The expressions can be either numerical or variable expressions.

\[
\begin{align*}
9 + 3 &= 12 \\
3x - 2 &= 10 \\
y^2 + 4 &= 2y - 1 \\
z &= 2
\end{align*}
\]

The equation at the right is true if the variable is replaced by 5.

The equation is false if the variable is replaced by 7.

A **solution of an equation** is a number that, when substituted for the variable, results in a true equation. 5 is a solution of the equation \(x + 8 = 13\). 7 is not a solution of the equation \(x + 8 = 13\).

**HOW TO 1**

Is \(-2\) a solution of \(2x + 5 = x^2 - 3\)?

\[
\begin{align*}
2x + 5 &= x^2 - 3 \\
2(-2) + 5 &= (-2)^2 - 3 \\
-4 + 5 &= 4 - 3 \\
1 &= 1
\end{align*}
\]

**In-Class Examples**

1. Is \(6\) a solution of \(4x + 3 - 2x - 9\)?
   - Yes
2. Is \(\frac{2}{3}\) a solution of \(4 - 6x - 9x + 1\)?
   - No

**YOU TRY IT 1**

Is \(\frac{1}{2}\) a solution of \(5 - 4x = 8x + 2\)?

**YOUR SOLUTION**

Yes

**YOU TRY IT 2**

Is 5 a solution of \(10x - x^2 = 3x - 10\)?

**YOUR SOLUTION**

No

*Solutions on p. S12*
To solve an equation of the form \( x + a = b \)

To solve an equation means to find a solution of the equation. The simplest equation to solve is an equation of the form \( \text{variable} = \text{constant} \), because the constant is the solution.

The solution of the equation \( x = 5 \) is 5 because 5 = 5 is a true equation.

The solution of the equation at the right is 7 because 7 + 2 = 9 is a true equation.

Note that if 4 is added to each side of the equation \( x + 2 = 9 \), the solution is still 7.

If \( -5 \) is added to each side of the equation \( x + 2 = 9 \), the solution is still 7.

Equations that have the same solution are called equivalent equations. The equations \( x + 2 = 9 \), \( x + 6 = 13 \), and \( x - 3 = 4 \) are equivalent equations; each equation has 7 as its solution. These examples suggest that adding the same number to each side of an equation produces an equivalent equation. This is called the Addition Property of Equations.

**Addition Property of Equations**

The same number can be added to each side of an equation without changing its solution. In symbols, the equation \( a = b \) has the same solution as the equation \( a + c = b + c \).

In solving an equation, the goal is to rewrite the given equation in the form \( \text{variable} = \text{constant} \). The Addition Property of Equations is used to remove a term from one side of the equation by adding the opposite of that term to each side of the equation.

**HOW TO**

Solve: \( x - 4 = 2 \)

\[
\begin{align*}
x - 4 &= 2 \\
x - 4 + 4 &= 2 + 4 \\
x &= 6
\end{align*}
\]

* The goal is to rewrite the equation in the form \( \text{variable} = \text{constant} \).

* Add 4 to each side of the equation.

* Simplify.

* The equation is in the form \( \text{variable} = \text{constant} \).

Check: \( x - 4 = 2 \)

\[
\begin{align*}
6 - 4 &= 2 \\
2 &= 2
\end{align*}
\]

A true equation

The solution is 6.

Because subtraction is defined in terms of addition, the Addition Property of Equations also makes it possible to subtract the same number from each side of an equation without changing the solution of the equation.
### OBJECTIVE C

To solve an equation of the form $ax = b$

The solution of the equation at the right is 3 because $2 \cdot 3 = 6$ is a true equation.

$2x = 6$

Note that if each side of $2x = 6$ is multiplied by 5, the solution is still 3.

$5(2x) = 5 \cdot 6$

$10x = 30$

$10 \cdot 3 = 30$

If each side of $2x = 6$ is multiplied by $-4$, the solution is still 3.

$2x = 6$

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

$-8x = -24$

$-8 \cdot 3 = -24$

The equations $2x = 6$, $10x = 30$, and $-8x = -24$ are equivalent equations; each equation has 3 as its solution. These examples suggest that multiplying each side of an equation by the same nonzero number produces an equivalent equation.

### Multiplication Property of Equations

Each side of an equation can be multiplied by the same nonzero number without changing the solution of the equation. In symbols, if $c \neq 0$, then the equation $a = b$ has the same solutions as the equation $ac = bc$. 
The Multiplication Property of Equations is used to remove a coefficient by multiplying each side of the equation by the reciprocal of the coefficient.

**HOW TO 4** Solve: \( \frac{3}{4}x = 9 \)

- The goal is to rewrite the equation in the form \( \text{variable} = \text{constant} \).
- Multiply each side of the equation by \( \frac{4}{3} \).
- Simplify.
- The equation is in the form \( \text{variable} = \text{constant} \).

The solution is 12. You should check this solution.

Because division is defined in terms of multiplication, each side of an equation can be divided by the same nonzero number without changing the solution of the equation.

**HOW TO 5** Solve: \( 6x = 14 \)

- The goal is to rewrite the equation in the form \( \text{variable} = \text{constant} \).
- Divide each side of the equation by 6.
- Simplify. The equation is in the form \( \text{variable} = \text{constant} \).

The solution is \( \frac{7}{3} \).

When using the Multiplication Property of Equations, multiply each side of the equation by the reciprocal of the coefficient when the coefficient is a fraction. Divide each side of the equation by the coefficient when the coefficient is an integer or a decimal.
CHAPTER 5 • Solving Equations

Any object that travels at a constant speed in a straight line is said to be in uniform motion. Uniform motion means that the speed and direction of an object do not change. For instance, a car traveling at a constant speed of 45 mph on a straight road is in uniform motion.

The solution of a uniform motion problem is based on the uniform motion equation, where \( d \) is the distance traveled, \( r \) is the rate of travel, and \( t \) is the time spent traveling. For instance, suppose a car travels at 50 mph for 3 h. Because the rate (50 mph) and time (3 h) are known, we can find the distance traveled by solving the equation \( d = rt \) for \( d \).

\[
\begin{align*}
\quad &d = rt \\
\quad &d = 50(3) \\
\quad &d = 150
\end{align*}
\]

The car travels a distance of 150 mi.

A jogger runs 3 mi in 45 min. What is the rate of the jogger in miles per hour?

**Strategy**

- Because the answer must be in miles per hour and the given time is in minutes, convert 45 min to hours.
- To find the rate of the jogger, solve the equation \( d = rt \) for \( r \).

**Solution**

\[
\begin{align*}
45 \text{ min} & = \frac{45}{60} \text{ h} = \frac{3}{4} \text{ h} \\
45 \text{ min} & = \frac{45}{60} \text{ h} = \frac{3}{4} \text{ h} \\
3 & = r \left( \frac{3}{4} \right) \\
3 & = \frac{3}{4} \cdot r \\
4 & = 3 \cdot \frac{4}{3} \\
4 & = \frac{4}{3} \cdot \frac{3}{4}
\end{align*}
\]

The rate of the jogger is 4 mph.

If two objects are moving in opposite directions, then the rate at which the distance between them is increasing is the sum of the speeds of the two objects. For instance, in the diagram below, two cars start from the same point and travel in opposite directions. The distance between them is changing at 70 mph.
Similarly, if two objects are moving toward each other, the distance between them is decreasing at a rate that is equal to the sum of the speeds. The rate at which the two planes at the right are approaching one another is 800 mph.

Two cars start from the same point and move in opposite directions. The car moving west is traveling 45 mph, and the car moving east is traveling 60 mph. In how many hours will the cars be 210 mi apart?

**Strategy**
The distance is 210 mi. Therefore, \( d = 210 \). The cars are moving in opposite directions, so the rate at which the distance between them is changing is the sum of the rates of each of the cars. The rate is 45 mph + 60 mph = 105 mph. Therefore, \( r = 105 \). To find the time, solve the equation \( d = rt \) for \( t \).

**Solution**
\[
\begin{align*}
210 &= 105t \\
210 &= 105t \\
\frac{210}{105} &= \frac{105t}{105} \\
2 &= t
\end{align*}
\]
In 2 h, the cars will be 210 mi apart.

If a motorboat is on a river that is flowing at a rate of 4 mph, then the boat will float down the river at a speed of 4 mph when the motor is not on. Now suppose the motor is turned on and the power adjusted so that the boat would travel 10 mph without the aid of the current. Then, if the boat is moving with the current, its effective speed is the speed of the boat using power plus the speed of the current: 10 mph + 4 mph = 14 mph. (See the figure below.)

However, if the boat is moving against the current, the current slows the boat down. The effective speed of the boat is the speed of the boat using power minus the speed of the current: 10 mph - 4 mph = 6 mph. (See the figure below.)
There are other situations in which the preceding concepts may be applied.

**HOW TO 8** An airline passenger is walking between two airline terminals and decides to get on a moving sidewalk that is 150 ft long. If the passenger walks at a rate of 7 ft/s and the moving sidewalk moves at a rate of 9 ft/s, how long, in seconds, will it take for the passenger to walk from one end of the moving sidewalk to the other? Round to the nearest thousandth.

**Strategy**
The distance is 150 ft. Therefore, \(d = 150\). The passenger is traveling at 7 ft/s and the moving sidewalk is traveling at 9 ft/s. The rate of the passenger is the sum of the two rates, or 16 ft/s. Therefore, \(r = 16\). To find the time, solve the equation \(d = rt\) for \(t\).

**Solution**
\[
\begin{align*}
150 &= 16t \\
\frac{150}{16} &= \frac{16}{16}t \\
9.375 &= t
\end{align*}
\]
It will take 9.375 s for the passenger to travel the length of the moving sidewalk.

**EXAMPLE - 6**

Two cyclists start at the same time at opposite ends of an 80-mile course. One cyclist is traveling 18 mph, and the second cyclist is traveling 14 mph. How long after they begin cycling will they meet?

**Strategy**
The distance is 80 mi. Therefore, \(d = 80\). The cyclists are moving toward each other, so the rate at which the distance between them is changing is the sum of the rates of each of the cyclists. The rate is 18 mph + 14 mph = 32 mph. Therefore, \(r = 32\). To find the time, solve the equation \(d = rt\) for \(t\).

**Solution**
\[
\begin{align*}
80 &= 32t \\
\frac{80}{32} &= \frac{32}{32}t \\
2.5 &= t
\end{align*}
\]
The cyclists will meet in 2.5 h.

**YOU TRY IT - 6**

A plane that can normally travel at 250 mph in calm air is flying into a headwind of 25 mph. How far can the plane fly in 3 h?

**Your strategy**

**Solution**

**675 mi**

**In-Class Examples**

1. Ted leaves his house at 8:00 A.M. and arrives at work at 8:30 A.M. If the trip to work is 15 mi, determine Ted’s average rate of speed. \[30 \text{ mph}\]

2. Joan leaves her house and travels at an average speed of 45 mph toward her cabin in the mountains. If the distance from her house to the cabin is 180 mi, how many hours will it take for Joan to arrive at her cabin if she stops one hour for lunch? \[5 \text{ h}\]

*Solution on p. S12*
5.1 Exercises

**Objective A**

To determine whether a given number is a solution of an equation.

1. Is 4 a solution of \(2x = 8\)?
   - Yes

2. Is 3 a solution of \(y + 4 = 7\)?
   - Yes

3. Is \(-1\) a solution of \(2b - 1 = 3\)?
   - No

4. Is \(-2\) a solution of \(3a - 4 = 10\)?
   - No

5. Is 1 a solution of \(4 - 2m = 3\)?
   - No

6. Is 2 a solution of \(7 - 3n = 2\)?
   - No

7. Is 5 a solution of \(2x + 5 = 3x\)?
   - Yes

8. Is 4 a solution of \(3y - 4 = 2y\)?
   - Yes

9. Is \(-2\) a solution of \(3a + 2 = 2 - a\)?
   - No

10. Is 3 a solution of \(x^2 + 1 = 4 + 3c\)?
    - No

11. Is 2 a solution of \(2x^2 - 1 = 4x - 1\)?
    - Yes

12. Is \(-1\) a solution of \(y^2 - 1 = 4y + 3\)?
    - No

13. Is 4 a solution of \((x + 1) = x^2 + 5\)?
    - No

14. Is 3 a solution of \(2(x - 1) = 3a + 3\)?
    - Yes

15. Is \(-\frac{1}{2}\) a solution of \(8x + 1 = -1\)?
    - Yes

16. Is \(\frac{1}{2}\) a solution of \(4y + 1 = 3\)?
    - Yes

17. Is \(\frac{5}{2}\) a solution of \(5m + 1 = 10m - 3\)?
    - No

18. Is \(\frac{3}{4}\) a solution of \(8x - 1 = 12x + 3\)?
    - No

19. If \(A\) is a fixed number such that \(A < 0\), is \(x\) a solution of the equation \(5x = A\) positive or negative?
    - Negative

20. Can a negative number be a solution of the equation \(7x - 2 = -x\)?
    - No

**Quick Quiz**

1. Is \(\frac{2}{3}\) a solution of \(6x + 5 = 9\)?
   - Yes

2. Is 6 a solution of \(x(x + 2) - x^2 + 2\)?
   - No

**Objective B**

To solve an equation of the form \(x + a = b\).

21. Without solving the equation \(x - \frac{11}{16} = \frac{19}{24}\), determine whether \(x\) is less than or greater than \(\frac{19}{24}\). Explain your answer.

22. Without solving the equation \(x + \frac{13}{15} = -\frac{21}{45}\), determine whether \(x\) is less than or greater than \(-\frac{21}{45}\). Explain your answer.

For Exercises 23 to 64, solve and check.

23. \(x + 5 = 7\)
   - \(x = 2\)

24. \(y + 3 = 9\)
   - \(y = 6\)

25. \(b - 4 = 11\)
   - \(b = 15\)

26. \(z - 6 = 10\)
   - \(z = 16\)

27. \(2 + a = 8\)
   - \(a = 6\)

28. \(5 + x = 12\)
   - \(x = 7\)

29. \(n - 5 = -2\)
   - \(n = 3\)

30. \(x - 6 = -5\)
   - \(x = 1\)

For answers to the Writing exercises, please see the Appendix in the Instructor’s Resource Binder that accompanies this textbook.

