

SOLUTIONS MANUAL



Beginning

Algebra



Lial · Hornsby · McGinnis

11th Edition

CHAPTER 2 LINEAR EQUATIONS AND INEQUALITIES IN ONE VARIABLE

2.1 The Addition Property of Equality

2.1 Classroom Examples, Now Try Exercises

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

$$\begin{aligned}x - 12 &= -3 && \text{Given} \\x - 12 + 12 &= -3 + 12 && \text{Add 12.} \\x &= 9 && \text{Combine like terms.}\end{aligned}$$

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

$$\begin{aligned}\text{Check: } x - 12 &= -3 && \text{Original equation} \\9 - 12 &\stackrel{?}{=} -3 && \text{Let } x = 9. \\-3 &= -3 && \text{True}\end{aligned}$$

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

$$\begin{aligned}\text{N1. } x - 13 &= 4 && \text{Given} \\x - 13 + 13 &= 4 + 13 && \text{Add 13.} \\x &= 17 && \text{Combine like terms.}\end{aligned}$$

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

$$\begin{aligned}\text{Check: } x - 13 &= 4 && \text{Original equation} \\17 - 13 &\stackrel{?}{=} 4 && \text{Let } x = 17. \\4 &= 4 && \text{True}\end{aligned}$$

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

$$\begin{aligned}2. \quad m - 4.1 &= -6.3 \\m - 4.1 + 4.1 &= -6.3 + 4.1 && \text{Add 4.1.} \\m &= -2.2\end{aligned}$$

$$\text{Check } m = -2.2: -6.3 = -6.3 \quad \text{True}$$

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

The solution set is $\{-2.2\}$.

$$\begin{aligned}\text{N2. } t - 5.7 &= -7.2 \\t - 5.7 + 5.7 &= -7.2 + 5.7 && \text{Add 5.7.} \\t &= -1.5\end{aligned}$$

$$\text{Check } t = -1.5: -7.2 = -7.2 \quad \text{True}$$

The solution set is $\{-1.5\}$.

$$\begin{aligned}3. \quad -22 &= x + 16 \\-22 - 16 &= x + 16 - 16 && \text{Subtract 16.} \\-38 &= x\end{aligned}$$

$$\text{Check } x = -38: -22 = -22 \quad \text{True}$$

The solution set is $\{-38\}$.

$$\begin{aligned}\text{N3. } -15 &= x + 12 \\-15 - 12 &= x + 12 - 12 && \text{Subtract 12.} \\-27 &= x\end{aligned}$$

$$\text{Check } x = -27: -15 = -15 \quad \text{True}$$

The solution set is $\{-27\}$.

$$\begin{aligned}4. \quad \frac{7}{2}p + 1 &= \frac{9}{2}p \\ \frac{7}{2}p + 1 - \frac{7}{2}p &= \frac{9}{2}p - \frac{7}{2}p && \text{Subtract } \frac{7}{2}p. \\1 &= \frac{2}{2}p && \text{Combine terms.} \\1 &= p\end{aligned}$$

$$\text{Check } p = 1: \frac{9}{2} = \frac{9}{2} \quad \text{True}$$

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

$$\begin{aligned}\text{N4. } \frac{2}{3}x - 4 &= \frac{5}{3}x \\ \frac{2}{3}x - 4 - \frac{2}{3}x &= \frac{5}{3}x - \frac{2}{3}x && \text{Subtract } \frac{2}{3}x. \\-4 &= \frac{3}{3}x && \text{Combine terms.} \\-4 &= x\end{aligned}$$

$$\text{Check } x = -4: -\frac{20}{3} = -\frac{20}{3} \quad \text{True}$$

The solution set is $\{-4\}$.

$$\begin{aligned}5. \quad 10 - x &= -2x + 9 && \text{Given} \\10 - x + 2x &= -2x + 9 + 2x && \text{Add } 2x. \\10 + x &= 9 && \text{Combine terms.} \\10 + x - 10 &= 9 - 10 && \text{Subtract 10.} \\x &= -1 && \text{Combine terms.}\end{aligned}$$

$$\text{Check } x = -1: 10 - (-1) = 2 + 9 \quad \text{True}$$

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

$$\begin{aligned}\text{N5. } 6x - 8 &= 12 + 5x && \text{Given.} \\6x - 8 - 5x &= 12 + 5x - 5x && \text{Subtract } 5x. \\x - 8 &= 12 && \text{Combine terms.} \\x - 8 + 8 &= 12 + 8 && \text{Add 8.} \\x &= 20 && \text{Combine terms.}\end{aligned}$$

$$\text{Check } x = 20: 120 - 8 = 12 + 100 \quad \text{True}$$

The solution set is $\{20\}$.

6. $9r + 4r + 6 - 2 = 9r + 4 + 3r$ *Given*
 $13r + 4 = 12r + 4$ *Combine terms.*
 $13r + 4 - 12r = 12r + 4 - 12r$ *Subtract 12r.*
 $r + 4 = 4$ *Combine terms.*
 $r + 4 - 4 = 4 - 4$ *Subtract 4.*
 $r = 0$ *Combine terms.*

Check $r = 0$: $4 = 4$ *True*

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

N6. $5x - 10 - 12x = 4 - 8x - 9$ *Given*
 $-7x - 10 = -8x - 5$ *Combine terms.*
 $-7x - 10 + 8x = -8x - 5 + 8x$ *Add 8x.*
 $x - 10 = -5$ *Combine terms.*
 $x - 10 + 10 = -5 + 10$ *Add 10.*
 $x = 5$ *Combine terms.*

Check $x = 5$: $-45 = -45$ *True*

The solution set is $\{5\}$.

7. $4(x + 1) - (3x + 5) = 1$ *Given*
 $4(x + 1) - 1(3x + 5) = 1$ $-a = -1a$
 $4x + 4 - 3x - 5 = 1$ *Distributive property*
 $x - 1 = 1$ *Combine terms.*
 $x - 1 + 1 = 1 + 1$ *Add 1.*
 $x = 2$

Check $x = 2$: $1 = 1$ *True*

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

N7. $4(3x - 2) - (11x - 4) = 3$ *Given*
 $4(3x - 2) - 1(11x - 4) = 3$ $-a = -1a$
 $12x - 8 - 11x + 4 = 3$ *Distributive property*
 $x - 4 = 3$ *Combine terms.*
 $x - 4 + 4 = 3 + 4$ *Add 4.*
 $x = 7$

Check $x = 7$: $3 = 3$ *True*

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

2.1 Section Exercises

1. (a) $5x + 8 - 4x + 7$

This is an expression, not an equation, since there is no equals symbol. It can be simplified by rearranging terms and then combining like terms.

$$5x + 8 - 4x + 7 = 5x - 4x + 8 + 7 = x + 15$$

(b) $-6y + 12 + 7y - 5$

This is an expression, not an equation, since there is no equals symbol. It can be simplified by rearranging terms and then combining like terms.

$$-6y + 12 + 7y - 5 = -6y + 7y + 12 - 5 = y + 7$$

(c) $5x + 8 - 4x = 7$

This is an equation because of the equals symbol.

$$5x + 8 - 4x = 7$$

$$x + 8 = 7$$

$$x = -1$$

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

(d) $-6y + 12 + 7y = -5$

This is an equation because of the equals symbol.

$$-6y + 12 + 7y = -5$$

$$y + 12 = -5$$

$$y = -17$$

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

2. Equations that have exactly the same solution sets are **equivalent equations**.

A. $x + 2 = 6$

$$x + 2 - 2 = 6 - 2$$
 Subtract 2.
 $x = 4$

So $x + 2 = 6$ and $x = 4$ are equivalent equations.

B. $10 - x = 5$

$$10 - x - 10 = 5 - 10$$
 Subtract 10.
 $-x = -5$
 $-1(-x) = -1(-5)$ *Multiply by -1.*
 $x = 5$

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

C. Subtract 3 from both sides to get $x = 6$, so $x + 3 = 9$ and $x = 6$ are equivalent equations.

D. Subtract 4 from both sides to get $x = 4$. The second equation is $x = -4$, so $4 + x = 8$ and $x = -4$ are not equivalent equations.

3. Equations A $x^2 - 5x + 6 = 0$ and B $x^3 = x$ are not linear equations in one variable because they

cannot be written in the form $Ax + B = C$. Note that in a linear equation the exponent on the variable must be 1.

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

For Exercises 5–52, all solutions should be checked by substituting into the original equation. Checks will be shown here for only a few of the exercises.

5.
$$\begin{aligned} x - 3 &= 9 \\ x - 3 + 3 &= 9 + 3 \\ x &= 12 \end{aligned}$$

Check this solution by replacing x with 12 in the original equation.

$$\begin{aligned} x - 3 &= 9 \\ 12 - 3 &\stackrel{?}{=} 9 \quad \text{Let } x = 12. \\ 9 &= 9 \quad \text{True} \end{aligned}$$

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

6.
$$\begin{aligned} x - 9 &= 8 \\ x - 9 + 9 &= 8 + 9 \\ x &= 17 \end{aligned}$$

Check $x = 17$:

$$\begin{aligned} 17 - 9 &\stackrel{?}{=} 8 \quad \text{Let } x = 17. \\ 8 &= 8 \quad \text{True} \end{aligned}$$

Thus, $\{17\}$ is the solution set.

7.
$$\begin{aligned} x - 12 &= 19 \\ x - 12 + 12 &= 19 + 12 \\ x &= 31 \end{aligned}$$

Check $x = 31$:

$$\begin{aligned} 31 - 12 &\stackrel{?}{=} 19 \quad \text{Let } x = 31. \\ 19 &= 19 \quad \text{True} \end{aligned}$$

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

8.
$$\begin{aligned} x - 18 &= 22 \\ x - 18 + 18 &= 22 + 18 \\ x &= 40 \end{aligned}$$

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

9.
$$\begin{aligned} x - 6 &= -9 \\ x - 6 + 6 &= -9 + 6 \\ x &= -3 \end{aligned}$$

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

10.
$$\begin{aligned} x - 5 &= -7 \\ x - 5 + 5 &= -7 + 5 \\ x &= -2 \end{aligned}$$

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

11.
$$\begin{aligned} r + 8 &= 12 \\ r + 8 - 8 &= 12 - 8 \\ r &= 4 \end{aligned}$$

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

12.
$$\begin{aligned} x + 7 &= 11 \\ x + 7 - 7 &= 11 - 7 \\ x &= 4 \end{aligned}$$

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

13.
$$\begin{aligned} x + 28 &= 19 \\ x + 28 - 28 &= 19 - 28 \\ x &= -9 \end{aligned}$$

Checking yields a true statement, so $\{-9\}$ is the solution set.

14.
$$\begin{aligned} x + 47 &= 26 \\ x + 47 - 47 &= 26 - 47 \\ x &= -21 \end{aligned}$$

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

15.
$$\begin{aligned} x + \frac{1}{4} &= -\frac{1}{2} \\ x + \frac{1}{4} - \frac{1}{4} &= -\frac{1}{2} - \frac{1}{4} \\ x &= -\frac{2}{4} - \frac{1}{4} \\ x &= -\frac{3}{4} \end{aligned}$$

Check $x = -\frac{3}{4}$: $-\frac{1}{2} = -\frac{1}{2}$ True

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

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

Check $x = -\frac{5}{6}$: $-\frac{1}{6} = -\frac{1}{6}$ True

The solution set is $\{-\frac{5}{6}\}$.

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17. $7 + r = -3$
 $r + 7 = -3$
 $r + 7 - 7 = -3 - 7$
 $r = -10$

The solution set is $\{-10\}$.

18. $8 + k = -4$
 $k + 8 = -4$
 $k + 8 - 8 = -4 - 8$
 $k = -12$

The solution set is $\{-12\}$.

19. $2 = p + 15$
 $2 - 15 = p + 15 - 15$
 $-13 = p$

The solution set is $\{-13\}$.

20. $5 = z + 19$
 $5 - 19 = z + 19 - 19$
 $-14 = z$

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

21. $-4 = x - 14$
 $-4 + 14 = x - 14 + 14$
 $10 = x$

The solution set is $\{10\}$.

22. $-7 = x - 22$
 $-7 + 22 = x - 22 + 22$
 $15 = x$

The solution set is $\{15\}$.

23. $-\frac{1}{3} = x - \frac{3}{5}$
 $-\frac{1}{3} + \frac{3}{5} = x - \frac{3}{5} + \frac{3}{5}$
 $-\frac{5}{15} + \frac{9}{15} = x$
 $\frac{4}{15} = x$

Check $x = \frac{4}{15}$: $-\frac{5}{15} = \frac{4}{15} - \frac{9}{15}$ *True*

The solution set is $\{\frac{4}{15}\}$.

24. $-\frac{1}{4} = x - \frac{2}{3}$
 $-\frac{1}{4} + \frac{2}{3} = x - \frac{2}{3} + \frac{2}{3}$
 $-\frac{3}{12} + \frac{8}{12} = x$
 $\frac{5}{12} = x$

Check $x = \frac{5}{12}$: $-\frac{3}{12} = \frac{5}{12} - \frac{8}{12}$ *True*

The solution set is $\{\frac{5}{12}\}$.

25. $x - 8.4 = -2.1$
 $x - 8.4 + 8.4 = -2.1 + 8.4$
 $x = 6.3$

The solution set is $\{6.3\}$.

26. $x - 15.5 = -5.1$
 $x - 15.5 + 15.5 = -5.1 + 15.5$
 $x = 10.4$

The solution set is $\{10.4\}$.

27. $t + 12.3 = -4.6$
 $t + 12.3 - 12.3 = -4.6 - 12.3$
 $t = -16.9$

The solution set is $\{-16.9\}$.

28. $x + 21.5 = -13.4$
 $x + 21.5 - 21.5 = -13.4 - 21.5$
 $x = -34.9$

The solution set is $\{-34.9\}$.

29. $3x = 2x + 7$
 $3x - 2x = 2x + 7 - 2x$ *Subtract 2x.*
 $1x = 7$ or $x = 7$

Check $x = 7$: $21 = 21$ *True*

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

30. $5x = 4x + 9$
 $5x - 4x = 4x + 9 - 4x$ *Subtract 4x.*
 $1x = 9$ or $x = 9$

Check $x = 9$: $45 = 45$ *True*

The solution set is $\{9\}$.

31. $10x + 4 = 9x$
 $10x + 4 - 9x = 9x - 9x$ *Subtract 9x.*
 $1x + 4 = 0$
 $x + 4 - 4 = 0 - 4$ *Subtract 4.*
 $x = -4$

Check $x = -4$: $-36 = -36$ *True*

The solution set is $\{-4\}$.

32. $8t + 5 = 7t$
 $8t + 5 - 7t = 7t - 7t$ *Subtract 7t.*
 $1t + 5 = 0$
 $t + 5 - 5 = 0 - 5$ *Subtract 5.*
 $t = -5$

Check $t = -5$: $-35 = -35$ *True*

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

$$\begin{aligned}
 33. \quad & 3x + 7 = 2x + 4 \\
 & 3x + 7 - 2x = 2x + 4 - 2x \\
 & \quad x + 7 = 4 \\
 & x + 7 - 7 = 4 - 7 \\
 & \quad x = -3
 \end{aligned}$$

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

$$\begin{aligned}
 34. \quad & 9x + 1 = 8x + 4 \\
 & 9x + 1 - 8x = 8x + 4 - 8x \\
 & \quad x + 1 = 4 \\
 & x + 1 - 1 = 4 - 1 \\
 & \quad x = 3
 \end{aligned}$$

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

$$\begin{aligned}
 35. \quad & 8t + 6 = 7t + 6 \\
 & 8t + 6 - 7t = 7t + 6 - 7t \\
 & \quad t + 6 = 6 \\
 & t + 6 - 6 = 6 - 6 \\
 & \quad t = 0
 \end{aligned}$$

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

$$\begin{aligned}
 36. \quad & 13t + 9 = 12t + 9 \\
 & 13t + 9 - 12t = 12t + 9 - 12t \\
 & \quad t + 9 = 9 \\
 & t + 9 - 9 = 9 - 9 \\
 & \quad t = 0
 \end{aligned}$$

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

$$\begin{aligned}
 37. \quad & -4x + 7 = -5x + 9 \\
 & -4x + 7 + 5x = -5x + 9 + 5x \\
 & \quad x + 7 = 9 \\
 & x + 7 - 7 = 9 - 7 \\
 & \quad x = 2
 \end{aligned}$$

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

$$\begin{aligned}
 38. \quad & -6x + 3 = -7x + 10 \\
 & -6x + 3 + 7x = -7x + 10 + 7x \\
 & \quad x + 3 = 10 \\
 & x + 3 - 3 = 10 - 3 \\
 & \quad x = 7
 \end{aligned}$$

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

$$\begin{aligned}
 39. \quad & \frac{2}{5}w - 6 = \frac{7}{5}w \\
 & \frac{2}{5}w - 6 - \frac{2}{5}w = \frac{7}{5}w - \frac{2}{5}w \quad \text{Subtract } \frac{2}{5}w. \\
 & \quad -6 = \frac{5}{5}w \\
 & \quad -6 = w
 \end{aligned}$$

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

$$\begin{aligned}
 40. \quad & \frac{2}{7}z - 2 = \frac{9}{7}z \\
 & \frac{2}{7}z - 2 - \frac{2}{7}z = \frac{9}{7}z - \frac{2}{7}z \quad \text{Subtract } \frac{2}{7}z. \\
 & \quad -2 = \frac{7}{7}z \\
 & \quad -2 = z
 \end{aligned}$$

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

$$\begin{aligned}
 41. \quad & 5.6x + 2 = 4.6x \\
 & 5.6x + 2 - 4.6x = 4.6x - 4.6x \\
 & \quad 1.0x + 2 = 0 \\
 & x + 2 - 2 = 0 - 2 \\
 & \quad x = -2
 \end{aligned}$$

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

$$\begin{aligned}
 42. \quad & 9.1x + 5 = 8.1x \\
 & 9.1x + 5 - 8.1x = 8.1x - 8.1x \\
 & \quad 1.0x + 5 = 0 \\
 & x + 5 - 5 = 0 - 5 \\
 & \quad x = -5
 \end{aligned}$$

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

$$\begin{aligned}
 43. \quad & 1.4x - 3 = 0.4x \\
 & 1.4x - 3 - 0.4x = 0.4x - 0.4x \\
 & \quad 1.0x - 3 = 0 \\
 & 1.0x - 3 + 3 = 0 + 3 \\
 & \quad x = 3
 \end{aligned}$$

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

$$\begin{aligned}
 44. \quad & 1.9t - 6 = 0.9t \\
 & 1.9t - 6 - 0.9t = 0.9t - 0.9t \\
 & \quad 1.0t - 6 = 0 \\
 & 1.0t - 6 + 6 = 0 + 6 \\
 & \quad t = 6
 \end{aligned}$$

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

$$\begin{aligned}
 45. \quad & 5p = 4p \\
 & 5p - 4p = 4p - 4p \\
 & \quad p = 0
 \end{aligned}$$

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

$$\begin{aligned}
 46. \quad & 8z = 7z \\
 & 8z - 7z = 7z - 7z \\
 & \quad z = 0
 \end{aligned}$$

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

$$\begin{aligned}
 47. \quad & 1.2y - 4 = 0.2y - 4 \\
 & 1.2y - 4 - 0.2y = 0.2y - 4 - 0.2y \\
 & \quad 1.0y - 4 = -4 \\
 & y - 4 + 4 = -4 + 4 \\
 & \quad y = 0
 \end{aligned}$$

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

$$\begin{aligned}
 48. \quad & 7.7r - 6 = 6.7r - 6 \\
 & 7.7r - 6 - 6.7r = 6.7r - 6 - 6.7r \\
 & 1.0r - 6 = -6 \\
 & r - 6 + 6 = -6 + 6 \\
 & r = 0
 \end{aligned}$$

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

$$\begin{aligned}
 49. \quad & \frac{1}{2}x + 5 = -\frac{1}{2}x \\
 & \frac{1}{2}x + \frac{1}{2}x + 5 = -\frac{1}{2}x + \frac{1}{2}x \\
 & x + 5 = 0 \\
 & x + 5 - 5 = 0 - 5 \\
 & x = -5
 \end{aligned}$$

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

$$\begin{aligned}
 50. \quad & \frac{1}{5}x + 7 = -\frac{4}{5}x \\
 & \frac{1}{5}x + 7 + \frac{4}{5}x = -\frac{4}{5}x + \frac{4}{5}x \\
 & \frac{5}{5}x + 7 = 0 \\
 & x + 7 - 7 = 0 - 7 \\
 & x = -7
 \end{aligned}$$

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

$$\begin{aligned}
 51. \quad & 3x + 7 - 2x = 0 \\
 & x + 7 = 0 \\
 & x + 7 - 7 = 0 - 7 \\
 & x = -7
 \end{aligned}$$

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

$$\begin{aligned}
 52. \quad & 5x + 4 - 4x = 0 \\
 & x + 4 = 0 \\
 & x + 4 - 4 = 0 - 4 \\
 & x = -4
 \end{aligned}$$

The solution set is $\{-4\}$.

$$\begin{aligned}
 53. \quad & 5t + 3 + 2t - 6t = 4 + 12 \\
 & (5 + 2 - 6)t + 3 = 16 \\
 & t + 3 - 3 = 16 - 3 \\
 & t = 13
 \end{aligned}$$

Check $t = 13$: $16 = 16$ True

The solution set is $\{13\}$.

$$\begin{aligned}
 54. \quad & 4x + 3x - 6 - 6x = 10 + 3 \\
 & (4 + 3 - 6)x - 6 = 13 \\
 & x - 6 + 6 = 13 + 6 \\
 & x = 19
 \end{aligned}$$

Check $x = 19$: $13 = 13$ True

The solution set is $\{19\}$.

$$\begin{aligned}
 55. \quad & 6x + 5 + 7x + 3 = 12x + 4 \\
 & 13x + 8 = 12x + 4 \\
 & 13x + 8 - 12x = 12x + 4 - 12x \\
 & x + 8 = 4 \\
 & x + 8 - 8 = 4 - 8 \\
 & x = -4
 \end{aligned}$$

Check $x = -4$: $-44 = -44$ True

The solution set is $\{-4\}$.

$$\begin{aligned}
 56. \quad & 4x - 3 - 8x + 1 = -5x + 9 \\
 & -4x - 2 = -5x + 9 \\
 & -4x - 2 + 5x = -5x + 9 + 5x \\
 & x - 2 = 9 \\
 & x - 2 + 2 = 9 + 2 \\
 & x = 11
 \end{aligned}$$

Check $x = 11$: $-46 = -46$ True

The solution set is $\{11\}$.

$$\begin{aligned}
 57. \quad & 5.2q - 4.6 - 7.1q = -0.9q - 4.6 \\
 & -1.9q - 4.6 = -0.9q - 4.6 \\
 & -1.9q - 4.6 + 0.9q = -0.9q - 4.6 + 0.9q \\
 & -1.0q - 4.6 = -4.6 \\
 & -1.0q - 4.6 + 4.6 = -4.6 + 4.6 \\
 & -q = 0 \\
 & q = 0
 \end{aligned}$$

Check $q = 0$: $-4.6 = -4.6$ True

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

$$\begin{aligned}
 58. \quad & -4.0x + 2.7 - 1.6x = -4.6x + 2.7 \\
 & -5.6x + 2.7 = -4.6x + 2.7 \\
 & -5.6x + 2.7 + 4.6x = -4.6x + 2.7 + 4.6x \\
 & -1.0x + 2.7 = 2.7 \\
 & -x + 2.7 - 2.7 = 2.7 - 2.7 \\
 & -x = 0 \\
 & x = 0
 \end{aligned}$$

Check $x = 0$: $2.7 = 2.7$ True

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

$$\begin{aligned}
 59. \quad & \frac{5}{7}x + \frac{1}{3} = \frac{2}{5} - \frac{2}{7}x + \frac{2}{5} \\
 & \frac{5}{7}x + \frac{1}{3} = \frac{4}{5} - \frac{2}{7}x \\
 & \frac{5}{7}x + \frac{2}{7}x + \frac{1}{3} = \frac{4}{5} - \frac{2}{7}x + \frac{2}{7}x \quad \text{Add } \frac{2}{7}x. \\
 & \frac{7}{7}x + \frac{1}{3} = \frac{4}{5} \quad \text{Combine like terms.} \\
 & 1x + \frac{1}{3} - \frac{1}{3} = \frac{4}{5} - \frac{1}{3} \quad \text{Subtract } \frac{1}{3}. \\
 & x = \frac{12}{15} - \frac{5}{15} \quad \text{LCD} = 15 \\
 & x = \frac{7}{15}
 \end{aligned}$$

Check $x = \frac{7}{15}$: $\frac{2}{3} = \frac{2}{3}$ True

The solution set is $\{\frac{7}{15}\}$.

$$\begin{aligned}
 60. \quad \frac{6}{7}s - \frac{3}{4} &= \frac{4}{5} - \frac{1}{7}s + \frac{1}{6} \\
 \frac{6}{7}s - \frac{3}{4} &= \frac{24}{30} - \frac{1}{7}s + \frac{5}{30} \quad \text{LCD} = 30 \\
 \frac{6}{7}s - \frac{3}{4} &= \frac{29}{30} - \frac{1}{7}s \quad \text{Add.} \\
 \frac{6}{7}s - \frac{3}{4} + \frac{1}{7}s &= \frac{29}{30} - \frac{1}{7}s + \frac{1}{7}s \quad \text{Add } \frac{1}{7}s. \\
 \frac{7}{7}s - \frac{3}{4} &= \frac{29}{30} \quad \text{Combine like terms.} \\
 1s - \frac{3}{4} + \frac{3}{4} &= \frac{29}{30} + \frac{3}{4} \quad \text{Add } \frac{3}{4}. \\
 s &= \frac{58}{60} + \frac{45}{60} \quad \text{LCD} = 60 \\
 s &= \frac{103}{60}
 \end{aligned}$$

Check $s = \frac{103}{60}$: $\frac{101}{140} = \frac{101}{140}$ True

The solution set is $\{\frac{103}{60}\}$.

$$\begin{aligned}
 61. \quad (5y + 6) - (3 + 4y) &= 10 \\
 5y + 6 - 3 - 4y &= 10 \quad \text{Distributive property} \\
 y + 3 &= 10 \quad \text{Combine terms.} \\
 y + 3 - 3 &= 10 - 3 \quad \text{Subtract 3.} \\
 y &= 7
 \end{aligned}$$

Check $y = 7$: $10 = 10$ True

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

$$\begin{aligned}
 62. \quad (8r - 3) - (7r + 1) &= -6 \\
 8r - 3 - 7r - 1 &= -6 \\
 r - 4 &= -6 \\
 r - 4 + 4 &= -6 + 4 \\
 r &= -2
 \end{aligned}$$

Check $r = -2$: $-6 = -6$ True

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

$$\begin{aligned}
 63. \quad 2(p + 5) - (9 + p) &= -3 \\
 2p + 10 - 9 - p &= -3 \\
 p + 1 &= -3 \\
 p + 1 - 1 &= -3 - 1 \\
 p &= -4
 \end{aligned}$$

Check $p = -4$: $-3 = -3$ True

The solution set is $\{-4\}$.

$$\begin{aligned}
 64. \quad 4(k - 6) - (3k + 2) &= -5 \\
 4k - 24 - 3k - 2 &= -5 \\
 k - 26 &= -5 \\
 k - 26 + 26 &= -5 + 26 \\
 k &= 21
 \end{aligned}$$

Check $k = 21$: $-5 = -5$ True

The solution set is $\{21\}$.

$$\begin{aligned}
 65. \quad -6(2b + 1) + (13b - 7) &= 0 \\
 -12b - 6 + 13b - 7 &= 0 \\
 b - 13 &= 0 \\
 b - 13 + 13 &= 0 + 13 \\
 b &= 13
 \end{aligned}$$

Check $b = 13$: $0 = 0$ True

The solution set is $\{13\}$.

$$\begin{aligned}
 66. \quad -5(3w - 3) + (1 + 16w) &= 0 \\
 -15w + 15 + 1 + 16w &= 0 \\
 w + 16 &= 0 \\
 w + 16 - 16 &= 0 - 16 \\
 w &= -16
 \end{aligned}$$

Check $w = -16$: $0 = 0$ True

The solution set is $\{-16\}$.

$$\begin{aligned}
 67. \quad 10(-2x + 1) &= -19(x + 1) \\
 -20x + 10 &= -19x - 19 \\
 -20x + 10 + 19x &= -19x - 19 + 19x \\
 -x + 10 &= -19 \\
 -x + 10 - 10 &= -19 - 10 \\
 -x &= -29 \\
 x &= 29
 \end{aligned}$$

Check $x = 29$: $-570 = -570$ True

The solution set is $\{29\}$.

$$\begin{aligned}
 68. \quad 2(2 - 3r) &= -5(r - 3) \\
 4 - 6r &= -5r + 15 \\
 4 - 6r + 5r &= -5r + 15 + 5r \\
 4 - r &= 15 \\
 4 - r - 4 &= 15 - 4 \\
 -r &= 11 \\
 r &= -11
 \end{aligned}$$

Check $r = -11$: $70 = 70$ True

The solution set is $\{-11\}$.

$$\begin{aligned}
 69. \quad -2(8p + 2) - 3(2 - 7p) - 2(4 + 2p) &= 0 \\
 -16p - 4 - 6 + 21p - 8 - 4p &= 0 \\
 p - 18 &= 0 \\
 p - 18 + 18 &= 0 + 18 \\
 p &= 18
 \end{aligned}$$

Check $p = 18$: $0 = 0$ True

The solution set is $\{18\}$.

$$\begin{aligned}
 70. \quad -5(1 - 2z) + 4(3 - z) - 7(3 + z) &= 0 \\
 -5 + 10z + 12 - 4z - 21 - 7z &= 0 \\
 -z - 14 &= 0 \\
 -z - 14 + z &= 0 + z \\
 -14 &= z
 \end{aligned}$$

Check $z = -14$: $0 = 0$ True

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

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$$\begin{aligned}
 71. \quad & 4(7x - 1) + 3(2 - 5x) - 4(3x + 5) = -6 \\
 & 28x - 4 + 6 - 15x - 12x - 20 = -6 \\
 & \quad \quad \quad x - 18 = -6 \\
 & x - 18 + 18 = -6 + 18 \\
 & \quad \quad \quad x = 12
 \end{aligned}$$

Check $x = 12$: $-6 = -6$ True

The solution set is $\{12\}$.

$$\begin{aligned}
 72. \quad & 9(2m - 3) - 4(5 + 3m) - 5(4 + m) = -3 \\
 & 18m - 27 - 20 - 12m - 20 - 5m = -3 \\
 & \quad \quad \quad m - 67 = -3 \\
 & m - 67 + 67 = -3 + 67 \\
 & \quad \quad \quad m = 64
 \end{aligned}$$

Check $m = 64$: $-3 = -3$ True

The solution set is $\{64\}$.

73. Answers will vary. One example is $x - 6 = -8$.

74. Answers will vary. One example is $x + \frac{1}{2} = 1$.

75. "Three times a number is 17 more than twice the number."

$$\begin{aligned}
 & 3x = 2x + 17 \\
 & 3x - 2x = 2x + 17 - 2x \\
 & \quad \quad \quad x = 17
 \end{aligned}$$

The number is 17 and $\{17\}$ is the solution set.

76. "One added to three times a number is three less than four times the number."

$$\begin{aligned}
 & 1 + 3x = 4x - 3 \\
 & 1 + 3x - 3x = 4x - 3 - 3x \\
 & \quad \quad \quad 1 = x - 3 \\
 & 1 + 3 = x - 3 + 3 \\
 & \quad \quad \quad 4 = x
 \end{aligned}$$

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

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

$$\begin{aligned}
 & 7x - 6x = -9 \\
 & \quad \quad \quad x = -9
 \end{aligned}$$

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

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

$$\begin{aligned}
 & 5x + 3x = 7x + 9 \\
 & \quad \quad \quad 8x = 7x + 9 \\
 & 8x - 7x = 7x + 9 - 7x \\
 & \quad \quad \quad x = 9
 \end{aligned}$$

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

$$79. \quad \frac{2}{3} \left(\frac{3}{2} \right) = \frac{2 \cdot 3}{3 \cdot 2} = 1$$

$$80. \quad \frac{5}{6} \left(\frac{6}{5} \right) = \frac{5 \cdot 6}{6 \cdot 5} = 1$$

$$\begin{aligned}
 81. \quad & -\frac{5}{4} \left(-\frac{4}{5}x \right) = -\frac{5}{4} \left(-\frac{4}{5} \right) x \\
 & \quad \quad \quad = \frac{5 \cdot 4}{4 \cdot 5} x \\
 & \quad \quad \quad = 1x = x
 \end{aligned}$$

$$\begin{aligned}
 82. \quad & -\frac{9}{7} \left(-\frac{7}{9}x \right) = -\frac{9}{7} \left(-\frac{7}{9} \right) x \\
 & \quad \quad \quad = \frac{9 \cdot 7}{7 \cdot 9} x \\
 & \quad \quad \quad = 1x = x
 \end{aligned}$$

$$\begin{aligned}
 83. \quad & 9 \left(\frac{r}{9} \right) = 9 \left(\frac{1}{9}r \right) \\
 & \quad \quad \quad = 9 \left(\frac{1}{9} \right) r \\
 & \quad \quad \quad = 1r = r
 \end{aligned}$$

$$\begin{aligned}
 84. \quad & 6 \left(\frac{t}{6} \right) = 6 \left(\frac{1}{6}t \right) \\
 & \quad \quad \quad = 6 \left(\frac{1}{6} \right) t \\
 & \quad \quad \quad = 1t = t
 \end{aligned}$$

2.2 The Multiplication Property of Equality

2.2 Classroom Examples, Now Try Exercises

$$\begin{aligned}
 1. \quad & 15x = 75 \\
 & \frac{15x}{15} = \frac{75}{15} \quad \text{Divide by 15.} \\
 & \quad \quad \quad x = 5
 \end{aligned}$$

Check $x = 5$: $75 = 75$ True

The solution set is $\{5\}$.

$$\begin{aligned}
 N1. \quad & 8x = 80 \\
 & \frac{8x}{8} = \frac{80}{8} \quad \text{Divide by 8.} \\
 & \quad \quad \quad x = 10
 \end{aligned}$$

Check $x = 10$: $80 = 80$ True

The solution set is $\{10\}$.

$$\begin{aligned}
 2. \quad & 8x = -20 \\
 & \frac{8x}{8} = -\frac{20}{8} \quad \text{Divide by 8.} \\
 & \quad \quad \quad x = -\frac{20}{8} = -\frac{5}{2} \quad \text{Write in lowest terms.}
 \end{aligned}$$

Check $x = -\frac{5}{2}$: $-20 = -20$ True

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

N2. $10x = -24$
 $\frac{10x}{10} = -\frac{24}{10}$ *Divide by 10.*
 $x = -\frac{24}{10} = -\frac{12}{5}$ *Write in lowest terms.*

Check $x = -\frac{12}{5}$: $-24 = -24$ *True*

The solution set is $\{-\frac{12}{5}\}$.

3. $-0.7x = 5.04$
 $\frac{-0.7x}{-0.7} = \frac{5.04}{-0.7}$ *Divide by -0.7 .*
 $x = -7.2$

Check $x = -7.2$: $5.04 = 5.04$ *True*

The solution set is $\{-7.2\}$.

N3. $-1.3x = 7.02$
 $\frac{-1.3x}{-1.3} = \frac{7.02}{-1.3}$ *Divide by -1.3 .*
 $x = -5.4$

Check $x = -5.4$: $7.02 = 7.02$ *True*

The solution set is $\{-5.4\}$.

4. $\frac{x}{4} = -6$
 $\frac{1}{4}x = -6$
 $4 \cdot \frac{1}{4}x = 4(-6)$ *Multiply by 4, the reciprocal of $\frac{1}{4}$.*
 $x = -24$

Check $x = -24$: $-6 = -6$ *True*

The solution set is $\{-24\}$.