Selected exercises available online at www.webassign.net/brookscole.
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31. \( b + 7 = 7 \)  \hspace{1cm} 32. \( y - 5 = -5 \)  \hspace{1cm} 33. \( z + 9 = 2 \)  \hspace{1cm} 34. \( n + 11 = 1 \)

35. \( 10 + m = 3 \)  \hspace{1cm} 36. \( 8 + x = 5 \)  \hspace{1cm} 37. \( 9 + x = -3 \)  \hspace{1cm} 38. \( 10 + y = -4 \)

39. \( 2 = x + 7 \)  \hspace{1cm} 40. \( -8 = n + 1 \)  \hspace{1cm} 41. \( 4 = m - 11 \)  \hspace{1cm} 42. \( -6 = y - 5 \)

43. \( 12 = 3 + w \)  \hspace{1cm} 44. \( -9 = 5 + x \)  \hspace{1cm} 45. \( 4 = -10 + b \)  \hspace{1cm} 46. \( -7 = -2 + x \)

47. \( m + \frac{2}{3} = -\frac{1}{3} \)  \hspace{1cm} 48. \( c + \frac{3}{4} = -\frac{1}{4} \)  \hspace{1cm} 49. \( x - \frac{1}{2} = \frac{1}{2} \)  \hspace{1cm} 50. \( x - \frac{2}{5} = \frac{3}{5} \)

51. \( \frac{5}{8} + y = \frac{1}{8} \)  \hspace{1cm} 52. \( \frac{4}{9} + a = -\frac{2}{9} \)  \hspace{1cm} 53. \( m + \frac{1}{2} = -\frac{1}{4} \)  \hspace{1cm} 54. \( b + \frac{1}{6} = -\frac{1}{3} \)

55. \( x + \frac{2}{3} = \frac{3}{4} \)  \hspace{1cm} 56. \( n + \frac{2}{3} = \frac{2}{3} \)  \hspace{1cm} 57. \( -\frac{5}{6} + x = -\frac{1}{4} \)  \hspace{1cm} 58. \( -\frac{1}{4} = c - \frac{2}{3} \)

59. \( d + 1.3619 = 2.0148 \) \( \text{0.6529} \)  \hspace{1cm} 60. \( w + 2.932 = 4.801 \) \( \text{1.869} \)

61. \( -0.813 + x = -1.096 \) \( \text{0.283} \)  \hspace{1cm} 62. \( -1.926 + t = -1.042 \) \( \text{0.884} \)

63. \( 6.149 = -3.108 + z \) \( \text{9.257} \)  \hspace{1cm} 64. \( 5.237 = -2.014 + x \) \( \text{7.251} \)

**Quick Quiz**

Solve.

1. \( a + 5 = -8 \) \( -13 \)  \hspace{1cm} 2. \( 7 - b = -4 \) \( 11 \)  \hspace{1cm} 3. \( c + \frac{5}{6} = -\frac{1}{3} \) \( -\frac{1}{2} \)

**OBJECTIVE C**

To solve an equation of the form \( ax = b \)

For Exercises 65 to 108, solve and check.

65. \( 5x = -15 \) \( \hspace{1cm} -\frac{3}{5} \)  \hspace{1cm} 66. \( 4y = -28 \) \( \hspace{1cm} -\frac{7}{2} \)  \hspace{1cm} 67. \( 3b = 0 \) \( \hspace{1cm} 0 \)  \hspace{1cm} 68. \( 2a = 0 \) \( \hspace{1cm} 0 \)
69. $-3x = 6$  
   $x = -2$

70. $-5m = 20$  
   $m = -4$

71. $-3x = -27$  
   $x = 9$

72. $\frac{1}{6}n = -30$  
   $n = 180$

73. $20 = \frac{1}{4}c$  
   $c = 80$

74. $18 = 2t$  
   $t = 9$

75. $0 = -5x$  
   $x = 0$

76. $0 = -8a$  
   $a = 0$

77. $49 = -7t$  
   $t = -7$

78. $\frac{x}{3} = 2$  
   $x = 6$

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

80. $\frac{-y}{2} = 5$  
   $y = -10$

81. $\frac{b}{3} = 6$  
   $b = 18$

82. $\frac{3}{4}y = 9$  
   $y = 12$

83. $\frac{2}{5}x = 6$  
   $x = 15$

84. $-\frac{2}{3}d = 8$  
   $d = -12$

85. $-\frac{3}{5}m = 12$  
   $m = -20$

86. $\frac{2n}{3} = 0$  
   $n = 0$

87. $\frac{5x}{6} = 0$  
   $x = 0$

88. $-\frac{3z}{8} = 9$  
   $z = -24$

89. $\frac{3x}{4} = 2$  
   $x = \frac{8}{3}$

90. $\frac{3}{4}c - \frac{3}{5}c = 0$  
   $c = \frac{4}{5}$

91. $\frac{2}{9} - \frac{2}{3}y = 1$  
   $y = \frac{1}{3}$

92. $-\frac{6}{7} = -\frac{3}{4}b$  
   $b = \frac{8}{7}$

93. $\frac{1}{5}y = -\frac{1}{10}$  
   $y = -\frac{1}{2}$

94. $\frac{2}{3}y = -\frac{8}{9}$  
   $y = -\frac{4}{3}$

95. $-1 = \frac{2n}{3}$  
   $n = -\frac{3}{2}$

96. $-\frac{3}{4} = \frac{a}{8}$  
   $a = -6$

97. $-\frac{2}{5}m = \frac{-6}{7}$  
   $m = \frac{15}{7}$

98. $5x + 2x = 14$  
   $x = 2$

99. $3n + 2n = 20$  
   $n = 4$

100. $7d - 4d = 9$  
    $d = 3$

101. $10y - 3y = 21$  
    $y = 3$

102. $2x - 5x = 9$  
    $x = -3$

103. $\frac{x}{1.46} = 3.25$  
    $x = 4.745$

104. $\frac{z}{2.95} = -7.88$  
    $z = -23.246$

105. $3.47a = 7.1482$  
    $a = 2.06$
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106. $2.31m = 2.4255$  
107. $-3.7x = 7.881$  
108. \( \frac{n}{2.65} = 9.08 \)

For Exercises 109 to 112, suppose \( y \) is a positive integer. Determine whether \( x \) is positive or negative.

109. \( 15x = y \)  
110. \( -6x = y \)  
111. \( \frac{1}{4}x = y \)  
112. \( \frac{2}{9}x = -y \)

**OBJECTIVE D**  To solve uniform motion problems

113. Joe and John live 2 mi apart. They leave their houses at the same time and walk toward each other until they meet. Joe walks faster than John does.
   a. Is the distance walked by Joe less than, equal to, or greater than the distance walked by John?
   b. Is the time spent walking by Joe less than, equal to, or greater than the time spent walking by John?
   c. What is the total distance traveled by both Joe and John?
   a. Greater than  \( b. \) Equal to  \( c. \) 2 mi

114. Morgan and Emma ride their bikes from Morgan’s house to the store. Morgan begins biking 5 min before Emma begins. Emma bikes faster than Morgan and catches up with her just as they reach the store.
   a. Is the distance biked by Emma less than, equal to, or greater than the distance biked by Morgan?
   b. Is the time spent biking by Emma less than, equal to, or greater than the time spent biking by Morgan?
   a. Equal to  \( b. \) Less than

115. As part of a training program for the Boston Marathon, a runner wants to build endurance by running at a rate of 9 mph for 20 min. How far will the runner travel in that time period?
   3 mi

116. It takes a hospital dietician 40 min to drive from home to the hospital, a distance of 20 mi. What is the dietician’s average rate of speed?
   30 mph

117. Marcella leaves home at 9:00 A.M. and drives to school, arriving at 9:45 A.M. If the distance between home and school is 27 mi, what is Marcella’s average rate of speed?
   36 mph

Quick Quiz
Solve.
1. \( 3x = -21 \)  
2. \( -12 - \frac{2}{3}x = -18 \)  
3. \( 8x - 3x = 30 \)  
6
118. The Ride for Health Bicycle Club has chosen a 36-mile course for this Saturday's ride. If the riders plan on averaging 12 mph while they are riding, and they have a 1-hour lunch break planned, how long will it take them to complete the trip?

4 h

119. Palmer's average running speed is 3 km/h faster than his walking speed. If Palmer can run around a 30-kilometer course in 2 h, how many hours would it take for Palmer to walk the same course?

2.5 h

120. A shopping mall has a moving sidewalk that takes shoppers from the shopping area to the parking garage, a distance of 250 ft. If your normal walking rate is 5 ft/s and the moving sidewalk is traveling at 3 ft/s, how many seconds would it take for you to walk from one end of the moving sidewalk to the other end?

31.25 s

121. Two joggers start at the same time from opposite ends of an 8-mile jogging trail and begin running toward each other. One jogger is running at a rate of 5 mph, and the other jogger is running at a rate of 7 mph. How long, in minutes, after they start will the two joggers meet?

40 min

122. Two cyclists start from the same point at the same time and move in opposite directions. One cyclist is traveling at 8 mph, and the other cyclist is traveling at 9 mph. After 30 min, how far apart are the two cyclists?

8.5 mi

123. Petra and Celine can paddle their canoe at a rate of 10 mph in calm water. How long will it take them to travel 4 mi against the 2-mph current of the river?

0.5 h

124. At 8:00 A.M., a train leaves a station and travels at a rate of 45 mph. At 9:00 A.M., a second train leaves the same station on the same track and travels in the direction of the first train at a speed of 60 mph. At 10:00 A.M., how far apart are the two trains?

30 mi

Applying the Concepts

125. a. Make up an equation of the form \( x + a = b \) that has 2 as a solution.
   b. Make up an equation of the form \( ax = b \) that has \(-1\) as a solution.
   a. Answers will vary.  
   b. Answers will vary.

126. Write out the steps for solving the equation \( \frac{1}{2} x = -3 \). Identify each Property of Real Numbers or Property of Equations as you use it.
In solving an equation of the form $ax + b = c$, the goal is to rewrite the equation in the form $\text{variable} = \text{constant}$. This requires the application of both the Addition and the Multiplication Properties of Equations.

**HOW TO 1**

Solve: $\frac{3}{4}x - 2 = -11$

The goal is to write the equation in the form $\text{variable} = \text{constant}$.

\[
\frac{3}{4}x - 2 + 2 = -11 + 2
\]

- Add 2 to each side of the equation.

\[
\frac{3}{4}x = -9
\]

- Simplify.

\[
4 \cdot \frac{3}{4}x = 4(-9)
\]

- Multiply each side of the equation by $\frac{3}{4}$

\[
x = -12
\]

- The equation is in the form $\text{variable} = \text{constant}$.

The solution is $-12$.

Here is an example of solving an equation that contains more than one fraction.

**HOW TO 2**

Solve: $\frac{2}{3}x + \frac{1}{2} = \frac{3}{4}$

\[
\frac{2}{3}x + \frac{1}{2} = \frac{3}{4}
\]

- Subtract $\frac{1}{2}$ from each side of the equation.

\[
\frac{2}{3}x = \frac{1}{4}
\]

- Simplify.

\[
\frac{3}{2} \left( \frac{2}{3}x \right) = \frac{3}{2} \left( \frac{1}{2} \right)
\]

- Multiply each side of the equation by $\frac{3}{2}$, the reciprocal of $\frac{2}{3}$

\[
x = \frac{3}{8}
\]

The solution is $\frac{3}{8}$.

It may be easier to solve an equation containing two or more fractions by multiplying each side of the equation by the least common multiple (LCM) of the denominators. For the equation above, the LCM of 3, 2, and 4 is 12. The LCM has the property that 3, 2, and 4 will divide evenly into it. Therefore, if both sides of the equation are multiplied by 12, the denominators will divide evenly into 12. The result is an equation that does not contain any fractions. Multiplying each side of an equation that contains fractions by the LCM of the denominators is called **clearing denominators**. It is an alternative method, as we show in the next example, of solving an equation that contains fractions.
Solve:

- Use the Distributive Property.
- Simplify.
- Subtract 6 from each side of the equation.
- Divide each side of the equation by 8.

The solution is $\frac{3}{8}$.

Note that both methods give exactly the same solution. You may use either method to solve an equation containing fractions.

**EXAMPLE 1**

Solve: $3a - 7 = -5$

**Solution**

- Add 7 to each side.
- Divide each side by 3.

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

**YOU TRY IT 1**

Solve: $5x + 7 = 10$

**In-Class Examples**

1. $8a + 3 - 10 = \frac{7}{8}$
2. $7 - 12 + 5a = -1$
3. $\frac{3}{8} - 4 = -2 - \frac{8}{5}$
4. $\frac{3}{8} + 2 = 5 - \frac{2}{3}$
5. $\frac{1}{3} - \frac{3}{5}x - \frac{1}{2} = -\frac{5}{18}$

**EXAMPLE 2**

Solve: $5 = 9 - 2x$

**Solution**

- Subtract 9 from each side.
- Divide each side by $-2$.

The solution is 2.

**YOU TRY IT 2**

Solve: $2 = 11 + 3x$
EXAMPLE • 3

Solve: \( \frac{2}{3} - \frac{x}{2} = \frac{3}{4} \)

Solution

\[
\frac{2}{3} - \frac{x}{2} = \frac{3}{4} \\
\frac{2}{3} \cdot \frac{4}{4} - \frac{x}{2} \cdot \frac{3}{3} = \frac{3}{4} \cdot \frac{2}{2} \\
\frac{8}{12} - \frac{3x}{6} = \frac{6}{8} \\
\frac{8}{12} - \frac{3x}{6} = \frac{3}{4} \\
\frac{8}{12} - \frac{6}{12} = \frac{3}{4} \\
\frac{2}{12} = \frac{3}{4} \\
\frac{x}{2} = \frac{1}{6} \\
x = \frac{1}{6}
\]

The solution is \( \frac{1}{6} \).