N4. $\frac{x}{5} = -7$
 $\frac{1}{5}x = -7$
 $5 \cdot \frac{1}{5}x = 5(-7)$ *Multiply by 5, the reciprocal of $\frac{1}{5}$.*
 $x = -35$

Check $x = -35$: $-7 = -7$ *True*

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

5. $-\frac{2}{3}t = -12$
 $-\frac{3}{2}\left(-\frac{2}{3}t\right) = -\frac{3}{2}(-12)$ *Multiply by $-\frac{3}{2}$.*
 $1 \cdot t = -\frac{3}{2} \cdot \frac{-12}{1}$ *Multiplicative inverse property*
 $t = 18$ *Multiplicative identity property; multiply fractions.*

Check $t = 18$: $-12 = -12$ *True*

The solution set is $\{18\}$.

N5. $\frac{4}{7}z = -16$
 $\frac{7}{4}\left(\frac{4}{7}z\right) = \frac{7}{4}(-16)$ *Multiply by $\frac{7}{4}$.*
 $1 \cdot t = \frac{7}{4} \cdot \frac{-16}{1}$ *Multiplicative inverse property*
 $t = -28$ *Multiplicative identity property; multiply fractions.*

Check $t = -28$: $-16 = -16$ *True*

The solution set is $\{-28\}$.

6. $-p = 7$
 $-1 \cdot p = 7$ $-p = -1 \cdot p$
 $(-1)(-1) \cdot p = (-1)(7)$ *Multiply by -1 .*
 $1 \cdot p = -7$
 $p = -7$

Check $p = -7$: $7 = 7$ *True*

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

N6. $-x = 9$
 $-1 \cdot x = 9$ $-x = -1 \cdot x$
 $(-1)(-1) \cdot x = (-1)(9)$ *Multiply by -1 .*
 $1 \cdot x = -9$
 $x = -9$

Check $x = -9$: $9 = 9$ *True*

The solution set is $\{-9\}$.

7. $4r - 9r = 20$
 $-5r = 20$ *Combine terms.*
 $\frac{-5r}{-5} = \frac{20}{-5}$ *Divide by -5 .*
 $r = -4$

Check $r = -4$: $20 = 20$ *True*

The solution set is $\{-4\}$.

N7. $9n - 6n = 21$
 $3n = 21$ *Combine terms.*
 $\frac{3n}{3} = \frac{21}{3}$ *Divide by 3.*
 $n = 7$

Check $n = 7$: $21 = 21$ *True*

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

2.2 Section Exercises

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

(b) addition property of equality; to get x alone on the left side of the equation, add -3 (or subtract 3) on each side.

(c) multiplication property of equality; to get x alone on the left side of the equation, multiply each side by -1 (or divide each side by -1).

(d) addition property of equality; to get x alone on the right side of the equation, add -6 (or subtract 6) on each side.

2. Choice C doesn't require the use of the multiplicative property of equality. After the equation is simplified, the variable x is alone on the left side.

$$\begin{aligned} 5x - 4x &= 7 \\ x &= 7 \end{aligned}$$

3. To find the solution of $-x = 5$, multiply (or divide) each side by -1 , or use the rule "If $-x = a$, then $x = -a$."

4. The resulting equation would be $0 = 0$. This is true, but does not help to solve the equation.

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

To get just x on the left side, multiply both sides of the equation by the reciprocal of $\frac{4}{5}$, which is $\frac{5}{4}$.

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

To get just x on the left side, multiply both sides of the equation by the reciprocal of $\frac{2}{3}$, which is $\frac{3}{2}$.

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

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

8. $\frac{x}{100} = 10$

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

9. $-\frac{9}{2}x = -4$

To get just x on the left side, multiply both sides of the equation by the reciprocal of $-\frac{9}{2}$, which is $-\frac{2}{9}$.

10. $-\frac{8}{3}x = -11$

To get just x on the left side, multiply both sides of the equation by the reciprocal of $-\frac{8}{3}$, which is $-\frac{3}{8}$.

11. $-x = 0.75$

This equation is equivalent to $-1x = 0.75$. To get just x on the left side, multiply both sides of the equation by the reciprocal of -1 , which is -1 .

12. $-x = 0.48$

This equation is equivalent to $-1x = 0.48$. To get just x on the left side, multiply both sides of the equation by the reciprocal of -1 , which is -1 .

13. $6x = 5$

To get just x on the left side, divide both sides of the equation by the coefficient of x , which is 6.

14. $7x = 10$

To get just x on the left side, divide both sides of the equation by the coefficient of x , which is 7.

15. $-4x = 16$

To get just x on the left side, divide both sides of the equation by the coefficient of x , which is -4 .

16. $-13x = 26$

To get just x on the left side, divide both sides of the equation by the coefficient of x , which is -13 .

17. $0.12x = 48$

To get just x on the left side, divide both sides of the equation by the coefficient of x , which is 0.12.

18. $0.21x = 63$

To get just x on the left side, divide both sides of the equation by the coefficient of x , which is 0.21.

19. $-x = 25$

This equation is equivalent to $-1x = 25$. To get just x on the left side, divide both sides of the equation by the coefficient of x , which is -1 .

20. $-x = 50$

This equation is equivalent to $-1x = 50$. To get just x on the left side, divide both sides of the equation by the coefficient of x , which is -1 .

21. $6x = 36$

$$\frac{6x}{6} = \frac{36}{6} \quad \text{Divide by 6.}$$

$$1x = 6$$

$$x = 6$$

Check $x = 6$: $36 = 36$ True

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

$$22. \quad 8x = 64$$

$$\frac{8x}{8} = \frac{64}{8} \quad \text{Divide by 8.}$$

$$x = 8$$

Check $x = 8$: $64 = 64$ True

The solution set is $\{8\}$.

$$23. \quad 2m = 15$$

$$\frac{2m}{2} = \frac{15}{2} \quad \text{Divide by 2.}$$

$$m = \frac{15}{2}$$

Check $m = \frac{15}{2}$: $15 = 15$ True

The solution set is $\{\frac{15}{2}\}$.

$$24. \quad 3m = 10$$

$$\frac{3m}{3} = \frac{10}{3} \quad \text{Divide by 3.}$$

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

Check $m = \frac{10}{3}$: $10 = 10$ True

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

$$25. \quad 4x = -20$$

$$\frac{4x}{4} = \frac{-20}{4} \quad \text{Divide by 4.}$$

$$x = -5$$

Check $x = -5$: $-20 = -20$ True

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

$$26. \quad 5x = -60$$

$$\frac{5x}{5} = \frac{-60}{5} \quad \text{Divide by 5.}$$

$$x = -12$$

Check $x = -12$: $-60 = -60$ True

The solution set is $\{-12\}$.

$$27. \quad -7x = 28$$

$$\frac{-7x}{-7} = \frac{28}{-7} \quad \text{Divide by } -7.$$

$$x = -4$$

Check $x = -4$: $28 = 28$ True

The solution set is $\{-4\}$.

$$28. \quad -9x = 36$$

$$\frac{-9x}{-9} = \frac{36}{-9} \quad \text{Divide by } -9.$$

$$x = -4$$

Check $x = -4$: $36 = 36$ True

The solution set is $\{-4\}$.

$$29. \quad 10t = -36$$

$$\frac{10t}{10} = \frac{-36}{10} \quad \text{Divide by 10.}$$

$$t = -\frac{36}{10} = -\frac{18}{5} \quad \text{Lowest terms}$$

Check $t = -\frac{18}{5}$: $-36 = -36$ True

The solution set is $\{-\frac{18}{5}\}$, or $\{-3.6\}$.

$$30. \quad 10s = -54$$

$$\frac{10s}{10} = \frac{-54}{10} \quad \text{Divide by 10.}$$

$$s = -\frac{54}{10} = -\frac{27}{5} \quad \text{Lowest terms}$$

Check $s = -\frac{27}{5}$: $-54 = -54$ True

The solution set is $\{-\frac{27}{5}\}$, or $\{-5.4\}$.

$$31. \quad -6x = -72$$

$$\frac{-6x}{-6} = \frac{-72}{-6} \quad \text{Divide by } -6.$$

$$x = 12$$

Check $x = 12$: $-72 = -72$ True

The solution set is $\{12\}$.

$$32. \quad -4x = -64$$

$$\frac{-4x}{-4} = \frac{-64}{-4} \quad \text{Divide by } -4.$$

$$x = 16$$

Check $x = 16$: $-64 = -64$ True

The solution set is $\{16\}$.

$$33. \quad 4r = 0$$

$$\frac{4r}{4} = \frac{0}{4} \quad \text{Divide by 4.}$$

$$r = 0$$

Check $r = 0$: $0 = 0$ True

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

$$34. \quad 7x = 0$$

$$\frac{7x}{7} = \frac{0}{7} \quad \text{Divide by 7.}$$

$$x = 0$$

Check $x = 0$: $0 = 0$ True

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

$$35. \quad -x = 12$$

$$-1 \cdot (-x) = -1 \cdot 12 \quad \text{Multiply by } -1.$$

$$x = -12$$

Check $x = -12$: $12 = 12$ True

The solution set is $\{-12\}$.

$$36. \quad -t = 14$$

$$-1 \cdot (-t) = -1 \cdot 14 \quad \text{Multiply by } -1.$$

$$t = -14$$

Check $t = -14$: $14 = 14$ True

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

$$37. \quad -x = -\frac{3}{4}$$

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

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

Check $x = \frac{3}{4}$: $-\frac{3}{4} = -\frac{3}{4}$ True

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

$$38. \quad -x = -\frac{1}{2}$$

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

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

Check $x = \frac{1}{2}$: $-\frac{1}{2} = -\frac{1}{2}$ True

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

$$39. \quad 0.2t = 8$$

$$\frac{0.2t}{0.2} = \frac{8}{0.2}$$

$$t = 40$$

Check $t = 40$: $8 = 8$ True

The solution set is $\{40\}$.

$$40. \quad 0.9x = 18$$

$$\frac{0.9x}{0.9} = \frac{18}{0.9}$$

$$x = 20$$

Check $x = 20$: $18 = 18$ True

The solution set is $\{20\}$.

$$41. \quad -2.1m = 25.62$$

$$\frac{-2.1m}{-2.1} = \frac{25.62}{-2.1}$$

$$m = -12.2$$

Check $m = -12.2$: $25.62 = 25.62$ True

The solution set is $\{-12.2\}$.

$$42. \quad -3.9x = 32.76$$

$$\frac{-3.9x}{-3.9} = \frac{32.76}{-3.9}$$

$$x = -8.4$$

Check $x = -8.4$: $32.76 = 32.76$ True

The solution set is $\{-8.4\}$.

$$43. \quad \frac{1}{4}x = -12$$

$$4 \cdot \frac{1}{4}x = 4(-12) \quad \text{Multiply by } 4.$$

$$1x = -48$$

$$x = -48$$

Check $x = -48$: $-12 = -12$ True

The solution set is $\{-48\}$.

$$44. \quad \frac{1}{5}p = -3$$

$$5 \cdot \frac{1}{5}p = 5(-3) \quad \text{Multiply by } 5.$$

$$p = -15$$

Check $p = -15$: $-3 = -3$ True

The solution set is $\{-15\}$.

$$45. \quad \frac{z}{6} = 12$$

$$\frac{1}{6}z = 12$$

$$6 \cdot \frac{1}{6}z = 6 \cdot 12$$

$$z = 72$$

Check $z = 72$: $12 = 12$ True

The solution set is $\{72\}$.

$$46. \quad \frac{x}{5} = 15$$

$$\frac{1}{5}x = 15$$

$$5 \cdot \frac{1}{5}x = 5 \cdot 15$$

$$x = 75$$

Check $x = 75$: $15 = 15$ True

The solution set is $\{75\}$.

$$47. \quad \frac{x}{7} = -5$$

$$\frac{1}{7}x = -5$$

$$7\left(\frac{1}{7}x\right) = 7(-5)$$

$$x = -35$$

Check $x = -35$: $-5 = -5$ True

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

$$48. \quad \frac{r}{8} = -3$$

$$\frac{1}{8}r = -3$$

$$8\left(\frac{1}{8}r\right) = 8(-3)$$

$$r = -24$$

Check $r = -24$: $-3 = -3$ True

The solution set is $\{-24\}$.

$$49. \quad \frac{2}{7}p = 4$$

$$\frac{7}{2}\left(\frac{2}{7}p\right) = \frac{7}{2}(4) \quad \begin{array}{l} \text{Multiply by} \\ \text{the reciprocal} \\ \text{of } \frac{2}{7}. \end{array}$$

$$p = 14$$

Check $p = 14$: $4 = 4$ True

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

$$50. \quad \frac{3}{8}x = 9$$

$$\left(\frac{8}{3}\right)\left(\frac{3}{8}x\right) = \left(\frac{8}{3}\right)(9) \quad \begin{array}{l} \text{Multiply by} \\ \text{the reciprocal} \\ \text{of } \frac{3}{8}. \end{array}$$

$$x = 24$$

Check $x = 24$: $9 = 9$ True

The solution set is $\{24\}$.

$$51. \quad -\frac{5}{6}t = -15$$

$$-\frac{6}{5}\left(-\frac{5}{6}t\right) = -\frac{6}{5}(-15) \quad \begin{array}{l} \text{Multiply by} \\ \text{the reciprocal} \\ \text{of } -\frac{5}{6}. \end{array}$$

$$t = 18$$

Check $t = 18$: $-15 = -15$ True

The solution set is $\{18\}$.

$$52. \quad -\frac{3}{4}z = -21$$

$$-\frac{4}{3}\left(-\frac{3}{4}z\right) = -\frac{4}{3}(-21) \quad \begin{array}{l} \text{Multiply by} \\ \text{the reciprocal} \\ \text{of } -\frac{3}{4}. \end{array}$$

$$z = 28$$

Check $z = 28$: $-21 = -21$ True

The solution set is $\{28\}$.

$$53. \quad -\frac{7}{9}x = \frac{3}{5}$$

$$-\frac{9}{7}\left(-\frac{7}{9}x\right) = -\frac{9}{7} \cdot \frac{3}{5} \quad \begin{array}{l} \text{Multiply by} \\ \text{the reciprocal} \\ \text{of } -\frac{7}{9}. \end{array}$$

$$x = -\frac{27}{35}$$

Check $x = -\frac{27}{35}$: $\frac{3}{5} = \frac{3}{5}$ True

The solution set is $\{-\frac{27}{35}\}$.

$$54. \quad -\frac{5}{6}x = \frac{4}{9}$$

$$\left(-\frac{6}{5}\right)\left(-\frac{5}{6}x\right) = \left(-\frac{6}{5}\right)\left(\frac{4}{9}\right) \quad \begin{array}{l} \text{Multiply by} \\ \text{the reciprocal} \\ \text{of } -\frac{5}{6}. \end{array}$$

$$x = -\frac{2 \cdot 3 \cdot 4}{5 \cdot 3 \cdot 3} = -\frac{8}{15}$$

Check $x = -\frac{8}{15}$: $\frac{4}{9} = \frac{4}{9}$ True

The solution set is $\{-\frac{8}{15}\}$.

$$55. \quad -0.3x = 9$$

$$\frac{-0.3x}{-0.3} = \frac{9}{-0.3} \quad \text{Divide by } -0.3.$$

$$x = -30$$

Check $x = -30$: $9 = 9$ True

The solution set is $\{-30\}$.

$$56. \quad -0.5x = 20$$

$$\frac{-0.5x}{-0.5} = \frac{20}{-0.5} \quad \text{Divide by } -0.5.$$

$$x = -40$$

Check $x = -40$: $20 = 20$ True

The solution set is $\{-40\}$.

$$57. \quad 4x + 3x = 21$$

$$7x = 21$$

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

$$x = 3$$

Check $x = 3$: $21 = 21$ True

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

$$58. \quad 8x + 3x = 121$$

$$11x = 121$$

$$\frac{11x}{11} = \frac{121}{11}$$

$$x = 11$$

Check $x = 11$: $121 = 121$ True

The solution set is $\{11\}$.

$$59. \quad 6r - 8r = 10$$

$$-2r = 10$$

$$\frac{-2r}{-2} = \frac{10}{-2}$$

$$r = -5$$

Check $r = -5$: $10 = 10$ True

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

$$60. \quad 3p - 7p = 24$$

$$-4p = 24$$

$$\frac{-4p}{-4} = \frac{24}{-4}$$

$$p = -6$$

Check $p = -6$: $24 = 24$ True

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

$$61. \quad \frac{2}{5}x - \frac{3}{10}x = 2$$

$$\frac{4}{10}x - \frac{3}{10}x = 2$$

$$\frac{1}{10}x = 2$$

$$10 \cdot \frac{1}{10}x = 10 \cdot 2$$

$$x = 20$$

Check $x = 20$: $8 - 6 = 2$ True

The solution set is $\{20\}$.

$$\begin{aligned}
 62. \quad \frac{2}{3}x - \frac{5}{9}x &= 4 \\
 \frac{6}{9}x - \frac{5}{9}x &= 4 \\
 \frac{1}{9}x &= 4 \\
 9 \cdot \frac{1}{9}x &= 9 \cdot 4 \\
 x &= 36
 \end{aligned}$$

Check $x = 36$: $24 - 20 = 4$ True

The solution set is $\{36\}$.

$$\begin{aligned}
 63. \quad 7m + 6m - 4m &= 63 \\
 9m &= 63 \\
 \frac{9m}{9} &= \frac{63}{9} \\
 m &= 7
 \end{aligned}$$

Check $m = 7$: $63 = 63$ True

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

$$\begin{aligned}
 64. \quad 9r + 2r - 7r &= 68 \\
 4r &= 68 \\
 \frac{4r}{4} &= \frac{68}{4} \\
 r &= 17
 \end{aligned}$$

Check $r = 17$: $68 = 68$ True

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

$$\begin{aligned}
 65. \quad -6x + 4x - 7x &= 0 \\
 -9x &= 0 \\
 \frac{-9x}{-9} &= \frac{0}{-9} \\
 x &= 0
 \end{aligned}$$

Check $x = 0$: $0 = 0$ True

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

$$\begin{aligned}
 66. \quad -5x + 4x - 8x &= 0 \\
 -9x &= 0 \\
 \frac{-9x}{-9} &= \frac{0}{-9} \\
 x &= 0
 \end{aligned}$$

Check $x = 0$: $0 = 0$ True

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

$$\begin{aligned}
 67. \quad 8w - 4w + w &= -3 \\
 5w &= -3 \\
 \frac{5w}{5} &= \frac{-3}{5} \\
 w &= -\frac{3}{5}
 \end{aligned}$$

Check $w = -\frac{3}{5}$: $-3 = -3$ True

The solution set is $\{-\frac{3}{5}\}$.

$$\begin{aligned}
 68. \quad 9x - 3x + x &= -4 \\
 7x &= -4 \\
 \frac{7x}{7} &= \frac{-4}{7} \\
 x &= -\frac{4}{7}
 \end{aligned}$$

Check $x = -\frac{4}{7}$: $-4 = -4$ True

The solution set is $\{-\frac{4}{7}\}$.

$$\begin{aligned}
 69. \quad \frac{1}{3}x - \frac{1}{4}x + \frac{1}{12}x &= 3 \\
 \left(\frac{1}{3} - \frac{1}{4} + \frac{1}{12}\right)x &= 3 && \text{Distributive property} \\
 \left(\frac{4}{12} - \frac{3}{12} + \frac{1}{12}\right)x &= 3 && \text{LCD} = 12 \\
 \frac{1}{6}x &= 3 && \text{Lowest terms} \\
 6\left(\frac{1}{6}x\right) &= 6(3) && \text{Multiply by 6.} \\
 x &= 18
 \end{aligned}$$

Check $x = 18$: $6 - 4.5 + 1.5 = 3$ True

The solution set is $\{18\}$.

$$\begin{aligned}
 70. \quad \frac{2}{5}x + \frac{1}{10}x - \frac{1}{20}x &= 18 \\
 \left(\frac{2}{5} + \frac{1}{10} - \frac{1}{20}\right)x &= 18 && \text{Distributive property} \\
 \left(\frac{8}{20} + \frac{2}{20} - \frac{1}{20}\right)x &= 18 && \text{LCD} = 20 \\
 \frac{9}{20}x &= 18 && \text{Add fractions.} \\
 \frac{20}{9}\left(\frac{9}{20}x\right) &= \frac{20}{9}(18) && \text{Multiply by } \frac{20}{9}. \\
 x &= 40
 \end{aligned}$$

Check $x = 40$: $16 + 4 - 2 = 18$ True

The solution set is $\{40\}$.