YOU TRY IT • 3

Solve: \( \frac{5}{8} - \frac{2x}{3} = \frac{5}{4} \)

Your solution

\( \frac{15}{16} \)

EXAMPLE • 4

Solve \( \frac{4}{5}x - \frac{1}{2} = \frac{3}{4} \) by first clearing denominators.

Solution

\[
\frac{4}{5}x - \frac{1}{2} = \frac{3}{4} \\
\frac{4}{5} \cdot \frac{5}{5}x - \frac{1}{2} \cdot \frac{5}{5} = \frac{3}{4} \cdot \frac{5}{5} \\
\frac{4}{5}x - \frac{5}{10} = \frac{15}{20} \\
\frac{4}{5}x - \frac{1}{2} = \frac{3}{4} \\
\frac{4}{5}x = \frac{5}{10} \\
x = \frac{5}{10} \cdot \frac{5}{4} \\
x = \frac{25}{20} \\
x = \frac{25}{20} \cdot \frac{16}{16} \\
x = \frac{25}{16}
\]

The solution is \( \frac{25}{16} \).

YOU TRY IT • 4

Solve \( \frac{2}{3}x + 3 = \frac{7}{2} \) by first clearing denominators.

Your solution

\( \frac{3}{4} \)

Instructor Note

One way to end this objective is to review the objective title, which is to solve equations of the form \( ax + b = c \). If you ask students what the variables of the equation are, they may answer \( a, b, c, \) and \( x \), and, in a sense, that is true. However, as written symbolic math evolved, it became customary to think of letters at the beginning of the alphabet as constants and those at the end of the alphabet as variables. This kind of implicit understanding is often lost on students.

For this objective, the goal was to solve for \( x \) given \( a, b, \) and \( c \). In the next section, we solve \( ax + b = cx + d \), again with the implicit understanding that \( a, b, c, \) and \( d \) are constants and coefficients.

Later in the text, we will introduce the equation \( y = mx + b \), which also makes implicit assumptions about variables and constants. As students proceed through math courses, they will constantly be exposed to the same kinds of understandings.

Solutions on p. S12
OBJECTIVE B

To solve application problems using formulas

EXAMPLE 6

To determine the total cost of production, an economist uses the equation \( T = U \cdot N + F \), where \( T \) is the total cost, \( U \) is the unit cost, \( N \) is the number of units made, and \( F \) is the fixed cost. Use this equation to find the number of units made during a month in which the total cost was $9000, the unit cost was $25, and the fixed cost was $3000.

Strategy

Given: \( T = 9000 \)
\( U = 25 \)
\( F = 3000 \)

Unknown: \( N \)

Solution

\[
\begin{align*}
T &= U \cdot N + F \\
9000 &= 25N + 3000 \\
6000 &= 25N \\
600 &= \frac{25N}{25} \\
240 &= N
\end{align*}
\]

There were 240 units made.

YOU TRY IT 6

The pressure at a certain depth in the ocean can be approximated by the equation \( P = 15 + \frac{1}{2}D \), where \( P \) is the pressure in pounds per square inch and \( D \) is the depth in feet. Use this equation to find the depth when the pressure is 45 pounds per square inch.

Your solution

60 ft

In-Class Examples

1. The relationship between degrees Celsius and degrees Fahrenheit can be represented by the equation \( F = 1.8C + 32 \), where \( F \) is the temperature in degrees Fahrenheit and \( C \) is the temperature in degrees Celsius. Use this equation to determine the temperature in degrees Celsius when the temperature is 98.6°F. 37°C
### 5.2 Exercises

**Objective A** To solve an equation of the form \( ax + b = c \)

**Suggested Assignment**
- Exercises 1–91, every other odd
- Exercises 93–103, odds
- More challenging problems: Exercises 107–109

For Exercises 1 to 80, solve and check.

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Equation</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
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<td>1.</td>
<td>( 3x + 1 = 10 )</td>
<td>( x = 3 )</td>
</tr>
<tr>
<td>2.</td>
<td>( 4y + 3 = 11 )</td>
<td>( y = 2 )</td>
</tr>
<tr>
<td>3.</td>
<td>( 2a - 5 = 7 )</td>
<td>( a = 6 )</td>
</tr>
<tr>
<td>4.</td>
<td>( 5m - 6 = 9 )</td>
<td>( m = 3 )</td>
</tr>
<tr>
<td>5.</td>
<td>( 5 = 4x + 9 )</td>
<td>( x = -1 )</td>
</tr>
<tr>
<td>6.</td>
<td>( 2 = 5b + 12 )</td>
<td>( b = -2 )</td>
</tr>
<tr>
<td>7.</td>
<td>( 2x - 5 = -11 )</td>
<td>( x = -3 )</td>
</tr>
<tr>
<td>8.</td>
<td>( 3n - 7 = -19 )</td>
<td>( n = -4 )</td>
</tr>
<tr>
<td>9.</td>
<td>( 4 - 3w = -2 )</td>
<td>( w = 2 )</td>
</tr>
<tr>
<td>10.</td>
<td>( 5 - 6x = -13 )</td>
<td>( x = 3 )</td>
</tr>
<tr>
<td>11.</td>
<td>( 8 - 3t = 2 )</td>
<td>( t = 2 )</td>
</tr>
<tr>
<td>12.</td>
<td>( 12 - 5x = 7 )</td>
<td>( x = 1 )</td>
</tr>
<tr>
<td>13.</td>
<td>( 4a - 20 = 0 )</td>
<td>( a = 5 )</td>
</tr>
<tr>
<td>14.</td>
<td>( 3y - 9 = 0 )</td>
<td>( y = 3 )</td>
</tr>
<tr>
<td>15.</td>
<td>( 6 + 2b = 0 )</td>
<td>( b = -3 )</td>
</tr>
<tr>
<td>16.</td>
<td>( 10 + 5m = 0 )</td>
<td>( m = -2 )</td>
</tr>
<tr>
<td>17.</td>
<td>( -2x + 5 = -7 )</td>
<td>( x = 6 )</td>
</tr>
<tr>
<td>18.</td>
<td>( -5d + 3 = -12 )</td>
<td>( d = 3 )</td>
</tr>
<tr>
<td>19.</td>
<td>( -1.2x + 3 = -0.6 )</td>
<td>( x = 3 )</td>
</tr>
<tr>
<td>20.</td>
<td>( -1.3 = -1.1y + 0.9 )</td>
<td>( y = 2 )</td>
</tr>
<tr>
<td>21.</td>
<td>( 2 = 7 - 5a )</td>
<td>( a = 1 )</td>
</tr>
<tr>
<td>22.</td>
<td>( 3 = 11 - 4m )</td>
<td>( m = 2 )</td>
</tr>
<tr>
<td>23.</td>
<td>( -35 = -6b + 1 )</td>
<td>( b = 6 )</td>
</tr>
<tr>
<td>24.</td>
<td>( -8x + 3 = -29 )</td>
<td>( x = 4 )</td>
</tr>
<tr>
<td>25.</td>
<td>( -3m - 21 = 0 )</td>
<td>( m = 7 )</td>
</tr>
<tr>
<td>26.</td>
<td>( -5x - 30 = 0 )</td>
<td>( x = 6 )</td>
</tr>
<tr>
<td>27.</td>
<td>( -4y + 15 = 15 )</td>
<td>( y = 0 )</td>
</tr>
<tr>
<td>28.</td>
<td>( -3x + 19 = 19 )</td>
<td>( x = 0 )</td>
</tr>
<tr>
<td>29.</td>
<td>( 9 - 4x = 6 )</td>
<td>( x = 3/4 )</td>
</tr>
<tr>
<td>30.</td>
<td>( 3t - 2 = 0 )</td>
<td>( t = 2/3 )</td>
</tr>
<tr>
<td>31.</td>
<td>( 9x - 4 = 0 )</td>
<td>( x = 4/9 )</td>
</tr>
<tr>
<td>32.</td>
<td>( 7 - 8z = 0 )</td>
<td>( z = 7/8 )</td>
</tr>
<tr>
<td>33.</td>
<td>( 1 - 3x = 0 )</td>
<td>( x = 1/3 )</td>
</tr>
<tr>
<td>34.</td>
<td>( 9d + 10 = 7 )</td>
<td>( d = -1/3 )</td>
</tr>
<tr>
<td>35.</td>
<td>( 12w + 11 = 5 )</td>
<td>( w = -1/2 )</td>
</tr>
<tr>
<td>36.</td>
<td>( 6y - 5 = -7 )</td>
<td>( y = -1/3 )</td>
</tr>
<tr>
<td>37.</td>
<td>( 8b - 3 = -9 )</td>
<td>( b = -3/4 )</td>
</tr>
<tr>
<td>38.</td>
<td>( 5 - 6m = 2 )</td>
<td>( m = 1/2 )</td>
</tr>
<tr>
<td>39.</td>
<td>( 7 - 9a = 4 )</td>
<td>( a = 1/3 )</td>
</tr>
<tr>
<td>40.</td>
<td>( 9 = -12c + 5 )</td>
<td>( c = 1/3 )</td>
</tr>
</tbody>
</table>

Selected exercises available online at [www.webassign.net/brookscole](http://www.webassign.net/brookscole).
41. \(10 = -18x + 7\)  
42. \(2y + \frac{1}{3} = \frac{7}{3}\)  
43. \(4a + \frac{3}{4} = \frac{19}{4}\)  
44. \(2n - \frac{3}{4} = \frac{13}{4}\)  
45. \(3x - \frac{5}{6} = \frac{13}{6}\)  
46. \(5y + \frac{3}{7} = \frac{3}{7}\)  
47. \(9x + \frac{4}{5} = \frac{4}{5}\)  
48. \(0.8 = 7d + 0.1\)  
49. \(0.9 = 10x - 0.6\)  
50. \(4 = 7 - 2w\)  
51. \(7 = 9 - 5a\)  
52. \(8r + 13 = 3\)  
53. \(12x + 19 = 3\)  
54. \(-6y + 5 = 13\)  
55. \(-4x + 3 = 9\)  
56. \(\frac{1}{2}a - 3 = 1\)  
57. \(\frac{1}{3}m - 1 = 5\)  
58. \(\frac{2}{5}y + 4 = 6\)  
59. \(\frac{3}{4}n + 7 = 13\)  
60. \(-\frac{2}{3}x + 1 = 7\)  
61. \(-\frac{3}{8}b + 4 = 10\)  
62. \(\frac{x}{4} - 6 = 1\)  
63. \(\frac{y}{5} - 2 = 3\)  
64. \(\frac{2x}{3} - 1 = 5\)  
65. \(\frac{2}{3}x - \frac{5}{6} = \frac{1}{3}\)  
66. \(\frac{5}{4}x + \frac{2}{3} = \frac{1}{4}\)  
67. \(\frac{1}{2} - \frac{2}{3}x = \frac{1}{4}\)  
68. \(\frac{3}{4} - \frac{3}{5}x = \frac{19}{20}\)  
69. \(\frac{3}{2} = \frac{5}{6} + \frac{3x}{8}\)  
70. \(\frac{1}{4} = \frac{5}{12} + \frac{5x}{6}\)  
71. \(\frac{11}{27} = \frac{4}{9} - \frac{2x}{3}\)  
72. \(\frac{37}{24} = \frac{7}{8} - \frac{5x}{6}\)  
73. \(7 = \frac{2x}{5} + 4\)  
74. \(5 - \frac{4c}{7} = 8\)  
75. \(7 - \frac{5}{9}y = 9\)  
76. \(6a + 3 + 2a = 11\)  
77. \(5y + 9 = 2y = 23\)  
78. \(7x - 4 - 2x = 6\)  
79. \(11z - 3 - 7z = 9\)  
80. \(2x - 6x + 1 = 9\)  
81. \(15x + 73 = -347\)  
82. \(17 = 25 - 40a\)  
83. \(290 + 51n = 187\)  
84. \(-72 = -86y + 49\)

Quick Quiz

Solve.

1. \(7b + 5 = 61\)  
2. \(12 - 4c = 15\)  
3. \(-\frac{3}{4}x = 3 - 7\)  
4. \(-3 - 6m + 4 + m = -1\)

For Exercises 81 to 84, without solving the equation, determine whether the solution is positive or negative.

81. \(15x + 73 = -347\)  
82. \(17 = 25 - 40a\)  
83. \(290 + 51n = 187\)  
84. \(-72 = -86y + 49\)
85. Solve $3x + 4y = 13$ when $y = -2$.
   $x = 7$

86. Solve $2x - 3y = 8$ when $y = 0$.
   $x = 4$

87. Solve $-4x + 3y = 9$ when $x = 0$.
   $y = 3$

88. Solve $5x - 2y = -3$ when $x = -3$.
   $y = -6$

89. If $2x - 3 = 7$, evaluate $3x + 4$.
   $x = 5$, $y = 19$

90. If $3x + 5 = -4$, evaluate $2x - 5$.
   $x = -11$

91. If $4 - 5x = -1$, evaluate $x^2 - 3x + 1$.
   $x = 1$, $y = -1$

92. If $2 - 3x = 11$, evaluate $x^2 + 2x - 3$.
   $x = -3$

**OBJECTIVE B** To solve application problems using formulas

**Champion Trees** American Forests is an organization that maintains the National Register of Big Trees, a listing of the largest trees in the United States. The formula used to award points to a tree is $P = c + h + \frac{s}{4}$, where $P$ is the point total for a tree with a circumference of $c$ inches, a height of $h$ feet, and an average crown spread of $s$ feet. Use this formula for Exercises 93 and 94. (Source: www.amfor.org)

93. Find the average crown spread of the baldcypress described in the article at the right.
   $57$ ft

94. One of the smallest trees in the United States is a Florida Crossopetalum in the Key Largo Hammocks State Botanical Site. This tree stands 11 ft tall, has a circumference of just 4.8 in., and scores 16.55 points using American Forests' formula. Find the tree's average crown spread. (Source: www.championtrees.org)
   $3$ ft

**Nutrition** The formula $C = 9f + 4p + 4c$ gives the number of calories $C$ in a serving of food that contains $f$ grams of fat, $p$ grams of protein, and $c$ grams of carbohydrate. Use this formula for Exercises 95 and 96. (Source: www.nutristrategy.com)

95. Find the number of grams of protein in an 8-ounce serving of vanilla yogurt that contains 174 calories, 2 g of fat, and 30 g of carbohydrate.
   $9$ g

96. Find the number of grams of fat in a serving of granola that contains 215 calories, 42 g of carbohydrate, and 5 g of protein.
   $3$ g

**Physics** The distance $s$, in feet, that an object will fall in $t$ seconds is given by $s = 16t^2 + vt$, where $v$ is the initial velocity of the object in feet per second. Use this equation for Exercises 97 and 98.

97. Find the initial velocity of an object that falls 80 ft in 2 s.
   $8$ ft/s

98. Find the initial velocity of an object that falls 144 ft in 3 s.
   $0$ ft/s

**In the News**

**The Senator Is a Champion**

Baldcypress trees are among the most ancient of North American trees. The 3500-year-old baldcypress known as the Senator, located in Big Tree Park, Longwood, is the Florida Champion specimen of the species. With a circumference of 425 in. and a height of 118 ft, this king of the swamp forest earned a total of 557.075 points under the point system used for the National Register of Big Trees.

(Source: www.championtrees.org)

**In the News**

**The Senator at Big Tree Park**
Depreciation  A company uses the equation $V = C - 6000t$ to determine the depreciated value $V$, after $t$ years, of a milling machine that originally cost $C$ dollars. Equations like this are used in accounting for straight-line depreciation. Use this equation for Exercises 99 and 100.

99. A milling machine originally cost $50,000. In how many years will the depreciated value of the machine be $38,000?
   
   2 years

100. A milling machine originally cost $78,000. In how many years will the depreciated value of the machine be $48,000?
   
   5 years

Anthropology  Anthropologists approximate the height of a primate by the size of its humerus (the bone from the elbow to the shoulder) using the equation $H = 1.2L + 27.8$, where $L$ is the length of the humerus and $H$ is the height, in inches, of the primate. Use this equation for Exercises 101 and 102.

101. An anthropologist estimates the height of a primate to be 66 in. What is the approximate length of the humerus of this primate? Round to the nearest tenth of an inch.
   
   31.8 in.

102. An anthropologist estimates the height of a primate to be 62 in. What is the approximate length of the humerus of this primate?
   
   28.5 in.

Car Safety  Black ice is an ice covering on roads that is especially difficult to see and therefore extremely dangerous for motorists. The distance that a car traveling 30 mph will slide after its brakes are applied is related to the outside temperature by the formula $C = \frac{1}{4}D - 45$, where $C$ is the Celsius temperature and $D$ is the distance in feet that the car will slide. Use this equation for Exercises 103 and 104.

103. Determine the distance a car will slide on black ice when the outside temperature is $-3°C$.  
   
   168 ft

104. Determine the distance a car will slide on black ice when the outside temperature is $-11°C$.  
   
   136 ft

105. If $A$ is a positive number, is the solution of the equation $Ax + 8 = -3$ positive or negative?
   
   Negative

106. If $A$ is a negative number, is the solution of the equation $Ax - 2 = -5$ positive or negative?
   
   Positive

Quick Quiz

1. A computer costing $1200 has a selling price of $2000. Find the markup rate. Use the markup equation $S = C + rC$, where $S$ is the selling price, $C$ is the cost, and $r$ is the markup rate. $66\frac{2}{3}\%$
To solve an equation of the form \( ax + b = cx + d \), the goal is to rewrite the equation in the form \( \text{variable} = \text{constant} \). Begin by rewriting the equation so that there is only one variable term in the equation. Then rewrite the equation so that there is only one constant term.

**Example 1**

Solve: \( 2x + 3 = 5x - 9 \)

Solution:

\[
\begin{align*}
2x + 3 &= 5x - 9 \\
2x - 5x + 3 &= 5x - 5x - 9 \\
-3x + 3 &= -9 \\
-3x + 3 - 3 &= -9 - 3 \\
-3x &= -12 \\
\frac{-3x}{3} &= \frac{-12}{3} \\
x &= 4
\end{align*}
\]

The solution is \( x = 4 \). You should verify this by checking this solution.

**You Try It 1**

Solve: \( 5x + 4 = 6 + 10x \)

Solution:

\[
\begin{align*}
5x + 4 &= 6 + 10x \\
5x + 4 - 10x &= 6 + 10x - 10x \\
-5x + 4 &= 6 \\
-5x + 4 - 4 &= 6 - 4 \\
-5x &= 2 \\
\frac{-5x}{-5} &= \frac{2}{-5} \\
x &= \frac{2}{-5}
\end{align*}
\]

The solution is \( x = \frac{2}{-5} \).
OBJECTIVE B

To solve an equation containing parentheses

Instructor Note
Remind students that the goal is still variable = constant.

HOW TO • 2

Solve: \(4 + 5(2x - 3) = 3(4x - 1)\)

\[
\begin{align*}
4 + 5(2x - 3) & = 3(4x - 1) \\
4 + 10x - 15 & = 12x - 3 \\
10x - 11 & = 12x - 3 \\
10x - 12x - 11 & = 12x - 12x - 3 \\
-2x - 11 & = -3 \\
-2x - 11 + 11 & = -3 + 11 \\
-2x & = 8 \\
\frac{-2x}{-2} & = \frac{8}{-2} \\
x & = -4
\end{align*}
\]

The solution is \(-4\). You should verify this by checking this solution.

In the next example, we solve an equation with parentheses and decimals.
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HOW TO 3
Solve: \(16 + 0.55x = 0.75(x + 20)\)

\[
\begin{align*}
16 + 0.55x &= 0.75(x + 20) \\
16 + 0.55x &= 0.75x + 15 \\
16 + 0.55x - 0.75x &= 0.75x - 0.75x + 15 \\
16 - 0.20x &= 15 \\
16 - 16 - 0.20x &= 15 - 16 \\
-0.20x &= -1 \\
\frac{-0.20x}{-0.20} &= \frac{-1}{-0.20} \\
x &= 5
\end{align*}
\]

The solution is 5.

EXAMPLE 3
Solve: \(3x - 4(2 - x) = 3(x - 2) - 4\)

Solution
\[
\begin{align*}
3x - 4(2 - x) &= 3(x - 2) - 4 \\
3x - 8 + 4x &= 3x - 6 - 4 \\
7x - 8 &= 3x - 10 \\
7x - 3x &= 3x - 3x - 10 \\
4x &= -8 \\
4x - 8 + 8 &= -10 + 8 \\
4x &= -2 \\
\frac{4x}{4} &= \frac{-2}{4} \\
x &= -\frac{1}{2}
\end{align*}
\]

The solution is \(-\frac{1}{2}\).

YOU TRY IT 3
Solve: \(5x - 4(3 - 2x) = 2(3x - 2) + 6\)

Your solution
2

In-Class Examples
1. Solve: \(9x - 3(2x + 5) - 4(5x + 2) - 6\)
2. Solve: \(5(6 - 2(5x + 1)) - 8x - 9\)
3. If \(4x - 2(x + 10)\), evaluate \(4x^2 - 10\).

EXAMPLE 4
Solve: \(3[2 - 4(2x - 1)] = 4x - 10\)

Solution
\[
\begin{align*}
3[2 - 4(2x - 1)] &= 4x - 10 \\
3[2 - 8x + 4] &= 4x - 10 \\
3[6 - 8x] &= 4x - 10 \\
18 - 24x &= 4x - 10 \\
18 - 24x - 4x &= 4x - 4x - 10 \\
18 - 28x &= -10 \\
18 - 18 - 28x &= -10 - 18 \\
-28x &= -28 \\
\frac{-28x}{-28} &= \frac{-28}{-28} \\
x &= 1
\end{align*}
\]

The solution is 1.
OBJECTIVE C

To solve application problems using formulas

A lever system is shown at the right. It consists of a lever, or bar; a fulcrum; and two forces, \( F_1 \) and \( F_2 \). The distance \( d \) represents the length of the lever, \( x \) represents the distance from \( F_1 \) to the fulcrum, and \( d - x \) represents the distance from \( F_2 \) to the fulcrum.

A principle of physics states that when the lever system balances, \( F_1 x = F_2 (d - x) \).

\[
F_1 x = F_2 (d - x) \\
50x = 100(15 - x) \\
50x = 1500 - 100x \\
50x + 100x = 1500 + 100x + 100x \\
150x = 1500 \\
150x = 1500 \\
x = 10
\]

The fulcrum is 10 ft from the 50-pound force.

In-Class Examples

1. A lever is 12 ft long. A force of 3 lb is applied to one end of the lever, and a force of 6 lb is applied to the other end. Where is the location of the fulcrum when the system balances?

   Solution on p. S13
5.3 EXERCISES

OBJECTIVE A To solve an equation of the form \( ax + b = cx + d \)

1. Describe the step that will enable you to rewrite the equation \( 2x - 3 = 7x + 12 \) so that it has one variable term with a positive coefficient.
   Subtract \( 2x \) from each side.

For Exercises 2 to 28, solve and check.

- 2. \( 8x + 5 = 4x + 13 \)
  
- 3. \( 6y + 2 = y + 17 \)
  
- 4. \( 5x - 4 = 2x + 5 \)
  
- 5. \( 13b - 1 = 4b - 19 \)
  
- 6. \( 15x - 2 = 4x - 13 \)
  
- 7. \( 7a - 5 = 2a - 20 \)
  
- 8. \( 3x + 1 = 11 - 2x \)
  
- 9. \( n - 2 = 6 - 3n \)
  
- 10. \( 2x - 3 = -11 - 2x \)
  
- 11. \( 4y - 2 = -16 - 3y \)
  
- 12. \( 0.2b + 3 = 0.5b + 12 \)
  
- 13. \( m + 0.4 = 3m + 0.8 \)
  
- 14. \( 4y - 8 = y - 8 \)
  
- 15. \( 5a + 7 = 2a + 7 \)
  
- 16. \( 6 - 5x = 8 - 3x \)
  
- 17. \( 10 - 4n = 16 - n \)
  
- 18. \( 5 + 7x = 11 + 9x \)
  
- 19. \( 3 - 2y = 15 + 4y \)
  
- 20. \( 2x - 4 = 6x \)
  
- 21. \( 2b - 10 = 7b \)
  
- 22. \( 8m = 3m + 20 \)
  
- 23. \( 9y = 5y + 16 \)
  
- 24. \( 8b + 5 = 5b + 7 \)
  
- 25. \( 6y - 1 = 2y + 2 \)
  
- 26. \( 7x - 8 = x - 3 \)
  
- 27. \( 2y - 7 = -1 - 2y \)
  
- 28. \( 2m - 1 = -6m + 5 \)
  
- 29. If \( 5x = 3x - 8 \), evaluate \( 4x + 2 \).
  
- 30. If \( 7x + 3 = 5x - 7 \), evaluate \( 3x - 2 \).
  
- 31. If \( 2 - 6a = 5 - 3a \), evaluate \( 4a^2 - 2a + 1 \).
  
- 32. If \( 1 - 5c = 4 - 4c \), evaluate \( 3c^2 - 4c + 2 \).

Quick Quiz

1. Solve: \( 7x + 4 = 3x - 20 \)
   
2. If \( 4 - 3x - 24 + 2x \), evaluate \( 3x^2 - 2x + 4 \).

Suggested Assignment

Exercises 1–55, every other odd
Exercises 57–73, odds
More challenging problem:
Exercise 74

Selected exercises available online at www.webassign.net/brookscole.
To solve an equation containing parentheses

33. Without solving any of the equations, determine which of the following equations has the same solution as the equation $5 - 2(x - 1) = 8$.
   (i) $3(x - 1) = 8$
   (ii) $5 - 2x + 2 = 8$
   (iii) $5 - 2x + 1 = 8$

Quick Quiz
   1. Solve: $3 + 2[4x - 3(5 - x)] - 3(x - 20) = -3$
   2. If $5x - 4 = 2(4x + 7)$, evaluate $3x^2 - 2x$.

For Exercises 34 to 54, solve and check.

34. $5x + 2(x + 1) = 23$
35. $6y + 2(2y + 3) = 16$
36. $9m - 3(2n - 1) = 15$

37. $12x - 2(4x - 6) = 28$
38. $7a - (3a - 4) = 12$
39. $9m - 4(2m - 3) = 11$

40. $5(3 - 2y) + 4y = 3$
41. $4(1 - 3x) + 7x = 9$
42. $5y - 3 - 7 + 4(y - 2)$

43. $0.22(x + 6) = 0.2x + 1.8$
44. $0.05(4 - x) + 0.1x = 0.32$
45. $0.3x + 0.3(x + 10) = 300$

46. $2a - 5 = 4(3a + 1) - 2$
47. $5 - (9 - 6x) = 2x - 2$
48. $7 - (5 - 8x) = 4x + 3$

49. $3[2 - 4(y - 1)] = 3(2y + 8)$

50. $5[2 - (2x - 4)] = 2(5 - 3x)$

51. $3a + 2[2 + 3(a - 1)] = 2(3a + 4)$
52. $5 + 3[1 + 2(2x - 3)] = 6(x + 5)$

53. $-2[4 - (3b + 2)] = 5 - 2(3b + 6)$
54. $-4[x - 2(2x - 3)] + 1 = 2x - 3$

55. If $4 - 3a = 7 - 2(2a + 5)$, evaluate $a^2 + 7a$.

56. If $9 - 5x = 12 - (6x + 7)$, evaluate $x^2 - 3x - 2$. 

0

26
OBJECTIVE C  To solve application problems using formulas

**Diving Scores**  In a diving competition, a diver’s total score for a dive is calculated using the formula
\[ P = D(x + y + z), \]
where \( P \) is the total points awarded, \( D \) is the degree of difficulty of the dive, and \( x \), \( y \), and \( z \) are the scores from three judges. Use this formula and the information in the article at the right for Exercises 57 to 60.