71. Answers will vary. One example is

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

72. Answers will vary. One example is

$$100x = 17.$$

73. "When a number is multiplied by 4, the result is 6."

$$\begin{aligned}
 4x &= 6 \\
 \frac{4x}{4} &= \frac{6}{4} \\
 x &= \frac{3}{2}
 \end{aligned}$$

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

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

$$\begin{aligned} -4x &= 10 \\ \frac{-4x}{-4} &= \frac{10}{-4} \\ x &= -\frac{10}{4} = -\frac{5}{2} \end{aligned}$$

The number is $-\frac{5}{2}$ and $\{-\frac{5}{2}\}$ is the solution set.

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

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

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

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

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

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

77.
$$\begin{aligned} -(3m + 5) & \\ &= -1(3m + 5) \\ &= -1(3m) - 1(5) \\ &= -3m - 5 \end{aligned}$$
78.
$$\begin{aligned} -4(-1 + 6x) & \\ &= -4(-1) - 4(6x) \\ &= 4 - 24x \end{aligned}$$
79.
$$\begin{aligned} 4(-5 + 2p) - 3(p - 4) & \\ &= 4(-5) + 4(2p) - 3(p) - 3(-4) \\ &= -20 + 8p - 3p + 12 \\ &= -20 + 12 + 8p - 3p \\ &= -8 + 5p \end{aligned}$$
80.
$$\begin{aligned} 2(4k - 7) - 4(-k + 3) & \\ &= 2(4k) + 2(-7) - 4(-k) - 4(3) \\ &= 8k - 14 + 4k - 12 \\ &= 8k + 4k - 14 - 12 \\ &= 12k - 26 \end{aligned}$$

81.
$$\begin{aligned} 4x + 5 + 2x &= 7x \\ 6x + 5 &= 7x && \text{Combine terms.} \\ 5 &= x && \text{Subtract } 6x. \end{aligned}$$

Check $x = 5$: $20 + 5 + 10 = 35$ True

The solution set is $\{5\}$.

82.
$$\begin{aligned} 2x + 5x - 3x + 4 &= 3x + 2 \\ 4x + 4 &= 3x + 2 && \text{Combine terms.} \\ x + 4 &= 2 && \text{Subtract } 3x. \\ x &= -2 && \text{Subtract } 4. \end{aligned}$$

Check $x = -2$:

$$\begin{aligned} -4 - 10 + 6 + 4 &\stackrel{?}{=} -6 + 2 \\ -4 &= -4 && \text{True} \end{aligned}$$

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

2.3 More on Solving Linear Equations

2.3 Classroom Examples, Now Try Exercises

1. *Step 1* (not necessary)

Step 2

$$\begin{aligned} -5p + 4 &= 19 \\ -5p + 4 - 4 &= 19 - 4 && \text{Subtract } 4. \\ -5p &= 15 && \text{Combine terms.} \end{aligned}$$

Step 3

$$\begin{aligned} \frac{-5p}{-5} &= \frac{15}{-5} && \text{Divide by } -5. \\ p &= -3 \end{aligned}$$

Step 4

Check $p = -3$: $15 + 4 = 19$ True

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

- N1. *Step 1* (not necessary)

Step 2

$$\begin{aligned} 7 + 2m &= -3 \\ 7 + 2m - 7 &= -3 - 7 && \text{Subtract } 7. \\ 2m &= -10 && \text{Combine terms.} \end{aligned}$$

Step 3

$$\begin{aligned} \frac{2m}{2} &= \frac{-10}{2} && \text{Divide by } 2. \\ m &= -5 \end{aligned}$$

Step 4

Check $m = -5$: $7 - 10 = -3$ True

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

2. *Step 1* (not necessary)

Step 2

$$\begin{aligned} 5 - 8x &= 2x - 5 \\ 5 - 8x + 8x &= 2x - 5 + 8x && \text{Add } 8x. \\ 5 &= 10x - 5 && \text{Combine terms.} \\ 5 + 5 &= 10x - 5 + 5 && \text{Add } 5. \\ 10 &= 10x && \text{Combine terms.} \end{aligned}$$

Step 3

$$\begin{aligned} \frac{10}{10} &= \frac{10x}{10} && \text{Divide by } 10. \\ 1 &= x \end{aligned}$$

Step 4

Check $x = 1$: $5 - 8 = 2 - 5$ True

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

N2. *Step 1* (not necessary)*Step 2*

$$2q + 3 = 4q - 9$$

$$2q + 3 - 2q = 4q - 9 - 2q \quad \text{Subtract } 2q.$$

$$3 = 2q - 9 \quad \text{Combine terms.}$$

$$3 + 9 = 2q - 9 + 9 \quad \text{Add 9.}$$

$$12 = 2q \quad \text{Combine terms.}$$

Step 3

$$\frac{12}{2} = \frac{2q}{2} \quad \text{Divide by 2.}$$

$$6 = q$$

Step 4

Check $q = 6$: $12 + 3 = 24 - 9$ True

The solution set is $\{6\}$.3. *Step 1*

$$11 + 3(x + 1) = 5x + 16$$

$$11 + 3x + 3 = 5x + 16 \quad \text{Distributive property}$$

$$3x + 14 = 5x + 16 \quad \text{Combine terms.}$$

Step 2

$$3x + 14 - 14 = 5x + 16 - 14 \quad \text{Subtract 14.}$$

$$3x = 5x + 2$$

$$3x - 5x = 5x + 2 - 5x \quad \text{Subtract } 5x.$$

$$-2x = 2$$

Step 3

$$\frac{-2x}{-2} = \frac{2}{-2} \quad \text{Divide by } -2.$$

$$x = -1$$

Step 4

Check $x = -1$: $11 = 11$ True

The solution set is $\{-1\}$.N3. *Step 1*

$$3(z - 6) - 5z = -7z + 7$$

$$3z - 18 - 5z = -7z + 7 \quad \text{Distributive property}$$

$$-2z - 18 = -7z + 7 \quad \text{Combine terms.}$$

Step 2

$$-2z - 18 + 18 = -7z + 7 + 18 \quad \text{Add 18.}$$

$$-2z = -7z + 25$$

$$-2z + 7z = -7z + 25 + 7z \quad \text{Add } 7z.$$

$$5z = 25$$

Step 3

$$\frac{5z}{5} = \frac{25}{5} \quad \text{Divide by 5.}$$

$$z = 5$$

Step 4

Check $z = 5$: $-28 = -28$ True

The solution set is $\{5\}$.4. *Step 1*

$$4x - (x + 7) = 9$$

$$4x - x - 7 = 9 \quad \text{Distributive property}$$

$$3x - 7 = 9$$

Step 2

$$3x - 7 + 7 = 9 + 7 \quad \text{Add 7.}$$

$$3x = 16$$

Step 3

$$\frac{3x}{3} = \frac{16}{3} \quad \text{Divide by 3.}$$

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

Step 4

Check $x = \frac{16}{3}$: $9 = 9$ True

The solution set is $\{\frac{16}{3}\}$.N4. *Step 1*

$$5x - (x + 9) = x - 4$$

$$5x - x - 9 = x - 4 \quad \text{Distributive property}$$

$$4x - 9 = x - 4$$

Step 2

$$4x - 9 + 9 = x - 4 + 9 \quad \text{Add 9.}$$

$$4x = x + 5$$

$$4x - x = x + 5 - x \quad \text{Subtract } x.$$

$$3x = 5$$

Step 3

$$\frac{3x}{3} = \frac{5}{3} \quad \text{Divide by 3.}$$

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

Step 4

Check $x = \frac{5}{3}$: $-\frac{7}{3} = -\frac{7}{3}$ True

The solution set is $\{\frac{5}{3}\}$.5. *Step 1*

$$2 - 3(2 + 6z) = 4(z + 1) - 8$$

$$2 - 6 - 18z = 4z + 4 - 8 \quad \text{Dist. prop.}$$

$$-4 - 18z = 4z - 4$$

Step 2

$$-4 - 18z + 4 = 4z - 4 + 4 \quad \text{Add 4.}$$

$$-18z = 4z$$

$$-18z - 4z = 4z - 4z \quad \text{Subtract } 4z.$$

$$-22z = 0$$

Step 3

$$\frac{-22z}{-22} = \frac{0}{-22} \quad \text{Divide by } -22.$$

$$z = 0$$

Step 4

Check $z = 0$: $2 - 3(2) \stackrel{?}{=} 4(1) - 8$

$$-4 = -4 \quad \text{True}$$

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

N5. *Step 1*

$$\begin{aligned} 24 - 4(7 - 2t) &= 4(t - 1) \\ 24 - 28 + 8t &= 4t - 4 && \text{Dist. prop.} \\ -4 + 8t &= 4t - 4 \end{aligned}$$

Step 2

$$\begin{aligned} -4 + 8t + 4 &= 4t - 4 + 4 && \text{Add 4.} \\ 8t &= 4t \\ 8t - 4t &= 4t - 4t && \text{Subtract 4t.} \\ 4t &= 0 \end{aligned}$$

Step 3

$$\begin{aligned} \frac{4t}{4} &= \frac{0}{4} && \text{Divide by 4.} \\ t &= 0 \end{aligned}$$

Step 4

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

The solution set is $\{0\}$.6. *Step 1*

$$\frac{1}{3}x - \frac{5}{12} = \frac{3}{4} + \frac{1}{2}x$$

The LCD of all the fractions in the equation is 12, so multiply each side by 12 to clear the fractions.

$$\begin{aligned} 12\left(\frac{1}{3}x - \frac{5}{12}\right) &= 12\left(\frac{3}{4} + \frac{1}{2}x\right) \\ 12\left(\frac{1}{3}x\right) - 12\left(\frac{5}{12}\right) &= 12\left(\frac{3}{4}\right) + 12\left(\frac{1}{2}x\right) \\ &&& \text{Distributive property} \\ 4x - 5 &= 9 + 6x \end{aligned}$$

Step 2

$$\begin{aligned} 4x - 6x - 5 &= 9 + 6x - 6x && \text{Subtract 6x.} \\ -2x - 5 &= 9 \\ -2x - 5 + 5 &= 9 + 5 && \text{Add 5.} \\ -2x &= 14 \end{aligned}$$

Step 3

$$\begin{aligned} \frac{-2x}{-2} &= \frac{14}{-2} && \text{Divide by -2.} \\ x &= -7 \end{aligned}$$

Step 4

Check $x = -7$: $-\frac{7}{3} - \frac{5}{12} \stackrel{?}{=} \frac{3}{4} - \frac{7}{2}$
 $\frac{-28-5}{12} \stackrel{?}{=} \frac{3-14}{4}$
 $-\frac{33}{12} = -\frac{11}{4}$ True

The solution set is $\{-7\}$.N6. *Step 1*

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

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

$$\begin{aligned} 8\left(\frac{1}{2}x + \frac{5}{8}x\right) &= 8\left(\frac{3}{4}x - 6\right) \\ 8\left(\frac{1}{2}x\right) + 8\left(\frac{5}{8}x\right) &= 8\left(\frac{3}{4}x\right) - 8(6) \\ &&& \text{Distributive property} \\ 4x + 5x &= 6x - 48 \\ 9x &= 6x - 48 \end{aligned}$$

Step 2

$$\begin{aligned} 9x - 6x &= 6x - 48 - 6x && \text{Subtract 6x.} \\ 3x &= -48 \end{aligned}$$

Step 3

$$\begin{aligned} \frac{3x}{3} &= \frac{-48}{3} && \text{Divide by 3.} \\ x &= -16 \end{aligned}$$

Step 4

Check $x = -16$: $-8 - 10 \stackrel{?}{=} -12 - 6$
 $-18 = -18$ True

The solution set is $\{-16\}$.7. *Step 1*

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

Multiply by 12.

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

Distributive property

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

Multiply.

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

Distributive property

$$-5x + 1 = -24$$

*Combine terms.**Step 2*

$$\begin{aligned} -5x + 1 - 1 &= -24 - 1 && \text{Subtract 1.} \\ -5x &= -25 && \text{Combine terms.} \end{aligned}$$

Step 3

$$\begin{aligned} \frac{-5x}{-5} &= \frac{-25}{-5} && \text{Divide by -5.} \\ x &= 5 \end{aligned}$$

Step 4

Check $x = 5$: $2 - 4 = -2$ True

The solution set is $\{5\}$.

N7. Step 1

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

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

Multiply by 6.

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

Distributive property

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

Multiply.

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

Distributive property

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

Combine terms.

Step 2

$$-5x - 4 + 4 = -24 + 4 \quad \text{Add 4.}$$

$$-5x = -20 \quad \text{Combine terms.}$$

Step 3

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

$$x = 4$$

Step 4

$$\text{Check } x = 4: 4 - 8 = -4 \quad \text{True}$$

The solution set is $\{4\}$.

8. Step 1

$$0.5(2 - 3x) = 4.5 - 0.1(x + 7)$$

To clear decimals, multiply both sides by 10.

$$10[0.5(2 - 3x)] = 10[4.5 - 0.1(x + 7)]$$

$$5(2 - 3x) = 45 - 1(x + 7)$$

$$10 - 15x = 45 - x - 7$$

$$10 - 15x = 38 - x$$

Step 2

$$10 - 15x + x = 38 - x + x$$

$$10 - 14x = 38$$

$$10 - 10 - 14x = 38 - 10$$

$$-14x = 28$$

Step 3

$$\frac{-14x}{-14} = \frac{28}{-14}$$

$$x = -2$$

Step 4

$$\text{Check } x = -2: 0.5(8) \stackrel{?}{=} 4.5 - 0.1(5)$$

$$4 = 4 \quad \text{True}$$

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

N8. Step 1

$$0.05(13 - t) - 0.2t = 0.08(30)$$

To clear decimals, multiply both sides by 100.

$$100[0.05(13 - t) - 0.2t] = 100[0.08(30)]$$

$$5(13 - t) - 20t = 8(30)$$

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

$$65 - 25t = 240$$

Step 2

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

$$-25t = 175$$

Step 3

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

$$t = -7$$

Step 4

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

$$2.4 = 2.4 \quad \text{True}$$

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

9. $3x - x + 10 = 2x - 4 + 14$

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

$$2x + 10 - 10 = 2x + 10 - 10 \quad \text{Subtract 10.}$$

$$2x = 2x$$

$$2x - 2x = 2x - 2x \quad \text{Subtract 2x.}$$

$$0 = 0 \quad \text{True}$$

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

N9. $-3(x - 7) = 2x - 5x + 21$

$$-3x + 21 = -3x + 21$$

$$-3x + 21 - 21 = -3x + 21 - 21 \quad \text{Subtract 21.}$$

$$-3x = -3x$$

$$-3x + 3x = -3x + 3x \quad \text{Add 3x.}$$

$$0 = 0 \quad \text{True}$$

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

10. $3x + 8 = 6(x - 1) - 3x$

$$3x + 8 = 6x - 6 - 3x \quad \text{Distributive property}$$

$$3x + 8 = 3x - 6 \quad \text{Combine terms.}$$

$$3x - 8 - 3x = 3x - 6 - 3x \quad \text{Subtract 3x.}$$

$$8 = -6 \quad \text{False}$$

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

$$\begin{array}{l} \text{N10.} \quad -4x + 12 = 3 - 4(x - 3) \\ \quad -4x + 12 = 3 - 4x + 12 \quad \text{Distributive} \\ \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \text{property} \\ \quad -4x + 12 = -4x + 15 \quad \text{Combine} \\ \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \text{terms.} \\ -4x + 12 + 4x = -4x + 15 + 4x \quad \text{Add } 4x. \\ \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad 12 = 15 \quad \text{False} \end{array}$$

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

11. The product of x and the other number is 36. To find the other number, you would divide 36 by x , so an expression for the other number is $\frac{36}{x}$.