57. Two judges gave Kinzbach’s platform dive scores of 8.5. Find the score given by the third judge.
7.5

58. Two judges gave Ross’s 1-meter dive scores of 8 and 8.5. Find the score given by the third judge.
8.5

59. Two judges gave Viola’s platform dive scores of 8. Find the score given by the third judge.
8

60. Two judges gave Viola’s 1-meter dive scores of 8 and 8.5. Find the score given by the third judge.
7.5

**Physics**  Two people sit on a seesaw that is 8 ft long. The seesaw balances when the fulcrum is 3 ft from one of the people.

a. How far is the fulcrum from the other person?
b. Which person is heavier, the person who is 3 ft from the fulcrum or the other person?
c. If the two people switch places, will the seesaw still balance?

a. 5 ft  b. The person who is 3 ft from the fulcrum  c. No

**Physics**  For Exercises 62 to 67, solve. Use the lever system equation \( F_1 x = F_2 (d - x) \).

62. A lever 10 ft long is used to move a 100-pound rock. The fulcrum is placed 2 ft from the rock. What force must be applied to the other end of the lever to move the rock?
25 lb

63. An adult and a child are on a seesaw 14 ft long. The adult weighs 175 lb and the child weighs 70 lb. How many feet from the child must the fulcrum be placed so that the seesaw balances?
10 ft

64. Two people are sitting 15 ft apart on a seesaw. One person weighs 180 lb. The second person weighs 120 lb. How far from the 180-pound person should the fulcrum be placed so that the seesaw balances?
6 ft

65. Two children are sitting on a seesaw that is 12 ft long. One child weighs 60 lb. The other child weighs 90 lb. How far from the 90-pound child should the fulcrum be placed so that the seesaw balances?
4.8 ft

---

**In the News**

**Hurricane Divers Make a Splash**

University of Miami divers JJ Kinzbach and Rueben Ross took the top two spots in Men’s Platform diving at the 2008 NCAA Zone B Championships. Ross also placed second in the Men’s 3-meter and 1-meter events. Brittany Viola won the Women’s Platform diving event and placed third in the 3-meter and 1-meter events. Statistics from some of the best dives follow.

<table>
<thead>
<tr>
<th>Diver</th>
<th>Event</th>
<th>Dive</th>
<th>Degree of Difficulty</th>
<th>Total Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kinzbach</td>
<td>Platform</td>
<td>Inward 3½ somersault tuck</td>
<td>3.2</td>
<td>81.60</td>
</tr>
<tr>
<td>Ross</td>
<td>1-meter</td>
<td>Inward 2½ somersault tuck</td>
<td>3.1</td>
<td>77.50</td>
</tr>
<tr>
<td>Viola</td>
<td>Platform</td>
<td>Forward 3½ somersault pike</td>
<td>3.0</td>
<td>72.00</td>
</tr>
<tr>
<td>Viola</td>
<td>1-meter</td>
<td>Inward 1½ somersault pike</td>
<td>2.4</td>
<td>57.60</td>
</tr>
</tbody>
</table>
66. In preparation for a stunt, two acrobats are standing on a plank 18 ft long. One acrobat weighs 128 lb and the second acrobat weighs 160 lb. How far from the 128-pound acrobat must the fulcrum be placed so that the acrobats are balanced on the plank?

10 ft

67. A screwdriver 9 in. long is used as a lever to open a can of paint. The tip of the screwdriver is placed under the lip of the can with the fulcrum 0.15 in. from the lip. A force of 30 lb is applied to the other end of the screwdriver. Find the force on the lip of the can.

1770 lb

**Business**

To determine the break-even point, or the number of units that must be sold so that no profit or loss occurs, an economist uses the formula $P = Cx + F$, where $P$ is the selling price per unit, $x$ is the number of units that must be sold to break even, $C$ is the cost to make each unit, and $F$ is the fixed cost. Use this equation for Exercises 68 to 71.

- **68.** A business analyst has determined that the selling price per unit for a laser printer is $1600. The cost to make one laser printer is $950, and the fixed cost is $211,250. Find the break-even point.

325 laser printers

- **69.** A business analyst has determined that the selling price per unit for a gas barbecue is $325. The cost to make one gas barbecue is $175, and the fixed cost is $39,000. Find the break-even point.

260 barbecues

- **70.** A manufacturer of headphones determines that the cost per unit for a pair of headphones is $38 and that the fixed cost is $24,400. The selling price for the headphones is $99. Find the break-even point.

400 headphones

- **71.** A manufacturing engineer determines that the cost per unit for a soprano recorder is $12 and that the fixed cost is $19,240. The selling price for the recorder is $49. Find the break-even point.

520 recorders

**Physiology**

The oxygen consumption $C$, in millimeters per minute, of a small mammal at rest is related to the animal’s weight $m$, in kilograms, by the equation $m = \frac{1}{6}(C - 5)$. Use this equation for Exercises 72 and 73.

- **72.** What is the oxygen consumption of a mammal that weighs 10.4 kg?

67.4 ml/min

- **73.** What is the oxygen consumption of a mammal that weighs 8.3 kg?

54.8 ml/min

**Applying the Concepts**

- **74.** The equation $x = x + 1$ has no solution, whereas the solution of the equation $2x + 3 = 3$ is zero. Is there a difference between no solution and a solution of zero? Explain your answer.

For answers to the Writing exercises, please see the Appendix in the Instructor’s Resource Binder that accompanies this textbook.
SECTION 5.4

Translating Sentences into Equations

**OBJECTIVE A**

To solve integer problems

An equation states that two mathematical expressions are equal. Therefore, to translate a sentence into an equation requires recognition of the words or phrases that mean “equals.” Some of these phrases are listed below.

- **equals**
- **is**
- **is equal to**
- **amounts to**
- **represents**

Once the sentence is translated into an equation, the equation can be solved by rewriting the equation in the form \( \text{variable} = \text{constant} \).

**Take Note**
You can check the solution to a translation problem.

**Check:**

5 less than 18 is 13

\[
\begin{align*}
18 - 5 &= 13 \\
13 - 13 &= 13
\end{align*}
\]

** HOW TO 1 **

Translate “five less than a number is thirteen” into an equation and solve.

The unknown number: \( n \)

- Assign a variable to the unknown number.
- Find two verbal expressions for the same value.
- Write a mathematical expression for each verbal expression. Write the equals sign.
- Solve the equation.

\[
\begin{align*}
\text{Five less than a number} &= \text{thirteen} \\
n - 5 &= 13 \\
n - 5 + 5 &= 13 + 5 \\
n &= 18
\end{align*}
\]

The number is 18.

Recall that the integers are the numbers \( \ldots, -4, -3, -2, -1, 0, 1, 2, 3, 4, \ldots \). An **even integer** is an integer that is divisible by 2. Examples of even integers are \(-8, 0, \text{and } 22\). An **odd integer** is an integer that is not divisible by 2. Examples of odd integers are \(-17, 1, \text{and } 39\).

**Consecutive integers** are integers that follow one another in order. Examples of consecutive integers are shown at the right. (Assume that the variable \( n \) represents an integer.)

\[
11, 12, 13 \\
-8, -7, -6 \\
n, n + 1, n + 2
\]

Examples of **consecutive even integers** are shown at the right. (Assume that the variable \( n \) represents an even integer.)

\[
24, 26, 28 \\
-10, -8, -6 \\
n, n + 2, n + 4
\]

Examples of **consecutive odd integers** are shown at the right. (Assume that the variable \( n \) represents an odd integer.)

\[
19, 21, 23 \\
-1, 1, 3 \\
n, n + 2, n + 4
\]

**Take Note**
Both consecutive even and consecutive odd integers are represented using \( n, n + 2, n + 4, \ldots \).
The sum of three consecutive odd integers is forty-five. Find the integers.

**Strategy**
- First odd integer: \( n \)
- Second odd integer: \( n + 2 \)
- Third odd integer: \( n + 4 \)
- The sum of the three odd integers is 45.

**Solution**
- Write an equation.
- Solve the equation.

\[
\begin{align*}
3n + 6 &= 45 \\
3n &= 39 \\
\therefore n &= 13
\end{align*}
\]

- The first odd integer is 13.
- Find the second odd integer.
- Find the third odd integer.

The three consecutive odd integers are 13, 15, and 17.

**In-Class Examples**

1. The sum of two numbers is twenty-five. The total of four times the smaller number and two is six less than the product of two and the larger number. Find the two numbers.

   \[
   \begin{align*}
   4x + 2 &= 2(25 - x) - 6; \quad 7, 18
   \end{align*}
   \]

2. Three times the largest of three consecutive integers is ten more than the sum of the other two. Find the three integers.

   \[
   \begin{align*}
   3(n + 2) &= n + (n + 1) + 10; \quad 5, 6, 7
   \end{align*}
   \]

**Solution on pp. S13–S14**
OBJECTIVE B
To translate a sentence into an equation and solve

EXAMPLE 2
Find three consecutive even integers such that three times the second equals four more than the sum of the first and third.

Strategy
• First even integer: $n$
  Second even integer: $n + 2$
  Third even integer: $n + 4$
• Three times the second equals four more than the sum of the first and third.

Solution
\[3(n + 2) = n + (n + 4) + 4\]
\[3n + 6 = 2n + 8\]
\[3n - 2n + 6 = 2n - 2n + 8\]
\[n + 6 = 8\]
\[n = 2\]
\[n + 2 = 2 + 2 = 4\]
\[n + 4 = 2 + 4 = 6\]
The three integers are 2, 4, and 6.

YOU TRY IT 2
Find three consecutive integers whose sum is negative six.

Your strategy

Solution
\[-3, -2, -1\]

EXAMPLE 3
A wallpaper hanger charges a fee of $25 plus $12 for each roll of wallpaper used in a room. If the total charge for hanging wallpaper is $97, how many rolls of wallpaper were used?

Strategy
To find the number of rolls of wallpaper used, write and solve an equation using $n$ to represent the number of rolls of wallpaper used.

Solution
$25$ plus $12$ for each roll of wallpaper is $97$
\[25 + 12n = 97\]
\[12n = 72\]
\[12n \div 12 = 72 \div 12\]
\[n = 6\]
6 rolls of wallpaper were used.

YOU TRY IT 3
The fee charged by a ticketing agency for a concert is $3.50 plus $17.50 for each ticket purchased. If your total charge for tickets is $161, how many tickets are you purchasing?

Your strategy

In-Class Examples
1. An electric company charges $.07 for each of the first 249 kWh (kilowatt-hours) and $.14 for each kilowatt-hour over 249 kWh. Find the number of kilowatt-hours used by a family whose electric bill was $46.55.
   457 kWh
2. A piano wire 24 in. long is cut into two pieces. The length of the longer piece is 4 in. more than three times the length of the shorter piece. Find the length of each piece.
   5 in., 19 in.
EXAMPLE 4

A board 20 ft long is cut into two pieces. Five times the length of the shorter piece is 2 ft more than twice the length of the longer piece. Find the length of each piece.

Strategy
Let \( x \) represent the length of the shorter piece. Then \( 20 - x \) represents the length of the longer piece.

Make a drawing.

To find the lengths, write and solve an equation using \( x \) to represent the length of the shorter piece and \( 20 - x \) to represent the length of the longer piece.

Solution

\[
5x = 2(20 - x) + 2
\]
\[
5x = 40 - 2x + 2
\]
\[
5x = 42 - 2x
\]
\[
5x + 2x = 42 - 2x + 2x
\]
\[
7x = 42
\]
\[
7x
\]
\[
7
\]
\[
x = 6
\]

\( 20 - x = 20 - 6 = 14 \)

The length of the shorter piece is 6 ft.
The length of the longer piece is 14 ft.

Solution on p. S14

YOU TRY IT 4

A wire 22 in. long is cut into two pieces. The length of the longer piece is 4 in. more than twice the length of the shorter piece. Find the length of each piece.

Your strategy

Your solution

6 in., 16 in.

Instructor Note

Problems that begin with sentences such as “The sum of two numbers is twelve” and “A board 12 ft long is cut into two pieces” can have their two constituent parts represented identically, using \( n \) and \( 12 - n \).

Some students have difficulty making the transition from the sentence “The sum of two numbers is sixteen” to the conclusion that if the first number is represented as \( n \), the second number may be represented as \( 16 - n \). The confusion is due in part to the use of the word sum and the fact that the representation of the two numbers does not involve addition. It can be pointed out, however, that the sum of \( n \) and \( 16 - n \) is, in fact, 16.
5.4 EXERCISES

OBJECTIVE A To solve integer problems

For Exercises 1 to 16, translate into an equation and solve.