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

2.3 Section Exercises

1. $7x + 8 = 1$

Use the addition property of equality to subtract 8 from each side.

2. $7x - 5x + 15 = 8 + x$

Combine like terms on the left.

3. $3(2t - 4) = 20 - 2t$

Clear the parentheses by using the distributive property.

4. $\frac{3}{4}z = -15$

Use the multiplication property of equality to multiply each side by $\frac{4}{3}$.

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

Clear fractions by multiplying by the LCD, 6.

6. $0.9x + 0.3(x + 12) = 6$

Clear the decimals by multiplying each side by 10.

7. Equations **A**, **B**, and **C** each have {all real numbers} for their solution set. However, equation **D** gives

$$\begin{array}{l} 3x = 2x \\ 3x - 2x = 2x - 2x \\ x = 0. \end{array}$$

The only solution of this equation is 0, so the correct choice is **D**.

8. $100[0.03(x - 10)] = 3(x - 10) = 3x - 30$, so choice **D** is correct.

Use the four-step method for solving linear equations as given in the text. The details of these steps will only be shown for a few of the exercises.

9. $3x + 2 = 14$
 $3x + 2 - 2 = 14 - 2$ Subtract 2.
 $3x = 12$ Combine terms.
 $\frac{3x}{3} = \frac{12}{3}$ Divide by 3.
 $x = 4$

Check $x = 4$: $12 + 2 = 14$ True

The solution set is $\{4\}$.

10. $4x + 3 = 27$
 $4x + 3 - 3 = 27 - 3$ Subtract 3.
 $4x = 24$ Combine terms.
 $\frac{4x}{4} = \frac{24}{4}$ Divide by 4.
 $x = 6$

Check $x = 6$: $24 + 3 = 27$ True

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

11. $-5z - 4 = 21$
 $-5z - 4 + 4 = 21 + 4$ Add 4.
 $-5z = 25$ Combine terms.
 $\frac{-5z}{-5} = \frac{25}{-5}$ Divide by -5 .
 $z = -5$

Check $z = -5$: $25 - 4 = 21$ True

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

12. $-7w - 4 = 10$
 $-7w - 4 + 4 = 10 + 4$ Add 4.
 $-7w = 14$ Combine terms.
 $\frac{-7w}{-7} = \frac{14}{-7}$ Divide by -7 .
 $w = -2$

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

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

13. $4p - 5 = 2p$
 $4p - 5 - 4p = 2p - 4p$ Subtract $4p$.
 $-5 = -2p$ Combine terms.
 $\frac{-5}{-2} = \frac{-2p}{-2}$ Divide by -2 .
 $\frac{5}{2} = p$

Check $p = \frac{5}{2}$: $10 - 5 = 5$ True

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

14. $6q - 2 = 3q$
 $6q - 2 - 6q = 3q - 6q$ Subtract $6q$.
 $-2 = -3q$ Combine terms.
 $\frac{-2}{-3} = \frac{-3q}{-3}$ Divide by -3 .
 $\frac{2}{3} = q$

Check $q = \frac{2}{3}$: $4 - 2 = 2$ True

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

15. $2x + 9 = 4x + 11$
 $-2x + 9 = 11$ Subtract $4x$.
 $-2x = 2$ Subtract 9 .
 $x = -1$ Divide by -2 .

Check $x = -1$: $7 = 7$ True

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

16. $7p + 8 = 9p - 2$
 $-2p + 8 = -2$ Subtract $9p$.
 $-2p = -10$ Subtract 8 .
 $p = 5$ Divide by -2 .

Check $p = 5$: $43 = 43$ True

The solution set is $\{5\}$.

17. $5m + 8 = 7 + 3m$
 For this equation, step 1 is not needed.
 Step 2
 $5m + 8 - 8 = 7 + 3m - 8$ Subtract 8 .
 $5m = 3m - 1$
 $5m - 3m = 3m - 1 - 3m$ Subtract $3m$.
 $2m = -1$

Step 3

$\frac{2m}{2} = \frac{-1}{2}$ Divide by 2 .
 $m = -\frac{1}{2}$

Step 4

Substitute $-\frac{1}{2}$ for m in the original equation.

$5m + 8 = 7 + 3m$
 $5(-\frac{1}{2}) + 8 \stackrel{?}{=} 7 + 3(-\frac{1}{2})$ Let $m = -\frac{1}{2}$.
 $-\frac{5}{2} + 8 \stackrel{?}{=} 7 + (-\frac{3}{2})$
 $\frac{11}{2} = \frac{11}{2}$ True

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

18. $4r + 2 = r - 6$
 $4r + 2 - r = r - 6 - r$ Subtract r .
 $3r + 2 = -6$
 $3r + 2 - 2 = -6 - 2$ Subtract 2 .
 $3r = -8$
 $\frac{3r}{3} = \frac{-8}{3}$ Divide by 3 .
 $r = -\frac{8}{3}$

Check $r = -\frac{8}{3}$: $-\frac{32}{3} + \frac{6}{3} = -\frac{8}{3} - \frac{18}{3}$ True

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

19. $-12x - 5 = 10 - 7x$
 $-12x - 5 + 7x = 10 - 7x + 7x$ Add $7x$.
 $-5x - 5 = 10$
 $-5x - 5 + 5 = 10 + 5$ Add 5 .
 $-5x = 15$
 $\frac{-5x}{-5} = \frac{15}{-5}$ Divide by -5 .
 $x = -3$

Check $x = -3$: $36 - 5 = 10 + 21$ True

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

20. $-16w - 3 = 13 - 8w$
 $-16w - 3 + 8w = 13 - 8w + 8w$ Add $8w$.
 $-8w - 3 = 13$
 $-8w - 3 + 3 = 13 + 3$ Add 3 .
 $-8w = 16$
 $\frac{-8w}{-8} = \frac{16}{-8}$ Div. by -8 .
 $w = -2$

Check $w = -2$: $32 - 3 = 13 + 16$ True

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

21. $12h - 5 = 11h + 5 - h$
 $12h - 5 = 10h + 5$ Combine terms.
 $2h - 5 = 5$ Subtract $10h$.
 $2h = 10$ Add 5 .
 $h = 5$ Divide by 2 .

Check $h = 5$: $55 = 55$ True

The solution set is $\{5\}$.

22. $-4x - 1 = -5x + 1 + 3x$
 $-4x - 1 = -2x + 1$ Combine terms.
 $-2x - 1 = 1$ Add $2x$.
 $-2x = 2$ Add 1 .
 $x = -1$ Divide by -2 .

Check $x = -1$: $3 = 3$ True

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

23. $7r - 5r + 2 = 5r + 2 - r$

$2r + 2 = 4r + 2$ *Combine terms.*

$2 = 2r + 2$ *Subtract 2r.*

$0 = 2r$ *Subtract 2.*

$0 = r$ *Divide by 2.*

Check $r = 0$: $2 = 2$ *True*

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

24. $9p - 4p + 6 = 7p + 6 - 3p$

$5p + 6 = 4p + 6$ *Combine terms.*

$p + 6 = 6$ *Subtract 4p.*

$p = 0$ *Subtract 6.*

Check $p = 0$: $6 = 6$ *True*

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

25. $3(4x + 2) + 5x = 30 - x$

$12x + 6 + 5x = 30 - x$ *Distributive property*

$17x + 6 = 30 - x$ *Combine terms.*

$18x + 6 = 30$ *Add 1x.*

$18x = 24$ *Subtract 6.*

$x = \frac{24}{18} = \frac{4}{3}$ *Divide by 18.*

Check $x = \frac{4}{3}$: $\frac{86}{3} = \frac{86}{3}$ *True*

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

26. $5(2m + 3) - 4m = 2m + 25$

$10m + 15 - 4m = 2m + 25$ *Distributive property*

$6m + 15 = 2m + 25$ *Combine terms.*

$6m = 2m + 10$ *Subtract 15.*

$4m = 10$ *Subtract 2m.*

$m = \frac{10}{4} = \frac{5}{2}$ *Divide by 4.*

Check $m = \frac{5}{2}$: $30 = 30$ *True*

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

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

$-2p + 7 = 3 - 5p - 1$ *Distributive property*

$-2p + 7 = -5p + 2$ *Combine terms.*

$3p + 7 = 2$ *Add 5p.*

$3p = -5$ *Subtract 7.*

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

Check $p = -\frac{5}{3}$: $\frac{31}{3} = \frac{31}{3}$ *True*

The solution set is $\{-\frac{5}{3}\}$.

28. $4x + 9 = 3 - (x - 2)$

$4x + 9 = 3 - x + 2$ *Distributive property*

$4x + 9 = -x + 5$ *Combine terms.*

$5x + 9 = 5$ *Add 1x.*

$5x = -4$ *Subtract 9.*

$x = -\frac{4}{5}$ *Divide by 5.*

Check $x = -\frac{4}{5}$: $\frac{29}{5} = \frac{29}{5}$ *True*

The solution set is $\{-\frac{4}{5}\}$.

29. $6(3w + 5) = 2(10w + 10)$

$18w + 30 = 20w + 20$

$18w = 20w - 10$ *Subtract 30.*

$-2w = -10$ *Subtract 20w.*

$w = 5$ *Divide by -2.*

Check $w = 5$: $120 = 120$ *True*

The solution set is $\{5\}$.

30. $4(2x - 1) = -6(x + 3)$

$8x - 4 = -6x - 18$

$14x - 4 = -18$ *Add 6x.*

$14x = -14$ *Add 4.*

$x = -1$ *Divide by 14.*

Check $x = -1$: $-12 = -12$ *True*

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

31. $-(4x + 2) - (-3x - 5) = 3$

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

$-4x - 2 + 3x + 5 = 3$

$-x + 3 = 3$

$-x = 0$

$x = 0$

Check $x = 0$: $3 = 3$ *True*

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

32. $-(6k - 5) - (-5k + 8) = -3$

$-1(6k - 5) - 1(-5k + 8) = -3$

$-6k + 5 + 5k - 8 = -3$

$-k - 3 = -3$

$-k = 0$

$k = 0$

Check $k = 0$: $-3 = -3$ *True*

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

33. $6(4x - 1) = 12(2x + 3)$

$24x - 6 = 24x + 36$

$-6 = 36$ *Subtract 24x.*

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

34. $6(2x + 8) = 4(3x - 6)$

$12x + 48 = 12x - 24$

$48 = -24$ *Subtract 12x.*

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

$$\begin{aligned}
 35. \quad & 3(2x - 4) = 6(x - 2) \\
 & 6x - 12 = 6x - 12 \\
 & -12 = -12 \quad \text{Subtract } 6x. \\
 & 0 = 0 \quad \text{Add } 12.
 \end{aligned}$$

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

$$\begin{aligned}
 36. \quad & 3(6 - 4x) = 2(-6x + 9) \\
 & 18 - 12x = -12x + 18 \\
 & 18 = 18 \quad \text{Add } 12x.
 \end{aligned}$$

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

$$\begin{aligned}
 37. \quad & 11x - 5(x + 2) = 6x + 5 \\
 & 11x - 5x - 10 = 6x + 5 \\
 & 6x - 10 = 6x + 5 \\
 & -10 = 5 \quad \text{Subtract } 6x.
 \end{aligned}$$

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

$$\begin{aligned}
 38. \quad & 6x - 4(x + 1) = 2x + 4 \\
 & 6x - 4x - 4 = 2x + 4 \\
 & 2x - 4 = 2x + 4 \\
 & -4 = 4 \quad \text{Subtract } 2x.
 \end{aligned}$$

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

$$39. \quad \frac{3}{5}t - \frac{1}{10}t = t - \frac{5}{2}$$

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

$$\begin{aligned}
 & 10\left(\frac{3}{5}t - \frac{1}{10}t\right) = 10\left(t - \frac{5}{2}\right) \\
 & \quad \text{Multiply both sides by } 10. \\
 & 10\left(\frac{3}{5}t\right) + 10\left(-\frac{1}{10}t\right) = 10t + 10\left(-\frac{5}{2}\right) \\
 & \quad \text{Distributive property} \\
 & 6t - t = 10t - 25 \\
 & 5t = 10t - 25 \\
 & -5t = -25 \quad \text{Subtract } 10t. \\
 & \frac{-5t}{-5} = \frac{-25}{-5} \quad \text{Divide by } -5. \\
 & t = 5
 \end{aligned}$$

$$\text{Check } t = 5: \frac{5}{2} = \frac{5}{2} \quad \text{True}$$

The solution set is $\{5\}$.

$$40. \quad -\frac{2}{7}r + 2r = \frac{1}{2}r + \frac{17}{2}$$

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

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

$$\text{Check } r = 7: 12 = 12 \quad \text{True}$$

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

$$41. \quad \frac{3}{4}x - \frac{1}{3}x + 5 = \frac{5}{6}x$$

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

$$\begin{aligned}
 & 12\left(\frac{3}{4}x - \frac{1}{3}x + 5\right) = 12\left(\frac{5}{6}x\right) \\
 & 9x - 4x + 60 = 10x \\
 & 5x + 60 = 10x \\
 & 60 = 5x \\
 & \frac{60}{5} = \frac{5x}{5} \\
 & 12 = x
 \end{aligned}$$

$$\text{Check } x = 12: 9 - 4 + 5 = 10 \quad \text{True}$$

The solution set is $\{12\}$.

$$42. \quad \frac{1}{5}x - \frac{2}{3}x - 2 = -\frac{2}{5}x$$

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

$$\begin{aligned}
 & 15\left(\frac{1}{5}x - \frac{2}{3}x - 2\right) = 15\left(-\frac{2}{5}x\right) \\
 & 3x - 10x - 30 = -6x \\
 & -7x - 30 = -6x \\
 & -30 = x
 \end{aligned}$$

$$\text{Check } x = -30: -6 + 20 - 2 = 12 \quad \text{True}$$

The solution set is $\{-30\}$.

$$43. \quad \frac{1}{7}(3x + 2) - \frac{1}{5}(x + 4) = 2$$

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

$$\begin{aligned}
 35 \left[\frac{1}{7}(3x+2) - \frac{1}{5}(x+4) \right] &= 35(2) \\
 5(3x+2) - 7(x+4) &= 70 \\
 15x+10 - 7x - 28 &= 70 \\
 8x - 18 &= 70 \\
 8x &= 88 \\
 \frac{8x}{8} &= \frac{88}{8} \\
 x &= 11
 \end{aligned}$$

Check $x = 11$: $5 - 3 = 2$ True

The solution set is $\{11\}$.

44. $\frac{1}{4}(3x-1) + \frac{1}{6}(x+3) = 3$

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

$$\begin{aligned}
 12 \left[\frac{1}{4}(3x-1) + \frac{1}{6}(x+3) \right] &= 12(3) \\
 3(3x-1) + 2(x+3) &= 36 \\
 9x-3 + 2x+6 &= 36 \\
 11x+3 &= 36 \\
 11x &= 33 \\
 \frac{11x}{11} &= \frac{33}{11} \\
 x &= 3
 \end{aligned}$$

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

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

45. $-\frac{1}{4}(x-12) + \frac{1}{2}(x+2) = x+4$

The LCD of all the fractions is 4.

$$\begin{aligned}
 4 \left[-\frac{1}{4}(x-12) + \frac{1}{2}(x+2) \right] &= 4(x+4) \\
 &\text{Multiply by 4.} \\
 4 \left(-\frac{1}{4} \right) (x-12) + 4 \left(\frac{1}{2} \right) (x+2) &= 4x+16 \\
 &\text{Distributive property} \\
 (-1)(x-12) + 2(x+2) &= 4x+16 \\
 &\text{Multiply.} \\
 -x+12 + 2x+4 &= 4x+16 \\
 &\text{Distributive property} \\
 x+16 &= 4x+16 \\
 -3x+16 &= 16 \\
 -3x &= 0 \\
 \frac{-3x}{-3} &= \frac{0}{-3} \quad \text{Divide by } -3. \\
 x &= 0
 \end{aligned}$$

Check $x = 0$: $4 = 4$ True

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

46. $\frac{1}{9}(p+18) + \frac{1}{3}(2p+3) = p+3$

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

$$\begin{aligned}
 9 \left[\frac{1}{9}(p+18) + \frac{1}{3}(2p+3) \right] &= 9(p+3) \\
 p+18 + 3(2p+3) &= 9p+27 \\
 p+18 + 6p+9 &= 9p+27 \\
 7p+27 &= 9p+27 \\
 -2p+27 &= 27 \\
 -2p &= 0 \\
 \frac{-2p}{-2} &= \frac{0}{-2} \\
 p &= 0
 \end{aligned}$$

Check $p = 0$: $3 = 3$ True

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

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

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

$$\begin{aligned}
 6 \left[\frac{2}{3}k - \left(k - \frac{1}{2}\right) \right] &= 6 \left[\frac{1}{6}(k - 51) \right] \\
 6 \left(\frac{2}{3}k \right) - 6 \left(k - \frac{1}{2} \right) &= 6 \left[\frac{1}{6}(k - 51) \right] \\
 &\text{Distributive property} \\
 4k - 6k + 3 &= 1(k - 51) \\
 -2k + 3 &= k - 51 \\
 -3k + 3 &= -51 \\
 -3k &= -54 \\
 k &= 18
 \end{aligned}$$

Check $k = 18$: $-\frac{11}{2} = -\frac{11}{2}$ True

The solution set is $\{18\}$.

48. $-\frac{5}{6}q - (q-1) = \frac{1}{4}(-q+80)$

The least common denominator is 12.

$$\begin{aligned}
 12 \left[-\frac{5}{6}q - (q-1) \right] &= 12 \left[\frac{1}{4}(-q+80) \right] \\
 &\text{Multiply by 12.} \\
 12 \left(-\frac{5}{6}q \right) - 12(q-1) &= 12 \left[\frac{1}{4}(-q+80) \right] \\
 -10q - 12q + 12 &= 3(-q+80) \\
 -22q + 12 &= -3q + 240 \\
 -19q + 12 &= 240 \\
 -19q &= 228 \\
 q &= \frac{228}{-19} = -12
 \end{aligned}$$

Check $q = -12$: $23 = 23$ True

The solution set is $\{-12\}$.