1. The difference between a number and fifteen is seven. Find the number.
   \[ x - 15 = 7; \quad x = 22 \]

3. The difference between nine and a number is seven. Find the number.
   \[ 9 - x = 7; \quad x = 2 \]

5. The difference between five and twice a number is one. Find the number.
   \[ 5 - 2x = 1; \quad x = 2 \]

7. The sum of twice a number and five is fifteen. Find the number.
   \[ 2x + 5 = 15; \quad x = 5 \]

9. Six less than four times a number is twenty-two. Find the number.
   \[ 4x - 6 = 22; \quad x = 8 \]

11. Three times the difference between four times a number and seven is fifteen. Find the number.
    \[ 3(4x - 7) = 15; \quad x = 3 \]

13. The sum of two numbers is twenty. Three times the smaller is equal to two times the larger. Find the two numbers.
    \[ 3x = 2(20 - x); \quad x = 8, 12 \]

15. The sum of two numbers is fourteen. The difference between two times the smaller and the larger is one. Find the two numbers.
    \[ 2x - (14 - x) = 1; \quad x = 5, 9 \]

17. The sum of three consecutive odd integers is fifty-one. Find the integers.
    \[ 15, 17, 19 \]

19. Find three consecutive odd integers such that three times the middle integer is one more than the sum of the first and third.
    \[-1, 1, 3 \]

21. Find two consecutive even integers such that three times the first equals twice the second.
    \[ 4, 6 \]

23. The sum of two numbers is seven. Twice one number is four less than the other number. Which of the following equations does not represent this situation?
   (i) \[ 2(7 - x) = x - 4 \]
   (ii) \[ 2x = (7 - x) - 4 \]
   (iii) \[ 2n - 4 = 7 - n \]

Quick Quiz

1. The product of five and a number is negative fifteen. Find the number. \[ 5x = -15; \quad x = -3 \]

2. Find three consecutive even integers such that four times the second is eight less than the third. \[ 4(x + 2) = (x + 4) - 8; \quad x = -2, -4, -6 \]

Selected exercises available online at www.webassign.net/brookscole.
OBJECTIVE B  To translate a sentence into an equation and solve

24. Recycling  Use the information in the article at the right to find how many tons of plastic drink bottles were stocked for sale in U.S. stores.
   2.7 million tons

25. Robots  Kiva Systems, Inc., builds robots that companies can use to streamline order fulfillment operations in their warehouses. Salary and other benefits for one human warehouse worker can cost a company about $64,000 a year, an amount that is 103 times the company’s yearly maintenance and operation costs for one robot. Find the yearly costs for a robot. Round to the nearest hundred. (Source: The Boston Globe)
   $600

26. Geometry  An isosceles triangle has two sides of equal length. The length of the third side is 1 ft less than twice the length of an equal side. Find the length of each side when the perimeter is 23 ft.
   6 ft, 6 ft, 11 ft

27. Geometry  An isosceles triangle has two sides of equal length. The length of one of the equal sides is 2 m more than three times the length of the third side. If the perimeter is 46 m, find the length of each side.
   20 m, 20 m, 6 m

28. Union Dues  A union charges monthly dues of $4.00 plus $.15 for each hour worked during the month. A union member’s dues for March were $29.20. How many hours did the union member work during the month of March?
   168 h

29. Technical Support  A technical information hotline charges a customer $15.00 plus $2.00 per minute to answer questions about software. How many minutes did a customer who received a bill for $37 use this service?
   11 min

30. Construction  The total cost to paint the inside of a house was $1346. This cost included $125 for materials and $33 per hour for labor. How many hours of labor were required to paint the inside of the house?
   37 h

31. Telecommunications  The cellular phone service for a business executive is $35 per month plus $.40 per minute of phone use. For a month in which the executive’s cellular phone bill was $99.80, how many minutes did the executive use the phone?
   162 min

32. Energy  The cost of electricity in a certain city is $.08 for each of the first 300 kWh (kilowatt-hours) and $.13 for each kilowatt-hour over 300 kWh. Find the number of kilowatt-hours used by a family with a $51.95 electric bill.
   515 kWh
Text Messaging  For Exercises 33 and 34, use the expression \(2.99 + 0.15n\), which represents the total monthly text-messaging bill for \(n\) text messages over 300 in 1 month.

33. How much does the customer pay per text message over 300 messages?
   
   

34. What is the fixed charge per month for the text-messaging service?

   

35. Contractors  Budget Plumbing charged $400 for a water softener and installation. The charge included $310 for the water softener and $30 per hour for labor. How many hours of labor were required for the job?

   

36. Purchasing  McPherson Cement sells cement for $75 plus $24 for each yard of cement. How many yards of cement can be purchased for $363?

   

37. Carpentry  A 12-foot board is cut into two pieces. Twice the length of the shorter piece is 3 ft less than the length of the longer piece. Find the length of each piece.

   

38. Sports  A 14-yard fishing line is cut into two pieces. Three times the length of the longer piece is four times the length of the shorter piece. Find the length of each piece.

   

39. Education  Seven thousand dollars is divided into two scholarships. Twice the amount of the smaller scholarship is $1000 less than the larger scholarship. What is the amount of the larger scholarship?

   

40. Investing  An investment of $10,000 is divided into two accounts, one for stocks and one for mutual funds. The value of the stock account is $2000 less than twice the value of the mutual fund account. Find the amount in each account.

   

Applying the Concepts

41. Make up two word problems: one that requires solving the equation \(6x = 123\), and one that requires solving the equation \(8x + 100 = 300\), to find the answer to the problem.

42. It is always important to check the answer to an application problem to be sure that the answer makes sense. Consider the following problem. A 4-quart juice mixture is made from apple juice and cranberry juice. There are 6 more quarts of apple juice than cranberry juice. Write and solve an equation for the number of quarts of each juice in the mixture. Does the answer to this question make sense? Explain.

For answers to the Writing exercises, please see the Appendix in the Instructor’s Resource Binder that accompanies this textbook.
A value mixture problem involves combining two ingredients that have different prices into a single blend. For example, a coffee merchant may blend two types of coffee into a single blend, or a candy manufacturer may combine two types of candy to sell as a variety pack.

The solution of a value mixture problem is based on the value mixture equation \( AC = V \), where \( A \) is the amount of an ingredient, \( C \) is the cost per unit of the ingredient, and \( V \) is the value of the ingredient.

**Strategy for Solving a Value Mixture Problem**

1. For each ingredient in the mixture, write a numerical or variable expression for the amount of the ingredient used, the unit cost of the ingredient, and the value of the amount used. For the blend, write a numerical or variable expression for the amount, the unit cost of the blend, and the value of the amount. The results can be recorded in a table.

<table>
<thead>
<tr>
<th>Amount, ( A )</th>
<th>Unit Cost, ( C )</th>
<th>Value, ( V )</th>
</tr>
</thead>
<tbody>
<tr>
<td>$6 grade</td>
<td>( x )</td>
<td>6</td>
</tr>
<tr>
<td>$3 grade</td>
<td>6 - ( x )</td>
<td>3</td>
</tr>
<tr>
<td>$5 blend</td>
<td>6</td>
<td>5</td>
</tr>
</tbody>
</table>

2. Determine how the values of the ingredients are related. Use the fact that the sum of the values of all the ingredients is equal to the value of the blend.

The sum of the values of the \$6 grade and the \$3 grade is equal to the value of the \$5 blend.

\[
6x + 3(6 - x) = 5(6)
\]

\[
6x + 18 - 3x = 30
\]

\[
3x + 18 = 30
\]

\[
3x = 12
\]

\[
x = 4
\]

\[
6 - x = 6 - 4 = 2
\]

• Find the amount of the \$3 grade coffee.

The merchant must use 4 lb of the \$6 coffee and 2 lb of the \$3 coffee.
EXAMPLE 1

How many ounces of a silver alloy that costs $4 an ounce must be mixed with 10 oz of an alloy that costs $6 an ounce to make a mixture that costs $4.32 an ounce?

Strategy

• Ounces of $4 alloy: \(x\)

<table>
<thead>
<tr>
<th>Amount</th>
<th>Cost</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$4 alloy</td>
<td>(x)</td>
<td>4</td>
</tr>
<tr>
<td>$6 alloy</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>$4.32 mixture</td>
<td>10 + (x)</td>
<td>4.32</td>
</tr>
</tbody>
</table>

• The sum of the values before mixing equals the value after mixing.

Solution

\[
4x + 6(10) = 4.32(10 + x)
\]
\[
4x + 60 = 43.2 + 4.32x
\]
\[
-0.32x + 60 = 43.2
\]
\[
-0.32x = -16.8
\]
\[
x = 52.5
\]

52.5 oz of the $4 silver alloy must be used.

YOU TRY IT 1

A gardener has 20 lb of a lawn fertilizer that costs $.80 per pound. How many pounds of a fertilizer that costs $.55 per pound should be mixed with this 20 lb of lawn fertilizer to produce a mixture that costs $.75 per pound?

Your strategy

5 lb

Solution on p. S14
Recall from Section 5.1 that an object traveling at a constant speed in a straight line is in uniform motion. The solution of a uniform motion problem is based on the equation \(rt = d\), where \(r\) is the rate of travel, \(t\) is the time spent traveling, and \(d\) is the distance traveled.

A car leaves a town traveling at 40 mph. Two hours later, a second car leaves the same town, on the same road, traveling at 60 mph. In how many hours will the second car pass the first car?

**Strategy for Solving a Uniform Motion Problem**

1. For each object, write a numerical or variable expression for the rate, time, and distance. The results can be recorded in a table.

The first car traveled 2 h longer than the second car.

Unknown time for the second car: \(t\)

Time for the first car: \(t + 2\)

<table>
<thead>
<tr>
<th></th>
<th>Rate, (r)</th>
<th>Time, (t)</th>
<th>Distance, (d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>First car</td>
<td>40</td>
<td>(t + 2)</td>
<td>(40(t + 2))</td>
</tr>
<tr>
<td>Second car</td>
<td>60</td>
<td>(t)</td>
<td>(60t)</td>
</tr>
</tbody>
</table>

The two cars travel the same distance.

\[40(t + 2) = 60t\]
\[40t + 80 = 60t\]
\[80 = 20t\]
\[4 = t\]

The second car will pass the first car in 4 h.
EXAMPLE • 2

Two cars, one traveling 10 mph faster than the other, start at the same time from the same point and travel in opposite directions. In 3 h, they are 300 mi apart. Find the rate of each car.

**Strategy**

- Rate of 1st car: \( r \)
- Rate of 2nd car: \( r + 10 \)

<table>
<thead>
<tr>
<th>Rate</th>
<th>Time</th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st car</td>
<td>( r )</td>
<td>3</td>
</tr>
<tr>
<td>2nd car</td>
<td>( r + 10 )</td>
<td>3</td>
</tr>
</tbody>
</table>

- The total distance traveled by the two cars is 300 mi.

**Solution**

\[
3r + 3(r + 10) = 300 \\
3r + 3r + 30 = 300 \\
6r + 30 = 300 \\
6r = 270 \\
r = 45
\]

\[
r + 10 = 45 + 10 = 55
\]

The first car is traveling 45 mph.
The second car is traveling 55 mph.

**YOU TRY IT • 2**

Two trains, one traveling at twice the speed of the other, start at the same time on parallel tracks from stations that are 288 mi apart and travel toward each other. In 3 h, the trains pass each other. Find the rate of each train.

**Your strategy**

**Your solution**

32 mph; 64 mph

EXAMPLE • 3

How far can the members of a bicycling club ride out into the country at a speed of 12 mph and return over the same road at 8 mph if they travel a total of 10 h?

**Strategy**

- Time spent riding out: \( t \)
- Time spent riding back: \( 10 - t \)

<table>
<thead>
<tr>
<th>Rate</th>
<th>Time</th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Out</td>
<td>12</td>
<td>( t )</td>
</tr>
<tr>
<td>Back</td>
<td>8</td>
<td>( 10 - t )</td>
</tr>
</tbody>
</table>

- The distance out equals the distance back.

**Solution**

\[
12t = 8(10 - t) \\
12t = 80 - 8t \\
20t = 80 \\
t = 4 \quad \text{(The time is 4 h.)}
\]

The distance out = \( 12t = 12(4) = 48 \) mi.
The club can ride 48 mi into the country.

<table>
<thead>
<tr>
<th>Rate</th>
<th>Time</th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Out</td>
<td>12</td>
<td>( t )</td>
</tr>
<tr>
<td>Back</td>
<td>8</td>
<td>( 10 - t )</td>
</tr>
</tbody>
</table>

**YOU TRY IT • 3**

A pilot flew out to a parcel of land and back in 5 h. The rate out was 150 mph, and the rate returning was 100 mph. How far away was the parcel of land?

**Your strategy**

**In-Class Examples**

1. Two planes leave an airport at the same time and fly in opposite directions. One of the planes is flying at 450 mph, and the other plane is flying at 550 mph. In how many hours will they be 2000 mi apart? 2 h

2. A cyclist starts on a course at 6 A.M. riding at 12 mph. An hour later, a second cyclist starts on the same course traveling at 18 mph. At what time will the second cyclist overtake the first cyclist? 9 A.M.

**Your solution**

300 mi

Solutions on pp. S14–S15
5.5 EXERCISES

OBJECTIVE A To solve value mixture problems

1. A grocer mixes peanuts that cost $3 per pound with almonds that cost $7 per pound. Which of the following statements could be true about the cost per pound, \( C \), of the mixture? There may be more than one correct answer.
   (i) \( C = 10 \)
   (ii) \( C > 7 \)
   (iii) \( C < 7 \)
   (iv) \( C < 3 \)
   (v) \( C > 3 \)
   (vi) \( C = 3 \)
   (iii) and (v)

2. An herbalist has 30 oz of herbs costing $2 per ounce. How many ounces of herbs costing $1 per ounce should be mixed with the 30 oz to produce a mixture costing $1.60 per ounce?
   20 oz

3. The manager of a farmer’s market has 500 lb of grain that costs $1.20 per pound. How many pounds of meal costing $0.80 per pound should be mixed with the 500 lb of grain to produce a mixture that costs $1.05 per pound?
   300 lb

4. Find the cost per pound of a meatloaf mixture made from 3 lb of ground beef costing $1.99 per pound and 1 lb of ground turkey costing $1.39 per pound.
   $1.84

5. Find the cost per ounce of a sunscreen made from 100 oz of a lotion that costs $2.50 per ounce and 50 oz of a lotion that costs $4.00 per ounce.
   $3

6. A snack food is made by mixing 5 lb of popcorn that costs $0.80 per pound with caramel that costs $2.40 per pound. How much caramel is needed to make a mixture that costs $1.40 per pound?
   3 lb

7. A wild birdseed mix is made by combining 100 lb of millet seed costing $0.60 per pound with sunflower seeds costing $1.10 per pound. How many pounds of sunflower seeds are needed to make a mixture that costs $0.70 per pound?
   25 lb

8. Ten cups of a restaurant’s house Italian dressing are made by blending olive oil costing $1.50 per cup with vinegar that costs $0.25 per cup. How many cups of each are used if the cost of the blend is $0.50 per cup?
   Olive oil: 2 c; vinegar: 8 c

9. A high-protein diet supplement that costs $6.75 per pound is mixed with a vitamin supplement that costs $3.25 per pound. How many pounds of each should be used to make 5 lb of a mixture that costs $4.65 per pound?
   Diet supplement: 2 lb; vitamin supplement: 3 lb

10. Find the cost per ounce of a mixture of 200 oz of a cologne that costs $5.50 per ounce and 500 oz of a cologne that costs $2.00 per ounce.
    $3.00

11. Find the cost per pound of a trail mix made from 40 lb of raisins that cost $4.40 per pound and 100 lb of granola that costs $2.30 per pound.
    $2.90

Quick Quiz

1. A trail mix is made by combining raisins that cost $4.20 per pound with granola that costs $2.20 per pound. How many pounds of each should be used to make 40 lb of trail mix that costs $2.75 per pound?
   Raisins: 11 lb; granola: 29 lb

Selected exercises available online at www.webassign.net/brookscole.
12. The manager of a specialty food store combined almonds that cost $4.50 per pound with walnuts that cost $2.50 per pound. How many pounds of each were used to make a 100-pound mixture that costs $3.24 per pound?

Almonds: 37 lb; walnuts: 63 lb

13. A goldsmith combined an alloy that cost $4.30 per ounce with an alloy that cost $1.80 per ounce. How many ounces of each were used to make a mixture of 200 oz costing $2.50 per ounce?

$4.30 alloy: 56 oz; $1.80 alloy: 144 oz

14. Find the cost per pound of sugar-coated breakfast cereal made from 40 lb of sugar that costs $1.00 per pound and 120 lb of corn flakes that cost $0.60 per pound.

$.70

15. Find the cost per pound of a coffee mixture made from 8 lb of coffee that costs $9.20 per pound and 12 lb of coffee that costs $5.50 per pound.

$.69

16. Adult tickets for a play cost $6.00, and children’s tickets cost $2.50. For one performance, 370 tickets were sold. Receipts for the performance totaled $1723. Find the number of adult tickets sold.

228 adult tickets

17. Tickets for a piano concert sold for $4.50 for each adult ticket. Student tickets sold for $2.00 each. The total receipts for 1720 tickets were $5980. Find the number of adult tickets sold.

1016 adult tickets

18. Tree Conservation A town’s parks department buys trees from the tree conservation program described in the news clipping at the right. The department spends $406 on 14 bundles of trees. How many bundles of seedlings and how many bundles of container-grown plants did the parks department buy?

8 bundles of seedlings, 6 bundles of container-grown plants

Quick Quiz

1. A ship leaves a dock at 10 A.M. and travels south at 30 mph. One hour later, a second ship leaves the same dock and travels south at 50 mph. At what time does the second ship overtake the first ship?

12:30 P.M.
21. Two small planes start from the same point and fly in opposite directions. The first plane is flying 25 mph slower than the second plane. In 2 h, the planes are 470 mi apart. Find the rate of each plane.
105 mph, 130 mph

22. Two cyclists start from the same point and ride in opposite directions. One cyclist rides twice as fast as the other. In 3 h, they are 81 mi apart. Find the rate of each cyclist.
9 mph, 18 mph

23. Two planes leave an airport at 8 A.M., one flying north at 480 km/h and the other flying south at 520 km/h. At what time will they be 3000 km apart?
11 A.M.

24. A long-distance runner started on a course running at an average speed of 6 mph. One-half hour later, a second runner began the same course at an average speed of 7 mph. How long after the second runner started did the second runner overtake the first runner?
3 h

25. A motorboat leaves a harbor and travels at an average speed of 9 mph toward a small island. Two hours later a cabin cruiser leaves the same harbor and travels at an average speed of 18 mph toward the same island. In how many hours after the cabin cruiser leaves the harbor will it be alongside the motorboat?
2 h

26. A 555-mile, 5-hour plane trip was flown at two speeds. For the first part of the trip, the average speed was 105 mph. For the remainder of the trip, the average speed was 115 mph. How long did the plane fly at each speed?
105 mph: 2 h, 115 mph: 3 h

27. An executive drove from home at an average speed of 30 mph to an airport where a helicopter was waiting. The executive boarded the helicopter and flew to the corporate offices at an average speed of 60 mph. The entire distance was 150 mi. The entire trip took 3 h. Find the distance from the airport to the corporate offices.
120 mi

28. After a sailboat had been on the water for 3 h, a change in the wind direction reduced the average speed of the boat by 5 mph. The entire distance sailed was 57 mi. The total time spent sailing was 6 h. How far did the sailboat travel in the first 3 h?
36 mi

29. A car and a bus set out at 3 P.M. from the same point headed in the same direction. The average speed of the car is twice the average speed of the bus. In 2 h the car is 68 mi ahead of the bus. Find the rate of the car.
68 mph

30. A passenger train leaves a train depot 2 h after a freight train leaves the same depot. The freight train is traveling 20 mph slower than the passenger train. Find the rate of each train if the passenger train overtakes the freight train in 3 h.
Passenger train: 50 mph; freight train: 30 mph
31. As part of flight training, a student pilot was required to fly to an airport and then return. The average speed on the way to the airport was 100 mph, and the average speed returning was 150 mph. Find the distance between the two airports if the total flying time was 5 h.
300 mi

32. A ship traveling east at 25 mph is 10 mi from a harbor when another ship leaves the harbor traveling east at 35 mph. How long does it take the second ship to catch up to the first ship?
1 h

33. At 10 A.M. a plane leaves Boston, Massachusetts, for Seattle, Washington, a distance of 3000 mi. One hour later a plane leaves Seattle for Boston. Both planes are traveling at a speed of 500 mph. How many hours after the plane leaves Seattle will the planes pass each other?
2.5 h

34. At noon a train leaves Washington, D.C., headed for Charleston, South Carolina, a distance of 500 mi. The train travels at a speed of 60 mph. At 1 P.M. a second train leaves Charleston headed for Washington, D.C., traveling at 50 mph. How long after the train leaves Charleston will the two trains pass each other?
4 h

35. Two cyclists start at the same time from opposite ends of a course that is 51 mi long. One cyclist is riding at a rate of 16 mph, and the second cyclist is riding at a rate of 18 mph. How long after they begin will they meet?
1.5 h

36. A bus traveling at a rate of 60 mph overtakes a car traveling at a rate of 45 mph. If the car had a 1-hour head start, how far from the starting point does the bus overtake the car?
180 mi

37. A car traveling at 48 mph overtakes a cyclist who, riding at 12 mph, had a 3-hour head start. How far from the starting point does the car overtake the cyclist?
48 mi

38. sQuba See the news clipping at the right. Two sQubas are on opposite sides of a lake 1.6 mi wide. They start toward each other at the same time, one traveling on the surface of the water and the other traveling underwater. In how many minutes after they start will the sQuba on the surface of the water be directly above the sQuba that is underwater? Assume they are traveling at top speed.
20 min

Applying the Concepts

39. Transportation A bicyclist rides for 2 h at a speed of 10 mph and then returns at a speed of 20 mph. Find the cyclist’s average speed for the trip.
\[ \frac{1}{3} \text{ mph} \]

40. Travel A car travels a 1-mile track at an average speed of 30 mph. At what average speed must the car travel the next mile so that the average speed for the 2 mi is 60 mph?
It is impossible to average 60 mph.

Underwater Driving—Not So Fast!
Swiss company Rinspeed, Inc., presented its new car, the sQuba, at the Geneva Auto Show. The sQuba can travel on land, on water, and underwater. With a new sQuba, you can expect top speeds of 77 mph when driving on land, 3 mph when driving on the surface of the water, and 1.8 mph when driving underwater!

Source: Seattle Times
Focus on Problem Solving

The questions below require an answer of always true, sometimes true, or never true. These problems are best solved by the trial-and-error method. The trial-and-error method of arriving at a solution to a problem involves repeated tests or experiments.

For example, consider the statement

Both sides of an equation can be divided by the same number without changing the solution of the equation.

The solution of the equation \( 6x = 18 \) is 3. If we divide both sides of the equation by 2, the result is \( 3x = 9 \) and the solution is still 3. So the answer “never true” has been eliminated. We still need to determine whether there is a case for which the statement is not true. Is there a number that we could divide both sides of the equation by and the result would be an equation for which the solution is not 3?

If we divide both sides of the equation by 0, the result is \( \frac{6x}{0} = \frac{18}{0} \); the solution of this equation is not 3 because the expressions on either side of the equals sign are undefined. Thus the statement is true for some numbers and not true for 0. The statement is sometimes true.

For Exercises 1 to 13, determine whether the statement is always true, sometimes true, or never true.

1. Both sides of an equation can be multiplied by the same number without changing the solution of the equation.

2. For an equation of the form \( ax = b, \ a \neq 0 \), multiplying both sides of the equation by the reciprocal of \( a \) will result in an equation of the form \( x = \text{constant} \).

3. Adding \(-3\) to each side of an equation yields the same result as subtracting 3 from each side of the equation.

4. An equation contains an equals sign.

5. The same variable term can be added to both sides of an equation without changing the solution of the equation.

6. An equation of the form \( ax + b = c \) cannot be solved if \( a \) is a negative number.

7. The solution of the equation \( \frac{x}{0} = 0 \) is 0.

8. In solving an equation of the form \( ax + b = cx + d \), subtracting \( cx \) from each side of the equation results in an equation with only one variable term in it.

9. If a rope 8 meters long is cut into two pieces and one of the pieces has a length of \( x \) meters, then the length of the other piece can be represented as \( (x - 8) \) meters.

10. An even integer is a multiple of 2.

For answers to the Focus on Problem Solving exercises, please see the Appendix in the Instructor’s Resource Binder that accompanies this textbook.
11. If the first of three consecutive odd integers is \( n \), then the second and third consecutive odd integers are represented by \( n + 1 \) and \( n + 3 \).

12. If we combine an alloy that costs $8 an ounce with an alloy that costs $5 an ounce, the cost of the resulting mixture will be greater than $8 an ounce.

13. If the speed of one train is 20 mph slower than that of a second train, then the speeds of the two trains can be represented as \( r \) and \( 20 - r \).

PROJECTS AND GROUP ACTIVITIES

Averages

We often discuss temperature in terms of average high or average low temperature. Temperatures collected over a period of time are analyzed to determine, for example, the average high temperature for a given month in your city or state. The following activity is planned to help you better understand the concept of “average.”

1. Choose two cities in the United States. We will refer to them as City X and City Y. Over an 8-day period, record the daily high temperature for each city.

2. Determine the average high temperature for City X for the 8-day period. (Add the eight numbers, and then divide the sum by 8.) Do not round your answer.

3. Subtract the average high temperature for City X from each of the eight daily high temperatures for City X. You should have a list of eight numbers; the list should include positive numbers, negative numbers, and possibly zero.

4. Find the sum of the list of eight differences recorded in Step 3.

5. Repeat Steps 2 through 4 for City Y.

6. Compare the two sums found in Steps 4 and 5 for City X and City Y.

7. If you were to conduct this activity again, what would you expect the outcome to be? Use the results to explain what an average high temperature is. In your own words, explain what “average” means.

For answers to the Projects and Group Activities exercises, please see the Appendix in the Instructor’s Resource Binder that accompanies this textbook.

CHAPTER 5

SUMMARY

KEY WORDS

An equation expresses the equality of two mathematical expressions. [5.1A, p. 282]

EXAMPLES

\[ 3 + 2(4x - 5) = x + 4 \] is an equation.
A solution of an equation is a number that, when substituted for the variable, results in a true equation. [5.1A, p. 282]

-2 is a solution of $2 - 3x = 8$ because $2 - 3(-2) = 8$ is a true equation.

To solve an equation means to find a solution of the equation. The goal is to rewrite the equation in the form $variable = constant$, because the constant is the solution. [5.1B, p. 283]

The equation $x = -3$ is in the form $variable = constant$. The constant, $-3$, is the solution of the equation.

Consecutive integers follow one another in order. [5.4A, p. 310]

5, 6, 7 are consecutive integers.
-9, -8, -7 are consecutive integers.

### ESSENTIAL RULES AND PROCEDURES

<table>
<thead>
<tr>
<th><strong>Addition Property of Equations</strong> [5.1B, p. 283]</th>
<th><strong>EXAMPLES</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>The same number can be added to each side of an equation without changing the solution of the equation.</td>
<td>If $a = b$, then $a + c = b + c$.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Multiplication Property of Equations</strong> [5.1C, p. 284]</th>
<th><strong>EXAMPLES</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Each side of an equation can be multiplied by the same nonzero number without changing the solution of the equation.</td>
<td>If $a = b$ and $c \neq 0$, then $ac = bc$.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Consecutive Integers</strong> [5.4A, p. 310]</th>
<th><strong>EXAMPLES</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>$n, n + 1, n + 2, \ldots$</td>
<td>The sum of three consecutive integers is 33. $n + (n + 1) + (n + 2) = 33$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Consecutive Even or Consecutive Odd Integers</strong></th>
<th><strong>EXAMPLES</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>$n, n + 2, n + 4$ [5.4A, p. 310]</td>
<td>The sum of three consecutive odd integers is 33. $n + (n + 2) + (n + 4) = 33$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Value Mixture Equation</strong> [5.5A, p. 317]</th>
<th><strong>EXAMPLES</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount · Unit Cost = Value $AC = V$</td>
<td>An herbalist has 30 oz of herbs costing $4 per ounce. How many ounces of herbs costing $2 per ounce should be mixed with the 30 oz to produce a mixture costing $3.20 per ounce? $30(4) + 2x = 3.20(30 + x)$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Uniform Motion Equation</strong> [5.1D, p. 286; 5.5B, p. 319]</th>
<th><strong>EXAMPLES</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance = Rate · Time $d = rt$</td>
<td>A boat traveled from a harbor to an island at an average speed of 20 mph. The average speed on the return trip was 15 mph. The total trip took 3.5 h. How long did it take to travel to the island? $20t = 15(3.5 - t)$</td>
</tr>
</tbody>
</table>
CHAPTER 5 • Solving Equations

CONCEPT REVIEW

Test your knowledge of the concepts presented in this chapter. Answer each question. Then check your answers against the ones provided in the Answer Section.