49. $0.2(60) + 0.05x = 0.1(60 + x)$

To eliminate the decimal in 0.2 and 0.1, we need to multiply both sides by 10. But to eliminate the decimal in 0.05, we need to multiply by 100, so we choose 100.

$$100[0.2(60) + 0.05x] = 100[0.1(60 + x)]$$

Multiply by 100.

$$100[0.2(60)] + 100(0.05x) = 100[0.1(60 + x)]$$

Distributive property

$$20(60) + 5x = 10(60 + x)$$

Multiply.

$$1200 + 5x = 600 + 10x$$

$$1200 - 5x = 600$$

$$-5x = -600$$

$$x = \frac{-600}{-5} = 120$$

Check $x = 120$: $18 = 18$ True

The solution set is $\{120\}$.

50. $0.3(30) + 0.15x = 0.2(30 + x)$

$$100[0.3(30) + 0.15x] = 100[0.2(30 + x)]$$

Multiply both sides by 100.

$$30(30) + 15x = 20(30 + x)$$

$$900 + 15x = 600 + 20x$$

$$900 - 5x = 600$$

$$-5x = -300$$

$$x = 60$$

Check $x = 60$: $18 = 18$ True

The solution set is $\{60\}$.

51. $1.00x + 0.05(12 - x) = 0.10(63)$

To clear the equation of decimals, we multiply both sides by 100.

$$100[1.00x + 0.05(12 - x)] = 100[0.10(63)]$$

$$100(1.00x) + 100[0.05(12 - x)] = (100)(0.10)(63)$$

$$100x + 5(12 - x) = 10(63)$$

$$100x + 60 - 5x = 630$$

$$95x + 60 = 630$$

$$95x = 570$$

$$x = \frac{570}{95} = 6$$

Check $x = 6$: $6.3 = 6.3$ True

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

52. $0.92x + 0.98(12 - x) = 0.96(12)$

$$100[0.92x + 0.98(12 - x)] = 100[0.96(12)]$$

Multiply both sides by 100.

$$92x + 98(12 - x) = 96(12)$$

$$92x + 1176 - 98x = 1152$$

$$-6x + 1176 = 1152$$

$$-6x = -24$$

$$x = \frac{-24}{-6} = 4$$

Check $x = 4$: $11.52 = 11.52$ True

The solution set is $\{4\}$.

53. $0.6(10,000) + 0.8x = 0.72(10,000 + x)$

$$100[0.6(10,000)] + 100(0.8x) =$$

$$100[0.72(10,000 + x)]$$

Multiply by both sides by 100.

$$60(10,000) + 80x = 72(10,000 + x)$$

$$600,000 + 80x = 720,000 + 72x$$

$$600,000 + 8x = 720,000$$

$$8x = 120,000$$

$$x = \frac{120,000}{8} = 15,000$$

Check $x = 15,000$: $18,000 = 18,000$ True

The solution set is $\{15,000\}$.

54. $0.2(5000) + 0.3x = 0.25(5000 + x)$

$$100[0.2(5000)] + 100(0.3x) =$$

$$100[0.25(5000 + x)]$$

Multiply both sides by 100.

$$20(5000) + 30x = 25(5000 + x)$$

$$100,000 + 30x = 125,000 + 25x$$

$$5x + 100,000 = 125,000$$

$$5x = 25,000$$

$$x = \frac{25,000}{5} = 5000$$

Check $x = 5000$: $2500 = 2500$ True

The solution set is $\{5000\}$.

55. $10(2x - 1) = 8(2x + 1) + 14$

$$20x - 10 = 16x + 8 + 14$$

$$20x - 10 = 16x + 22$$

$$4x - 10 = 22$$

$$4x = 32$$

$$x = 8$$

Check $x = 8$: $150 = 150$ True

The solution set is $\{8\}$.

56. $9(3k - 5) = 12(3k - 1) - 51$

$$27k - 45 = 36k - 12 - 51$$

$$27k - 45 = 36k - 63$$

$$-45 = 9k - 63$$

$$18 = 9k$$

$$2 = k$$

Check $k = 2$: $9 = 9$ True

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

57.
$$\frac{1}{2}(x + 2) + \frac{3}{4}(x + 4) = x + 5$$
 To clear fractions, multiply both sides by the LCD, which is 4.

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

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

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

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

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

$$x + 16 = 20$$

$$x = 4$$

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

The solution set is $\{4\}$.

58.
$$\frac{1}{3}(x + 3) + \frac{1}{6}(x - 6) = x + 3$$
 To clear fractions, multiply both sides by the LCD, which is 6.

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

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

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

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

$$3x = 6x + 18$$

$$-3x = 18$$

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

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

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

59.
$$0.1(x + 80) + 0.2x = 14$$
 To eliminate the decimals, multiply both sides by 10.

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

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

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

$$3x + 80 = 140$$

$$3x = 60$$

$$x = 20$$

Check $x = 20$: $14 = 14$ True

The solution set is $\{20\}$.

60.
$$0.3(x + 15) + 0.4(x + 25) = 25$$
 To clear the decimals, multiply both sides by 10.

$$3(x + 15) + 4(x + 25) = 250$$

$$3x + 45 + 4x + 100 = 250$$

$$7x + 145 = 250$$

$$7x = 105$$

$$x = 15$$

Check $x = 15$: $25 = 25$ True

The solution set is $\{15\}$.

61.
$$4(x + 8) = 2(2x + 6) + 20$$

$$4x + 32 = 4x + 12 + 20$$

$$4x + 32 = 4x + 32$$

$$4x = 4x$$

$$0 = 0$$

62.
$$4(x + 3) = 2(2x + 8) - 4$$

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

$$4x + 12 = 4x + 12$$

$$12 = 12$$

Since $0 = 0$ is a true statement, the solution set is $\{\text{all real numbers}\}$.

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

63.
$$9(v + 1) - 3v = 2(3v + 1) - 8$$

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

$$6v + 9 = 6v - 6$$

$$9 = -6$$

64.
$$8(t - 3) + 4t = 6(2t + 1) - 10$$

$$8t - 24 + 4t = 12t + 6 - 10$$

$$12t - 24 = 12t - 4$$

$$-24 = -4$$

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

Because $-24 = -4$ is a false statement, the equation has no solution set, symbolized by \emptyset .

65. The sum of q and the other number is 11. To find the other number, you would subtract q from 11, so an expression for the other number is $11 - q$.
66. The sum of r and the other number is 34. To find the other number, you would subtract r from 34, so an expression for the other number is $34 - r$.
67. The product of x and the other number is 9. To find the other number, you would divide 9 by x , so an expression for the other number is $\frac{9}{x}$.
68. The product of m and the other number is -6 . To find the other number, you would divide -6 by m , so an expression for the other number is $\frac{-6}{m}$.
69. An expression for the total number of yards is $x + 9$.
70. An expression for the total number of yards is $y + 6$.
71. If a baseball player gets 65 hits in one season, and h of the hits are in one game, then $65 - h$ of the hits came in the rest of the games.
72. If a hockey player scores 42 goals in one season, and n of the goals are in one game, then $42 - n$ of the goals came in the rest of the games.

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73. If Monica is x years old now, then 15 years from now, she will be $x + 15$ years old. Five years ago, she was $x - 5$ years old.
74. If Chandler is y years old now, then four years ago he was $y - 4$ years old. Eleven years from now, he will be $y + 11$ years old.
75. Since the value of each quarter is 25 cents, the value of r quarters is $25r$ cents.
76. Since the value of each dime is 10 cents, the value of y dimes is $10y$ cents.
77. Since each bill is worth 5 dollars, the number of bills is $\frac{t}{5}$.
78. Since each bill is worth 10 dollars, the number of bills is $\frac{v}{10}$.
79. Since each adult ticket costs x dollars, the cost of 3 adult tickets is $3x$. Since each child's ticket costs y dollars, the cost of 2 children's tickets is $2y$. Therefore, the total cost is $3x + 2y$ (dollars).
80. Since each adult ticket costs p dollars, the cost of 4 adult tickets is $4p$. Since each child's ticket costs q dollars, the cost of 6 children's tickets is $6q$. Therefore, the total cost is $4p + 6q$ (dollars).
81. "A number added to -6 " is written
 $-6 + x$.
82. "A number decreased by 9" is written
 $x - 9$.
83. "The difference between -5 and a number" is written
 $-5 - x$.
84. "The quotient of -6 and a nonzero number" is written
 $\frac{-6}{x}$.
85. "The product of 12 and the difference between a number and 9" is written
 $12(x - 9)$.
86. "The quotient of 9 more than a number and 6 less than the number" is written
 $\frac{x + 9}{x - 6}$.

Summary Exercises on Solving Linear Equations

1. $x + 2 = -3$
 $x = -5$ Subtract 2.

Check $x = -5$: $-3 = -3$ True

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

2. $2m + 8 = 16$
 $2m = 8$ Subtract 8.
 $m = 4$ Divide by 2.

Check $m = 4$: $16 = 16$ True

The solution set is $\{4\}$.

3. $12.5x = -63.75$
 $x = \frac{-63.75}{12.5}$ Divide by 12.5.
 $= -5.1$

Check $x = -5.1$: $-63.75 = -63.75$ True

The solution set is $\{-5.1\}$.

4. $-x = -12$
 $x = 12$ Multiply by -1 .

Check $x = 12$: $-12 = -12$ True

The solution set is $\{12\}$.

5. $\frac{4}{5}x = -20$
 $x = \left(\frac{5}{4}\right)(-20)$ Multiply by $\frac{5}{4}$.
 $= -25$

Check $x = -25$: $-20 = -20$ True

The solution set is $\{-25\}$.

6. $7m - 5m = -12$
 $2m = -12$ Combine terms.
 $m = -6$ Divide by 2.

Check $m = -6$: $-12 = -12$ True

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

7. $5x - 9 = 3(x - 3)$
 $5x - 9 = 3x - 9$ Distributive property
 $2x - 9 = -9$ Subtract 3x.
 $2x = 0$ Add 9.
 $x = 0$ Divide by 2.

Check $x = 0$: $-9 = -9$ True

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

8. $\frac{x}{-2} = 8$
 $-\frac{1}{2}x = 8$ Equivalent form
 $x = -2(8)$ Multiply by -2 .
 $= -16$

Check $x = -16$: $8 = 8$ True

The solution set is $\{-16\}$.

9. $-x = 6$
 $x = -6$ Multiply by -1 .

Check $x = -6$: $6 = 6$ True

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

$$10. \quad \frac{2}{3}x + 8 = \frac{1}{4}x$$

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

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

$$8x + 96 = 3x$$

$$5x + 96 = 0$$

$$5x = -96$$

$$x = -\frac{96}{5}$$

$$\text{Check } x = -\frac{96}{5}: \quad -\frac{24}{5} = -\frac{24}{5} \quad \text{True}$$

The solution set is $\left\{-\frac{96}{5}\right\}$.

$$11. \quad 4x + 2(3 - 2x) = 6$$

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

$$6 = 6$$

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

$$12. \quad -6z = -14$$

$$z = \frac{-14}{-6} \quad \text{Divide by } -6.$$

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

$$\text{Check } z = \frac{7}{3}: \quad -14 = -14 \quad \text{True}$$

The solution set is $\left\{\frac{7}{3}\right\}$.

$$13. \quad -3(m - 4) + 2(5 + 2m) = 29$$

$$-3m + 12 + 10 + 4m = 29$$

$$m + 22 = 29$$

$$m = 7$$

$$\text{Check } m = 7: \quad 29 = 29 \quad \text{True}$$

The solution set is {7}.

$$14. \quad -0.3x + 2.1(x - 4) = -6.6$$

To eliminate the decimals, multiply both sides by 10.

$$10[-0.3x + 2.1(x - 4)] = 10(-6.6)$$

$$-3x + 21(x - 4) = -66$$

$$-3x + 21x - 84 = -66$$

$$18x - 84 = -66$$

$$18x = 18$$

$$x = 1$$

$$\text{Check } x = 1: \quad -0.3 - 6.3 = -6.6 \quad \text{True}$$

The solution set is {1}.

$$15. \quad 0.08x + 0.06(x + 9) = 1.24$$

To eliminate the decimals, multiply both sides by 100.

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

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

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

$$14x + 54 = 124$$

$$14x = 70$$

$$x = 5$$

$$\text{Check } x = 5: \quad 0.4 + 0.84 = 1.24 \quad \text{True}$$

The solution set is {5}.

$$16. \quad x - 16.2 = 7.5$$

$$x = 23.7 \quad \text{Add } 16.2.$$

$$\text{Check } x = 23.7: \quad 7.5 = 7.5 \quad \text{True}$$

The solution set is {23.7}.

$$17. \quad 7m - (2m - 9) = 39$$

$$7m - 2m + 9 = 39$$

$$5m + 9 = 39$$

$$5m = 30$$

$$m = 6$$

$$\text{Check } m = 6: \quad 39 = 39 \quad \text{True}$$

The solution set is {6}.

$$18. \quad 7(p - 2) + p = 2(p + 2)$$

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

$$8p - 14 = 2p + 4$$

$$6p - 14 = 4$$

$$6p = 18$$

$$p = 3$$

$$\text{Check } p = 3: \quad 10 = 10 \quad \text{True}$$

The solution set is {3}.

$$19. \quad -2t + 5t - 9 = 3(t - 4) - 5$$

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

$$3t - 9 = 3t - 17$$

$$-9 = -17$$

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

$$20. \quad 3(m + 5) - 1 + 2m = 5(m + 2)$$

$$3m + 15 - 1 + 2m = 5m + 10$$

$$5m + 14 = 5m + 10$$

$$14 = 10$$

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

$$21. \quad 0.2(50) + 0.8r = 0.4(50 + r)$$

To eliminate the decimals, multiply both sides by 10.

$$10[0.2(50) + 0.8r] = 10[0.4(50 + r)]$$

$$2(50) + 8r = 4(50 + r)$$

$$100 + 8r = 200 + 4r$$

$$100 + 4r = 200$$

$$4r = 100$$

$$r = 25$$

$$\text{Check } r = 25: \quad 10 + 20 = 30 \quad \text{True}$$

The solution set is {25}.

22. $2.3x + 13.7 = 1.3x + 2.9$

To eliminate the decimals, multiply both sides by 10.

$$10[2.3x + 13.7] = 10[1.3x + 2.9]$$

$$23x + 137 = 13x + 29$$

$$10x + 137 = 29$$

$$10x = -108$$

$$x = -10.8$$

Check $x = -10.8$: $-11.14 = -11.14$ True

The solution set is $\{-10.8\}$.

23. $2(3 + 7x) - (1 + 15x) = 2$

$$6 + 14x - 1 - 15x = 2$$

$$-x + 5 = 2$$

$$-x = -3$$

$$x = 3$$

Check $x = 3$: $48 - 46 = 2$ True

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

24. $6q - 9 = 12 + 3q$

$$3q - 9 = 12$$

$$3q = 21$$

$$q = 7$$

Check $q = 7$: $33 = 33$ True

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

25. $2(4 + 3r) = 3(r + 1) + 11$

$$8 + 6r = 3r + 3 + 11$$

$$8 + 6r = 3r + 14$$

$$8 + 3r = 14$$

$$3r = 6$$

$$r = 2$$

Check $r = 2$: $20 = 20$ True

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

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

$$8r + 9 = 12 + 8r - 3$$

$$8r + 9 = 8r + 9$$

$$9 = 9$$

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

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

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

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

$$x - 16 = 6x + 3x$$

$$x - 16 = 9x$$

$$-16 = 8x$$

$$x = -2$$

Check $x = -2$: $-4.5 = -3 - 1.5$ True

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

28. $0.6(100 - x) + 0.4x = 0.5(92)$

To eliminate the decimals, multiply both sides by 10.

$$10[0.6(100 - x) + 0.4x] = 10[0.5(92)]$$

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

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

$$600 - 2x = 460$$

$$-2x = -140$$

$$x = 70$$

Check $x = 70$: $18 + 28 = 46$ True

The solution set is $\{70\}$.

29. $\frac{3}{4}(z - 2) - \frac{1}{3}(5 - 2z) = -2$

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

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

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

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

$$17z - 38 = -24$$

$$17z = 14$$

$$z = \frac{14}{17}$$

Check $z = \frac{14}{17}$: $-\frac{15}{17} - \frac{19}{17} = -2$ True

The solution set is $\{\frac{14}{17}\}$.

30. $2 - (m + 4) = 3m - 2$

$$2 - m - 4 = 3m - 2$$

$$-m - 2 = 3m - 2$$

$$-4m - 2 = -2$$

$$-4m = 0$$

$$m = \frac{0}{-4} = 0$$

Check $m = 0$: $-2 = -2$ True

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

2.4 An Introduction to Applications of Linear Equations

2.4 Classroom Examples, Now Try Exercises

1. Step 2

Let x = the number.

Step 3

If	the product of	the	19 less
5	added	9 and a	than the
is	to	number,	number.
↓	↓	↓	↓
5	+	9x	= x - 19

Step 4

Solve the equation.

$$\begin{aligned}
 5 + 9x &= x - 19 \\
 5 + 9x - 5 &= x - 19 - 5 && \text{Subtract 5.} \\
 9x &= x - 24 \\
 9x - x &= x - 24 - x && \text{Subtract } x. \\
 8x &= -24 \\
 \frac{8x}{8} &= \frac{-24}{8} && \text{Divide by 8.} \\
 x &= -3
 \end{aligned}$$

Step 5
The number is -3 .

Step 6
9 times -3 is -27 . 5 added to -27 is -22 , which is 19 less than -3 , so -3 is the number.

N1. *Step 2*
Let $x =$ the number.