1. What is the difference between an expression and an equation?

2. How do you know when a number is not a solution of an equation?

3. How is the Addition Property of Equations used to solve an equation?

4. How is the Multiplication Property of Equations used to solve an equation?

5. How do you check the solution of an equation?

6. How do you solve the equation \(-14x = 28\)?

7. What steps do you need to take to solve \(\frac{1}{3}x - \frac{2}{9} = \frac{1}{3}\)?

8. How do you solve an equation containing parentheses?

9. What formula is used to solve a uniform motion problem?

10. The solution of a value mixture problem is based on what equation?

11. What formula is used to solve a lever system problem?

12. What is the difference between consecutive integers and consecutive even integers?
1. Solve: \(x + 3 = 24\)
   \(x = 21\) [5.1B]

2. Solve: \(x + 5(3x - 20) = 10(x - 4)\)
   \(x = 10\) [5.3B]

3. Solve: \(5x - 6 = 29\)
   \(x = 7\) [5.2A]

4. Is 3 a solution of \(5x - 2 = 4x + 5\)?
   No [5.1A]

5. Solve: \(\frac{3}{5}d = 12\)
   \(d = 20\) [5.1C]

6. Solve: \(6x + 3(2x - 1) = -27\)
   \(x = -2\) [5.3B]

7. Solve: \(x - 3 = -7\)
   \(x = -4\) [5.1B]

8. Solve: \(5x + 3 = 10x - 17\)
   \(x = 4\) [5.3A]

9. Solve: \(7 - [4 + 2(x - 3)] = 11(x + 2)\)
   \(x = -1\) [5.3B]

10. Solve: \(-6x + 16 = -2x\)
    \(x = 4\) [5.3A]

11. Solve: \(7 - 3x = 2 - 5x\)
    \(x = \frac{5}{2}\) [5.3A]

12. Solve: \(-\frac{3}{8}x = -\frac{15}{32}\)
    \(x = \frac{5}{4}\) [5.1C]

13. Solve: \(35 - 3x = 5\)
    \(x = 10\) [5.2A]

14. Solve: \(3x = 2(3x - 2)\)
    \(x = \frac{4}{3}\) [5.3B]

15. **Lever Systems** A lever is 12 ft long. At a distance of 2 ft from the fulcrum, a force of 120 lb is applied. How large a force must be applied to the other end so that the system will balance? Use the lever system equation \(F_1x = F_2(d - x)\).
    \(24\) lb [5.3C]

16. **Travel** A bus traveled on a level road for 2 h at an average speed that was 20 mph faster than its speed on a winding road. The time spent on the winding road was 3 h. Find the average speed on the winding road if the total trip was 200 mi.
    \(32\) mph [5.5B]
17. **Integers** The difference between nine and twice a number is five. Find the number.
   \[ 2 \] [5.4B]

18. **Integers** The product of five and a number is fifty. Find the number.
   \[ 10 \] [5.4B]

19. **Juice Mixtures** A health food store combined cranberry juice that cost $1.79 per quart with apple juice that cost $1.19 per quart. How many quarts of each were used to make 10 qt of cranapple juice costing $1.61 per quart?
   Cranberry juice: 7 qt; apple juice: 3 qt [5.5A]

20. **Integers** Four times the second of three consecutive integers equals the sum of the first and third integers. Find the integers.
   \[-1, 0, 1\] [5.4A]

21. **Integers** Translate “four less than the product of five and a number is sixteen” into an equation and solve.
   \[5n - 4 = 16; 4\] [5.4A]

22. **Buildings** The Empire State Building is 1472 ft tall. This is 654 ft less than twice the height of the Eiffel Tower. Find the height of the Eiffel Tower.
   1063 ft [5.4B]

23. **Temperature** Find the Celsius temperature when the Fahrenheit temperature is 100°. Use the formula \[ F = \frac{9}{5}C + 32 \], where \( F \) is the Fahrenheit temperature and \( C \) is the Celsius temperature. Round to the nearest tenth.
   \[ 37.8°C \] [5.2B]

24. **Travel** A jet plane traveling at 600 mph overtakes a propeller-driven plane that had a 2-hour head start. The propeller-driven plane is traveling at 200 mph. How far from the starting point does the jet overtake the propeller-driven plane?
   600 mi [5.5B]

25. **Integers** The sum of two numbers is twenty-one. Three times the smaller number is two less than twice the larger number. Find the two numbers.
   \[8, 13\] [5.4A]

26. **Farming** A farmer harvested 28,336 bushels of corn. This amount represents an increase of 3036 bushels over last year’s crop. How many bushels of corn did the farmer harvest last year?
   25,300 bushels [5.4B]
1. Solve: \(3x - 2 = 5x + 8\)  
\[-5\]  [5.3A]

2. Solve: \(x - 3 = -8\)  
\[-5\]  [5.1B]

3. Solve: \(3x - 5 = -14\)  
\[-3\]  [5.2A]

4. Solve: \(4 - 2(3 - 2x) = 2(5 - x)\)  
\(2\)  [5.3B]

5. Is \(-2\) a solution of \(x^2 - 3x = 2x - 6\)?  
No  [5.1A]

6. Solve: \(7 - 4x = -13\)  
\(5\)  [5.2A]

7. Solve: \(5 = 3 - 4x\)  
\(-\frac{1}{2}\)  [5.2A]

8. Solve: \(5x - 2(4x - 3) = 6x + 9\)  
\(-\frac{1}{3}\)  [5.3B]

9. Solve: \(5x + 3 - 7x = 2x - 5\)  
\(2\)  [5.3A]

10. Solve: \(\frac{3}{4}x = -9\)  
\(-12\)  [5.1C]

11. Solve: \(\frac{x}{5} - 12 = 7\)  
95  [5.2A]

12. Solve: \(8 - 3x = 2x - 8\)  
\(\frac{16}{5}\)  [5.3A]

13. Solve: \(y - 4y + 3 = 12\)  
\(-3\)  [5.2A]

14. Solve: \(2x + 4(x - 3) = 5x - 1\)  
\(11\)  [5.3B]

15. **Flour Mixtures** A baker wants to make a 15-pound blend of flour that costs $0.60 per pound. The blend is made using a rye flour that costs $0.70 per pound and a wheat flour that costs $0.40 per pound. How many pounds of each flour should be used?  
Rye: 10 lb; wheat: 5 lb  [5.5A]

16. **Manufacturing** A financial manager has determined that the cost per unit for a calculator is $15 and that the fixed cost per month is $2000. Find the number of calculators produced during a month in which the total cost was $5000. Use the equation \(T = U \cdot N + F\), where \(T\) is the total cost, \(U\) is the cost per unit, \(N\) is the number of units produced, and \(F\) is the fixed cost.  
200 calculators  [5.2B]
17. **Integers**  Find three consecutive even integers whose sum is 36.
   \[10, 12, 14\]  [5.4A]

18. **Manufacturing**  A clock manufacturer’s fixed costs per month are $5000. The unit cost for each clock is $15. Find the number of clocks made during a month in which the total cost was $65,000. Use the formula \(T = U \cdot N + F\), where \(T\) is the total cost, \(U\) is the cost per unit, \(N\) is the number of units made, and \(F\) is the fixed costs.
   \(4000\) clocks  [5.2B]

19. **Integers**  Translate “The difference between three times a number and fifteen is twenty-seven” into an equation and solve.
   \[3x - 15 = 27; 14\]  [5.4A]

20. **Travel**  A cross-country skier leaves a camp to explore a wilderness area. Two hours later a friend leaves the camp in a snowmobile, traveling 4 mph faster than the skier. This friend meets the skier 1 h later. Find the rate of the snowmobile.
   \(6\) mph  [5.5B]

21. **Manufacturing**  A company makes 140 televisions per day. Three times the number of 15-inch TVs made equals 20 less than the number of 25-inch TVs made. Find the number of 25-inch TVs made each day.
   \(110\) 25-inch TVs  [5.4B]

22. **Integers**  The sum of two numbers is eighteen. The difference between four times the smaller number and seven is equal to the sum of two times the larger number and five. Find the two numbers.
   \(8, 10\)  [5.4A]

23. **Travel**  As part of flight training, a student pilot was required to fly to an airport and then return. The average speed to the airport was 90 mph, and the average speed returning was 120 mph. Find the distance between the two airports if the total flying time was 7 h.
   \(360\) mi  [5.5B]

24. **Physics**  Find the time required for a falling object to increase in velocity from 24 ft/s to 392 ft/s. Use the formula \(V = V_0 + 32t\), where \(V\) is the final velocity of a falling object, \(V_0\) is the starting velocity of the falling object, and \(t\) is the time for the object to fall.
   \(11.5\) s  [5.2B]

25. **Chemistry**  A chemist mixes 100 g of water at 80°C with 50 g of water at 20°C. To find the final temperature of the water after mixing, use the equation \(m_1(T_1 - T) = m_2(T - T_2)\), where \(m_1\) is the quantity of water at the hotter temperature, \(T_1\) is the temperature of the hotter water, \(m_2\) is the quantity of water at the cooler temperature, \(T_2\) is the temperature of the cooler water, and \(T\) is the final temperature of the water after mixing.
   \(60°C\)  [5.3C]
CUMULATIVE REVIEW EXERCISES

1. Subtract: $-6 - (-20) - 8$
   \[ \frac{6}{6} \] [3.2B]

2. Multiply: $(-2)(-6)(-4)$
   \[-48 \] [3.3A]

3. Subtract: \[ \frac{-5}{6} - \left( \frac{-7}{16} \right) \]
   \[ \frac{-19}{48} \] [3.4A]

4. Divide: $-2 \frac{1}{3} + \frac{1}{6}$
   \[-2 \] [3.4B]

5. Simplify: $-4^2 \cdot \left( \frac{-3}{2} \right)^3$
   \[ 54 \] [3.5A]

6. Simplify: $25 - 3 \left( \frac{5 - 2)^2}{2^2 + 1} - (-2) \right)$
   \[ 24 \] [3.5A]

7. Evaluate $3(a - c) - 2ab$ when $a = 2$, $b = 3$, and $c = -4$.
   \[ \frac{6}{6} \] [4.1A]

8. Simplify: $3x - 8x + (-12x)$
   \[ -17x \] [4.2A]

9. Simplify: $2a - (-3b) - 7a - 5b$
   \[ -5a - 2b \] [4.2A]

10. Simplify: $(16x) \left( \frac{1}{8} \right)$
    \[ 2x \] [4.2B]

11. Simplify: $-4(-9y)$
    \[ 36y \] [4.2B]

12. Simplify: $-2(-x^2 - 3x + 2)$
    \[ 2x^2 + 6x - 4 \] [4.2C]

13. Simplify: $-2(x - 3) + 2(4 - x)$
    \[ -4x + 14 \] [4.2D]

14. Simplify: $-3[2x - 4(x - 3)] + 2$
    \[ 6x - 34 \] [4.2D]

15. Is $-3$ a solution of $x^3 + 6x + 9 = x + 3$?
    Yes [5.1A]

16. Is $\frac{1}{2}$ a solution of $3 - 8x = 12x - 2$?
    No [5.1A]

17. Simplify: \[ \left( \frac{3}{8} - \frac{1}{4} \right) + \frac{3}{4} + \frac{4}{9} \]
    \[ \frac{11}{18} \] [3.5A]

18. Solve: \[ \frac{3}{5}x = -15 \]
    \[ -25 \] [5.1C]

19. Solve: $7x - 8 = -29$
    \[ -3 \] [5.2A]

20. Solve: $13 - 9x = -14$
    \[ 3 \] [5.2A]
21. Multiply: $9.67 \times 0.0049 = 0.047383$ [2.6B]

22. Find 6 less than 13. $7$ [1.2B]

23. Solve: $8x - 3(4x - 5) = -2x - 11$
   $13$ [5.3B]

24. Solve: $6 - 2(5x - 8) = 3x - 4$
   $2$ [5.3B]

25. Solve: $5x - 8 = 12x + 13$
   $-3$ [5.3A]

26. Solve: $11 - 4x = 2x + 8$
   $1$ [5.3A]

27. **Chemistry** A chemist mixes 300 g of water at 75°C with 100 g of water at 15°C. To find the final temperature of the water after mixing, use the equation $m_1(T_1 - T) = m_2(T - T_2)$, where $m_1$ is the quantity of water at the hotter temperature, $T_1$ is the temperature of the hotter water, $m_2$ is the quantity of water at the cooler temperature, $T_2$ is the temperature of the cooler water, and $T$ is the final temperature of the water after mixing.
   $60°C$ [5.3C]

28. **Integers** Translate “The difference between twelve and the product of five and a number is negative eighteen” into an equation and solve.
   $12 - 5x = -18; 6$ [5.4A]

29. **Construction** The area of a cement foundation of a house is 2000 ft². This is 200 ft² more than three times the area of the garage. Find the area of the garage.
   $600 ft²$ [5.4B]

30. **Flour Mixtures** How many pounds of an oat flour that costs $0.80 per pound must be mixed with 40 lb of a wheat flour that costs $0.50 per pound to make a blend that costs $0.60 per pound?
   $20 lb$ [5.5A]

31. **Integers** Translate “the sum of three times a number and four” into a mathematical expression.
   $3n + 4$ [4.3B]

32. **Integers** Three less than eight times a number is three more than five times the number. Find the number.
   $2$ [5.4B]

33. **Sprinting** A sprinter ran to the end of a track at an average rate of 8 m/s and then jogged back to the starting point at an average rate of 3 m/s. The sprinter took 55 s to run to the end of the track and jog back. Find the length of the track.
   $120 m$ [5.5B]