Step 3
If 5 added a result the 7 less
is to number, is than 3 times
↓ ↓ ↓ ↓ ↓
5 + x = 3x - 7

Step 4
Solve the equation.

$$\begin{aligned}
 5 + x &= 3x - 7 \\
 5 + x - 5 &= 3x - 7 - 5 && \text{Subtract 5.} \\
 x &= 3x - 12 \\
 x - 3x &= 3x - 12 - 3x && \text{Subtract } 3x. \\
 -2x &= -12 \\
 \frac{-2x}{-2} &= \frac{-12}{-2} && \text{Divide by } -2. \\
 x &= 6
 \end{aligned}$$

Step 5
The number is 6.

Step 6
5 added to 6 is 11. 3 times 6 is 18, and 7 less than 18 is 11, so 6 is the number.

2. *Step 2*
Let $x =$ the number of medals Norway won.
Let $x + 5 =$ the number of medals Canada won.

Step 3
The total is the number of medals Norway won plus the number of medals Canada won.
↓ ↓ ↓ ↓ ↓
43 = x + (x + 5)

Step 4
Solve this equation.

$$\begin{aligned}
 43 &= 2x + 5 \\
 43 - 5 &= 2x + 5 - 5 \\
 38 &= 2x \\
 \frac{38}{2} &= \frac{2x}{2} \\
 19 &= x
 \end{aligned}$$

Step 5
Norway won 19 medals and Canada won $19 + 5 = 24$ medals.

Step 6
24 is 5 more than 19 and the sum of 19 and 24 is 43.

N2. *Step 2*
Let $x =$ the number of medals Germany won.
Let $x - 7 =$ the number of medals Russia won.

Step 3
The total is the number of medals Germany won plus the number of medals Russia won.
↓ ↓ ↓ ↓ ↓
51 = x + (x - 7)

Step 4
Solve this equation.

$$\begin{aligned}
 51 &= 2x - 7 \\
 51 + 7 &= 2x - 7 + 7 \\
 58 &= 2x \\
 \frac{58}{2} &= \frac{2x}{2} \\
 29 &= x
 \end{aligned}$$

Step 5
Germany won 29 medals and Russia won $29 - 7 = 22$ medals.

Step 6
22 is 7 fewer than 29 and the sum of 22 and 29 is 51.

3. *Step 2*
Let $x =$ the number of orders for muffins.
Then $\frac{1}{6}x =$ the number of orders for croissants.

Step 3
The total is the number of orders for muffins plus the number of orders for croissants.
↓ ↓ ↓ ↓ ↓
56 = x + $\frac{1}{6}x$

Step 4
Solve this equation.

$$56 = 1x + \frac{1}{6}x \quad x = 1x$$

$$56 = \frac{6}{6}x + \frac{1}{6}x \quad LCD = 6$$

$$56 = \frac{7}{6}x \quad \text{Combine like terms.}$$

$$\frac{6}{7}(56) = \frac{6}{7}\left(\frac{7}{6}x\right) \quad \text{Multiply by } \frac{6}{7}.$$

$$48 = x$$

Step 5
The number of orders for muffins was 48, so the number of orders for croissants was $\frac{1}{6}(48) = 8$.

Step 6
One-sixth of 48 is 8 and the sum of 48 and 8 is 56.

N3. Step 2
Let x = the number of orders for chocolate scones.
Then $\frac{2}{3}x$ = the number of orders for bagels.

Step 3

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

Step 4
Solve this equation.

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

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

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

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

$$315 = x$$

Step 5
The number of orders for chocolate scones was 315, so the number of orders for bagels was $\frac{2}{3}(315) = 210$.

Step 6
Two-thirds of 315 is 210 and the sum of 315 and 210 is 525.

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

Step 3

Number		number		the total
of		of		in
members	plus	nonmembers	is	attendance
↓	↓	↓	↓	↓
x	+	$2x$	=	27

Step 4
Solve this equation.

$$x + 2x = 27$$

$$3x = 27$$

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

$$x = 9$$

Step 5
There were 9 members and $2 \cdot 9 = 18$ nonmembers.

Step 6
18 is twice as much as 9 and the sum of 9 and 18 is 27.

N4. Step 2
Let x = the number of residents.
Then $4x$ = the number of guests.
(If each resident brought four guests, there would be four times as many guests as residents.)

Step 3

Number		number		the total
of		of		in
residents	plus	guests	is	attendance
↓	↓	↓	↓	↓
x	+	$4x$	=	175

Step 4
Solve this equation.

$$x + 4x = 175$$

$$5x = 175$$

$$\frac{5x}{5} = \frac{175}{5}$$

$$x = 35$$

Step 5
There were 35 residents and $4 \cdot 35 = 140$ guests.

Step 6
140 is four times as much as 35 and the sum of 35 and 140 is 175.

5. Step 2
Let x = the length of the middle-sized piece.
Then $x + 10$ = the length of the longest piece
and $x - 5$ = the length of the shortest piece.

Step 3

Length of		length of		
shortest		middle-sized		
piece	plus	piece		
↓	↓	↓		
$x - 5$	+	x		
	length of		total length	
plus	longest piece	is	of pipe.	
↓	↓	↓	↓	
+	$x + 10$	=	50	

Step 4
Solve this equation.

$$\begin{aligned}(x - 5) + x + (x + 10) &= 50 \\ 3x + 5 &= 50 \\ 3x &= 45 \\ \frac{3x}{3} &= \frac{45}{3} \\ x &= 15\end{aligned}$$

Step 5
The middle-sized piece is 15 inches long, the longest piece is $15 + 10 = 25$ inches long, and the shortest piece is $15 - 5 = 10$ inches long.

Step 6
Since 25 inches is 10 inches longer than 15 inches, 15 inches is 5 inches longer than 10 inches, and $15 + 25 + 10 = 50$ inches (the length of the pipe), the answers are correct.

- N5.** *Step 2*
Let $x =$ the time spent practicing free throws.
Then $2x =$ the time spent lifting weights
and $x + 2 =$ the time spent watching game films.

Time spent practicing free throws	plus	time spent lifting weights		
↓		↓		
x	+	$2x$		
			plus	total
			time spent watching game films	time.
↓		↓	↓	↓
+		$x + 2$	=	6

Step 4
Solve this equation.

$$\begin{aligned}x + 2x + (x + 2) &= 6 \\ 4x + 2 &= 6 \\ 4x &= 4 \\ \frac{4x}{4} &= \frac{4}{4} \\ x &= 1\end{aligned}$$

Step 5
The time spent practicing free throws is 1 hour, the time spent lifting weights is $2(1) = 2$ hours, and the time spent watching game films is $1 + 2 = 3$ hours.

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

- 6.** *Step 2*
Let $x =$ the lesser page number.
Then $x + 1 =$ the greater page number.

Step 3
Because the sum of the page numbers is 569, an equation is

$$x + (x + 1) = 569$$

- Step 4* $2x + 1 = 569$ *Combine like terms.*
 $2x = 568$ *Subtract 1.*
 $x = 284$ *Divide by 2.*

Step 5
The lesser page number is 284, and the greater page number is $284 + 1 = 285$.

Step 6
285 is one more than 284 and the sum of 284 and 285 is 569.

- N6.** *Step 2*
Let $x =$ the lesser page number.
Then $x + 1 =$ the greater page number.

Step 3
Because the sum of the page numbers is 593, an equation is

$$x + (x + 1) = 593$$

- Step 4* $2x + 1 = 593$ *Combine like terms.*
 $2x = 592$ *Subtract 1.*
 $x = 296$ *Divide by 2.*

Step 5
The lesser page number is 296, and the greater page number is $296 + 1 = 297$.

Step 6
297 is one more than 296 and the sum of 296 and 297 is 593.

- 7.** Let $x =$ the lesser even integer.
Then $x + 2 =$ the greater even integer.

From the given information, we have

$$6 \cdot x + (x + 2) = 86.$$

Solve this equation.

$$\begin{aligned}7x + 2 &= 86 \\ 7x &= 84 \\ x &= 12\end{aligned}$$

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

- N7.** Let $x =$ the lesser odd integer.
Then $x + 2 =$ the greater odd integer.

From the given information, we have

$$2 \cdot x + 3(x + 2) = 191.$$

Solve this equation.

$$\begin{aligned} 2x + 3x + 6 &= 191 \\ 5x + 6 &= 191 \\ 5x &= 185 \\ x &= 37 \end{aligned}$$

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

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

The complement	is	eight times the angle.
↓	↓	↓
$90 - x$	$=$	$8x$

Solve this equation.

$$\begin{aligned} 90 - x &= 8x \\ 90 &= 9x \\ 10 &= x \end{aligned}$$

The measure of the angle is 10° .

- N8. Let $x =$ the degree measure of the angle. Then $90 - x =$ the degree measure of its complement.

The complement	is	twice the angle.
↓	↓	↓
$90 - x$	$=$	$2x$

Solve this equation.

$$\begin{aligned} 90 - x &= 2x \\ 90 &= 3x \\ 30 &= x \end{aligned}$$

The measure of the angle is 30° .

9. *Step 2*
Let $x =$ the degree measure of the angle. Then $90 - x =$ the degree measure of its complement, and $180 - x =$ the degree measure of its supplement.

Step 3

complement	plus	supplement	equals	174
↓	↓	↓	↓	↓
$90 - x$	$+$	$180 - x$	$=$	174

Step 4

$$\begin{aligned} 270 - 2x &= 174 \\ -2x &= -96 && \text{Subtract 270.} \\ x &= 48 && \text{Divide by } -2. \end{aligned}$$

Step 5
The measure of the angle is 48° .

Step 6
The complement of 48° is $90^\circ - 48^\circ = 42^\circ$ and the supplement is $180^\circ - 48^\circ = 132^\circ$. The sum of 42° and 132° is 174° .

- N9. *Step 2*
Let $x =$ the degree measure of the angle. Then $90 - x =$ the degree measure of its complement, and $180 - x =$ the degree measure of its supplement.

Step 3

supplement	equals	46° less than 3 times its complement
↓	↓	↓
$180 - x$	$=$	$3(90 - x) - 46$

Step 4

$$\begin{aligned} 180 - x &= 3(90 - x) - 46 \\ 180 - x &= 270 - 3x - 46 && \text{Dist. property} \\ 180 - x &= 224 - 3x && \text{Combine terms.} \\ 180 + 2x &= 224 && \text{Add 3x.} \\ 2x &= 44 && \text{Subtract 180.} \\ x &= 22 && \text{Divide by 2.} \end{aligned}$$

Step 5
The measure of the angle is 22° .

Step 6
The complement of 22° is $90^\circ - 22^\circ = 68^\circ$ and 46° less than 3 times 68° is $3(68^\circ) - 46^\circ = 204^\circ - 46^\circ = 158^\circ$. The supplement is $180^\circ - 22^\circ = 158^\circ$.

2.4 Section Exercises

- Choice **D**, $6\frac{1}{2}$, is *not* a reasonable answer in an applied problem that requires finding the number of cars on a dealer's lot, since you cannot have $\frac{1}{2}$ of a car. The number of cars must be a whole number.
- Choice **D**, 25, is *not* a reasonable answer since finding the number of hours a light bulb is on during a day cannot be more than 24.
- Choice **A**, -10, is *not* a reasonable answer since distance cannot be negative.
- Choice **C**, -5, is *not* a reasonable answer since time cannot be negative.

The applied problems in this section should be solved by using the six-step method shown in the text. These steps will only be listed in a few of the solutions, but all of the solutions are based on this method.

5. *Step 2*
Let $x =$ the number.

Step 3

The product of 8, and a number increased by 6, is 104.

$$\begin{array}{ccccccc} & & & & \text{is} & & 104. \\ & & & & \downarrow & & \downarrow \\ & & & & 8 & \cdot & (x + 6) & = & 104 \end{array}$$

Step 4

Solve this equation.

$$\begin{aligned} 8(x + 6) &= 104 \\ 8x + 48 &= 104 \\ 8x &= 56 \\ x &= 7 \end{aligned}$$

Step 5

The number is 7.

Step 6

7 increased by 6 is 13. The product of 8 and 13 is 104, so 7 is the number.

6. *Step 2*

Let $x =$ the number.

Step 3

The product of 5, and 3 more than twice a number, is 85.

$$\begin{array}{ccccccc} & & & & \text{is} & & 85. \\ & & & & \downarrow & & \downarrow \\ & & & & 5 & \cdot & (2x + 3) & = & 85 \end{array}$$

Step 4

Solve this equation.

$$\begin{aligned} 10x + 15 &= 85 \\ 10x &= 70 \\ x &= 7 \end{aligned}$$

Step 5

The number is 7.

Step 6

If the number is 7, then twice the number is 14, and 3 more than twice the number is 17. The product of 5 and 17 is 85, so 7 is the number.

7. *Step 2*

Let $x =$ the unknown number. Then $5x + 2$ represents "2 is added to five times a number," and $4x + 5$ represents "5 more than four times the number."

Step 3 $5x + 2 = 4x + 5$

Step 4 $5x + 2 = 4x + 5$

$$\begin{aligned} x + 2 &= 5 \\ x &= 3 \end{aligned}$$

Step 5

The number is 3.

Step 6

Check that 3 is the correct answer by substituting this result into the words of the original problem. 2 added to five times a number is $2 + 5(3) = 17$

and 5 more than four times the number is $5 + 4(3) = 17$. The values are equal, so the number 3 is the correct answer.

8. *Step 2*

Let $x =$ the unknown number. Then $8 + 4x$ represents "four times a number added to 8," and $5 + 3x$ represents "three times the number, added to 5."

Step 3 $8 + 4x = 5 + 3x$

Step 4 $8 + 4x = 5 + 3x$

$$\begin{aligned} 8 + x &= 5 \\ x &= -3 \end{aligned}$$

Step 5

The number is -3 .

Step 6

Check that -3 is the correct answer by substituting this result into the words of the original problem. Four times a number is added to 8 is $8 + 4(-3) = -4$ and three times the number added to 5 is $5 + 3(-3) = -4$. The values are equal, so the number -3 is the correct answer.

9. *Step 2*

Let $x =$ the unknown number. Then $x - 2$ is two subtracted from the number, $3(x - 2)$ is triple the difference, and $x + 6$ is six more than the number.

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

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

$$\begin{aligned} 2x - 6 &= 6 \\ 2x &= 12 \\ x &= 6 \end{aligned}$$

Step 5

The number is 6.

Step 6

Check that 6 is the correct answer by substituting this result into the words of the original problem. Two subtracted from the number is $6 - 2 = 4$. Triple this difference is $3(4) = 12$, which is equal to 6 more than the number, since $6 + 6 = 12$.

10. *Step 2*

Let $x =$ the unknown number. Then $x + 3$ is 3 is added to a number, $2(x + 3)$ is this sum is doubled, and $x + 2$ is 2 more than the number.

Step 3 $2(x + 3) = x + 2$

Step 4 $2x + 6 = x + 2$

$$\begin{aligned} x + 6 &= 2 \\ x &= -4 \end{aligned}$$

Step 5

The number is -4 .

Step 6

Check that -4 is the correct answer by substituting this result into the words of the original problem. Three added to the number is -1 , double this value is -2 . Two more than -4 is also -2 , so the number is -4 .

11. Step 2

Let x = the unknown number. Then $3x$ is three times the number, $x + 7$ is 7 more than the number, $2x$ is twice the number, and $-11 - 2x$ is the difference between -11 and twice the number.

Step 3 $3x + (x + 7) = -11 - 2x$

Step 4 $4x + 7 = -11 - 2x$
 $6x + 7 = -11$
 $6x = -18$
 $x = -3$

Step 5

The number is -3 .

Step 6

Check that -3 is the correct answer by substituting this result into the words of the original problem. The sum of three times a number and 7 more than the number is $3(-3) + (-3 + 7) = -5$ and the difference between -11 and twice the number is $-11 - 2(-3) = -5$. The values are equal, so the number -3 is the correct answer.

12. Step 2

Let x = the unknown number. Then $2x + 4$ is 4 is added to twice the number, $2(2x + 4)$ is the sum multiplied by 2, and $3x + 4$ is the number is multiplied by 3 and 4 is added to the product.

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

Step 4 $4x + 8 = 3x + 4$
 $x + 8 = 4$
 $x = -4$

Step 5

The number is -4 .

Step 6

Check that -4 is the correct answer by substituting this result into the words of the original problem.

Twice the number is $2(-4) = -8$. Four added to twice the number is $-8 + 4 = -4$. This sum multiplied by 2 is $2(-4) = -8$. The number multiplied by 3 is $3(-4) = -12$. Four added to this product is $-12 + 4 = -8$. Because both results are -8 , the answer, -4 , checks.

13. Let x = the number of drive-in movie screens in Ohio.

Then $x + 2$ = the number of drive-in movie screens in Pennsylvania.

Since the total number of screens was 68, we can write the equation

$$x + (x + 2) = 68.$$

Solve this equation.

$$2x + 2 = 68$$

$$2x = 66$$

$$x = 33$$

Since $x = 33$, $x + 2 = 35$.

There were 33 drive-in movie screens in Ohio and 35 in Pennsylvania. Since 35 is 2 more than 33 and $33 + 35 = 68$, this answer checks.

14. Let x = the number of *Cheers* viewers.

Then $x + 8$ = the number of *M*A*S*H* viewers.

Since the total number of viewers is 92 (all numbers in millions), we can write the equation

$$x + (x + 8) = 92.$$

Solve this equation.

$$2x + 8 = 92$$

$$2x = 84$$

$$x = 42$$

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

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

15. Let x = the number of Republicans.

Then $x + 18$ = the number of Democrats.

The number of Republicans	plus	the number of Democrats
↓		↓
x	+	$(x + 18)$

equals

the total number of
Republican and Democrat
members in the Senate.

↓	↓
=	98

Solve the equation.

$$x + (x + 18) = 98$$

$$2x + 18 = 98$$

$$2x = 80$$

$$x = 40$$

There were 40 Republicans and $40 + 18 = 58$ Democrats.

- 16.** Let x = the number of Republicans.
Then $x + 78$ = the number of Democrats.
Since the total number of Democrats and Republicans was 434, we can write the equation
- $$x + (x + 78) = 434.$$
- Solve this equation.
- $$\begin{aligned} 2x + 78 &= 434 \\ 2x &= 356 \\ x &= 178 \end{aligned}$$
- Since $x = 178$, $x + 78 = 256$.
There were 256 Democrats and 178 Republicans.
Since $256 + 178 = 434$, this answer checks.
- 17.** Let x = revenue from ticket sales for Bon Jovi.
Then $x - 6.1$ = revenue from ticket sales for Bruce Springsteen.
Since the total revenue from ticket sales was \$415.3 (all numbers in millions), we can write the equation
- $$x + (x - 6.1) = 415.3.$$
- Solve this equation.
- $$\begin{aligned} 2x - 6.1 &= 415.3 \\ 2x &= 421.4 \\ x &= 210.7 \end{aligned}$$
- Since $x = 210.7$, $x - 6.1 = 204.6$.
Bon Jovi took in \$210.7 million and Bruce Springsteen took in \$204.6 million. Since 204.6 is 6.1 less than 210.7 and $210.7 + 204.6 = 415.3$, this answer checks.
- 18.** Let x = the number of Toyota Camry sales.
Then $x - 81$ = the number of Honda Accord sales.
Since the total number of sales was 865 (all numbers in thousands), we can write the equation
- $$x + (x - 81) = 865.$$
- Solve this equation.
- $$\begin{aligned} 2x - 81 &= 865 \\ 2x &= 946 \\ x &= 473 \end{aligned}$$
- Since $x = 473$, $x - 81 = 392$.
There were 473 thousand Toyota Camry sales and 392 thousand Honda Accord sales. Since 392 is 81 less than 473 and $473 + 392 = 865$, this answer checks.
- 19.** Let x = the number of games the Celtics lost.
Then $3x + 2$ = the number of games the Celtics won.
Since the total number of games played was 82, we can write the equation
- $$x + (3x + 2) = 82.$$
- Solve this equation.
- $$\begin{aligned} 4x + 2 &= 82 \\ 4x &= 80 \\ x &= 20 \end{aligned}$$
- Since $x = 20$, $3x + 2 = 62$.
The Celtics won 62 games and lost 20 games.
Since $62 + 20 = 82$, this answer checks.
- 20.** Let x = the number of games the Rays lost.
Then $2x - 33$ = the number of games the Rays won.
Since the total number of games played was 162, we can write the equation
- $$x + (2x - 33) = 162.$$
- Solve this equation.
- $$\begin{aligned} 3x - 33 &= 162 \\ 3x &= 195 \\ x &= 65 \end{aligned}$$
- Since $x = 65$, $2x - 33 = 97$.
The Rays won 97 games and lost 65 games. Since $97 + 65 = 162$, this answer checks.
- 21.** Let x = the number of mg of vitamin C in a one-cup serving of pineapple juice.
Then $4x - 3$ = the number of mg of vitamin C in a one-cup serving of orange juice.
Since the total amount of vitamin C in a serving of the two juices is 122 mg, we can write
- $$x + (4x - 3) = 122.$$
- Solve this equation.
- $$\begin{aligned} 5x - 3 &= 122 \\ 5x &= 125 \\ x &= 25 \end{aligned}$$
- Since $x = 25$, $4x - 3 = 97$.
A one-cup serving of pineapple juice has 25 mg of vitamin C and a one-cup serving of orange juice has 97 mg of vitamin C. Since 97 is 3 less than four times 25 and $25 + 97 = 122$, this answer checks.

22. Let $x =$ the number of calories in a one-cup serving of tomato juice.
Then $3x + 9 =$ the number of calories in a one-cup serving of pineapple juice.

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

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

Solve this equation.

$$\begin{aligned} 4x + 9 &= 173 \\ 4x &= 164 \\ x &= 41 \end{aligned}$$

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

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

23. Let $x =$ the number of CDs sold.
Then $\frac{8}{5}x =$ the number of DVDs sold.

The total number of CDs and DVDs sold was 273, so

$$x + \frac{8}{5}x = 273.$$

Solve this equation.

$$\begin{aligned} 1x + \frac{8}{5}x &= 273 \\ \frac{13}{5}x &= 273 \\ \frac{5}{13} \left(\frac{13}{5}x \right) &= \frac{5}{13}(273) \\ x &= \frac{5}{\cancel{13}} \cdot \frac{273}{1} = 105 \end{aligned}$$

Since $x = 105$, $\frac{8}{5}x = \frac{8}{5}(105) = 168$.

There were 168 DVDs sold.

24. Let $x =$ the number of calories burned doing weight training.

Then $\frac{12}{5}x =$ the number of calories burned doing aerobics.

The total number of calories burned was 374, so

$$\begin{aligned} x + \frac{12}{5}x &= 374 \\ 1x + \frac{12}{5}x &= 374 \\ \frac{17}{5}x &= 374 \\ \frac{5}{17} \left(\frac{17}{5}x \right) &= \frac{5}{17}(374) \\ x &= \frac{5}{\cancel{17}} \cdot \frac{374}{1} = 110 \end{aligned}$$

Since $x = 110$, $\frac{12}{5}x = \frac{12}{5}(110) = 264$.

Weight training burns 110 calories and aerobics burns 264 calories.

25. Let $x =$ the number of kg of onions.
Then $6.6x =$ the number of kg of grilled steak.
The total weight of these two ingredients was 617.6 kg, so

$$x + 6.6x = 617.6.$$

Solve this equation.

$$\begin{aligned} 1x + 6.6x &= 617.6 \\ 7.6x &= 617.6 \\ x &= \frac{617.6}{7.6} \approx 81.3 \end{aligned}$$

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

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

26. Let $x =$ the population of China.
Then $0.8x = \frac{4}{5}x =$ the population of India.
The combined population of the two countries was 2.4 billion, so

$$x + \frac{4}{5}x = 2.4.$$

Solve this equation.

$$\begin{aligned} 1x + \frac{4}{5}x &= 2.4 \\ \frac{9}{5}x &= 2.4 \\ \frac{5}{9} \left(\frac{9}{5}x \right) &= \frac{5}{9} \left(\frac{24}{10} \right) \\ x &= \frac{4}{3} \quad [\approx 1.3] \end{aligned}$$

Since $x = \frac{4}{3}$, $\frac{4}{5}x = \frac{4}{5} \left(\frac{4}{3} \right) = \frac{16}{15} \quad [\approx 1.1]$.

To the nearest tenth of a billion, the population of China was 1.3 billion and the population of India was 1.1 billion.

27. Let $x =$ the value of the 1945 nickel.
Then $2x =$ the value of the 1950 nickel.
The total value of the two coins is \$24.00, so

$$x + 2x = 24.$$

Solve this equation.

$$\begin{aligned} 3x &= 24 \\ x &= 8 \quad \text{Divide by 3.} \end{aligned}$$

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

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

28. Let $x =$ the number of pounds of nickel.
Then $3x =$ the number of pounds of copper.

The total number of pounds would be 560, so

$$x + 3x = 560.$$

Solve this equation.

$$\begin{aligned} 4x &= 560 \\ x &= \frac{560}{4} = 140 \end{aligned}$$

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

29. Let x = the number of ounces of rye flour.
Then $4x$ = the number of ounces of whole wheat flour.

The total number of ounces would be 32, so

$$x + 4x = 32.$$

Solve this equation.

$$\begin{aligned} 5x &= 32 \\ x &= \frac{32}{5} = 6.4 \end{aligned}$$

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

30. Let x = the number of milligrams of inert ingredients.
Then $9x$ = the number of milligrams of active ingredients.

The total number of milligrams would be 250, so

$$x + 9x = 250.$$

Solve this equation.

$$\begin{aligned} 10x &= 250 \\ x &= \frac{250}{10} = 25 \end{aligned}$$

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

31. Let x = the number of tickets booked on United Airlines.
Then $x + 7$ = the number of tickets booked on American Airlines, and
 $2x + 4$ = the number of tickets booked on Southwest Airlines.

The total number of tickets booked was 55, so

$$x + (x + 7) + (2x + 4) = 55.$$

Solve this equation.

$$\begin{aligned} 4x + 11 &= 55 \\ 4x &= 44 \\ x &= \frac{44}{4} = 11 \end{aligned}$$

Since $x = 11$, $x + 7 = 11 + 7 = 18$, and $2x + 4 = 2(11) + 4 = 26$. He booked 18 tickets on American, 11 tickets on United, and 26 tickets on Southwest.

32. Let x = the number of hours making telephone calls.
Then $x + 0.5$ = the number of hours writing e-mails, and
 $2x$ = the number of hours attending meetings.

The total number of hours is 7.5, so

$$x + (x + 0.5) + 2x = 7.5.$$

Solve this equation.

$$\begin{aligned} 4x + 0.5 &= 7.5 \\ 4x &= 7 \\ x &= \frac{7}{4} = 1.75 \end{aligned}$$

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

33. Let x = the length of the shortest piece.
Then $x + 5$ = the length of the middle piece, and
 $x + 9$ = the length of the longest piece.

The total length is 59 inches, so

$$x + (x + 5) + (x + 9) = 59.$$

Solve this equation.

$$\begin{aligned} 3x + 14 &= 59 \\ 3x &= 45 \\ x &= 15 \end{aligned}$$

Since $x = 15$, $x + 5 = 20$, and $x + 9 = 24$.

The shortest piece should be 15 inches, the middle piece should be 20 inches, and the longest piece should be 24 inches. The answer checks since

$$15 + 20 + 24 = 59.$$

34. Let x = the number of silver medals.
Then $x + 7$ = the number of bronze medals, and
 $(x + 7) + 23$ = the number of gold medals.
The total number of medals earned by China was 100, so

$$x + (x + 7) + (x + 30) = 100.$$

Solve this equation.

$$\begin{aligned} 3x + 37 &= 100 \\ 3x &= 63 \\ x &= 21 \end{aligned}$$

Since $x = 21$, $x + 7 = 28$, and $x + 30 = 51$.

China earned 51 gold medals, 21 silver medals, and 28 bronze medals. The answer checks since

$$51 + 21 + 28 = 100.$$

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

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

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

Solve this equation.

$$\begin{aligned}3x + 88.2 &= 196.2 \\3x &= 108 \\x &= 36\end{aligned}$$

Mercury is 36 million miles from the sun, Venus is $36 + 31.2 = 67.2$ million miles from the sun, and Earth is $36 + 57 = 93$ million miles from the sun. The answer checks since

$$36 + 67.2 + 93 = 196.2.$$

- 36.** Let x = the number of satellites of Saturn.
Then $x + 16$ = the number of satellites of Jupiter,
and $x - 20$ = the number of satellites of Uranus.

Since the total number of satellites is 137,

$$x + (x + 16) + (x - 20) = 137.$$

Solve this equation.

$$\begin{aligned}3x - 4 &= 137 \\3x &= 141 \\x &= \frac{141}{3} = 47\end{aligned}$$

Since $x = 47$, $x + 16 = 63$, and $x - 20 = 27$.

Uranus has 27 known satellites.

- 37.** Let x = the measure of angles A and B .
Then $x + 60$ = the measure of angle C .

The sum of the measures of the angles of any triangle is 180° , so

$$x + x + (x + 60) = 180.$$

Solve this equation.

$$\begin{aligned}3x + 60 &= 180 \\3x &= 120 \\x &= 40\end{aligned}$$

Angles A and B have measures of 40 degrees, and angle C has a measure of $40 + 60 = 100$ degrees.

The answer checks since

$$40 + 40 + 100 = 180.$$

- 38.** Let x = the measure of angles B and C .
Then $x + 141$ = the measure of angle A .

The sum of the measures of the angles of any triangle is 180° , so

$$(x + 141) + x + x = 180.$$

Solve this equation.

$$\begin{aligned}3x + 141 &= 180 \\3x &= 39 \\x &= 13\end{aligned}$$

Since $x = 13$, $x + 141 = 154$.

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

$$154 + 13 + 13 = 180.$$

- 39.** Let x = the number on the first locker.
Then $x + 1$ = the number on the next locker.

Since the numbers have a sum of 137, we can write the equation

$$x + (x + 1) = 137.$$

Solve the equation.

$$\begin{aligned}2x + 1 &= 137 \\2x &= 136 \\x &= \frac{136}{2} = 68\end{aligned}$$

Since $x = 68$, $x + 1 = 69$.

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

- 40.** Let x = the number on the first check.
Then $x + 1$ = the number on the second check.

Since the sum of the numbers is 357, we can write the equation

$$x + (x + 1) = 357.$$

Solve this equation.

$$\begin{aligned}2x + 1 &= 357 \\2x &= 356 \\x &= \frac{356}{2} = 178\end{aligned}$$

Since $x = 178$, $x + 1 = 179$.

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

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

Let x = the lesser page number.

Then $x + 1$ = the greater page number.

$$\begin{aligned}x + (x + 1) &= 203 \\2x + 1 &= 203 \\2x &= 202 \\x &= 101\end{aligned}$$

Since $x = 101$, $x + 1 = 102$.

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

- 42.** Let x = the first apartment number.
Then $x + 1$ = the second apartment number.

Since the sum of the numbers is 59, we have

$$x + (x + 1) = 59.$$

Solve the equation.

$$\begin{aligned}2x + 1 &= 59 \\2x &= 58 \\x &= 29\end{aligned}$$

Since $x = 29$, $x + 1 = 30$.

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

43. Let x = the lesser even integer.
Then $x + 2$ = the greater even integer.

The lesser added to three times the greater gives a sum of 46 can be written as

$$\begin{aligned}x + 3(x + 2) &= 46. \\x + 3x + 6 &= 46 \\4x + 6 &= 46 \\4x &= 40 \\x &= 10\end{aligned}$$

Since $x = 10$, $x + 2 = 12$.

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

44. Let x = the lesser odd integer.
Then $x + 2$ = the greater odd integer.

Twice the greater is 17 more than the lesser can be written as

$$\begin{aligned}2(x + 2) &= x + 17. \\2x + 4 &= x + 17 \\x + 4 &= 17 \\x &= 13\end{aligned}$$

Since $x = 13$, $x + 2 = 15$.

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

45. Let x = the lesser integer.
Then $x + 1$ = the greater integer.

$$\begin{aligned}x + 3(x + 1) &= 43 \\x + 3x + 3 &= 43 \\4x + 3 &= 43 \\4x &= 40 \\x &= 10\end{aligned}$$

Since $x = 10$, $x + 1 = 11$.

The integers are 10 and 11. This answer checks since $10 + 3(11) = 43$.

46. Let x = the lesser integer.
Then $x + 1$ = the greater integer.

$$\begin{aligned}5x + 3(x + 1) &= 59 \\5x + 3x + 3 &= 59 \\8x + 3 &= 59 \\8x &= 56 \\x &= 7\end{aligned}$$

Since $x = 7$, $x + 1 = 8$.

The integers are 7 and 8. This answer checks since $5(7) + 3(8) = 35 + 24 = 59$.

47. Let x = the first even integer.
Then $x + 2$ = the second even integer, and
 $x + 4$ = the third even integer.

$$\begin{aligned}x + (x + 2) + (x + 4) &= 60 \\3x + 6 &= 60 \\3x &= 54 \\x &= 18\end{aligned}$$

Since $x = 18$, $x + 2 = 20$, and $x + 4 = 22$.

The first even integer is 18. This answer checks since $18 + 20 + 22 = 60$.

48. Let x = the first odd integer.
Then $x + 2$ = the second odd integer, and
 $x + 4$ = the third odd integer.

$$\begin{aligned}x + (x + 2) + (x + 4) &= 69 \\3x + 6 &= 69 \\3x &= 63 \\x &= 21\end{aligned}$$

Since $x = 21$, $x + 2 = 23$, and $x + 4 = 25$.

The third odd integer is 25. This answer checks since $21 + 23 + 25 = 69$.

49. Let x = the first odd integer.
Then $x + 2$ = the second odd integer, and
 $x + 4$ = the third odd integer.

$$\begin{aligned}2[(x + 4) - 6] &= [x + 2(x + 2)] - 23 \\2(x - 2) &= x + 2x + 4 - 23 \\2x - 4 &= 3x - 19 \\-4 &= x - 19 \\15 &= x\end{aligned}$$

Since $x = 15$, $x + 2 = 17$, and $x + 4 = 19$.

The integers are 15, 17, and 19.

50. Let x = the first even integer.
Then $x + 2$ = the second even integer, and
 $x + 4$ = the third even integer.

$$\begin{aligned}x + (x + 4) &= 3(x + 2) - 22 \\x + x + 4 &= 3x + 6 - 22 \\2x + 4 &= 3x - 16 \\-x + 4 &= -16 \\-x &= -20 \\x &= 20\end{aligned}$$

Since $x = 20$, $x + 2 = 22$, and $x + 4 = 24$.

The integers are 20, 22, and 24.

51. Let x = the measure of the angle.
Then $90 - x$ = the measure of its complement.
The "complement is four times its measure" can be written as

$$90 - x = 4x.$$

Solve this equation.

$$90 = 5x$$

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

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

52. Let x = the measure of the angle.
Then $90 - x$ = the measure of its complement.
The "complement is five times its measure" can be written as

$$90 - x = 5x.$$

Solve this equation.

$$90 = 6x$$

$$x = \frac{90}{6} = 15$$

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

53. Let x = the measure of the angle.
Then $180 - x$ = the measure of its supplement.
The "supplement is eight times its measure" can be written as

$$180 - x = 8x.$$

Solve this equation.

$$180 = 9x$$

$$x = \frac{180}{9} = 20$$

The measure of the angle is 20° . The supplement is $180^\circ - 20^\circ = 160^\circ$, which is eight times 20° .

54. Let x = the measure of the angle.
Then $180 - x$ = the measure of its supplement.
The "supplement is three times its measure" can be written as

$$180 - x = 3x.$$

Solve this equation.

$$180 = 4x$$

$$x = \frac{180}{4} = 45$$

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

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

Its supplement	measures	39°
\downarrow	\downarrow	\downarrow
$180 - x$	$=$	39
more than		twice its complement.
\downarrow		\downarrow
$+$		$2(90 - x)$

Solve the equation.

$$180 - x = 39 + 2(90 - x)$$

$$180 - x = 39 + 180 - 2x$$

$$180 - x = 219 - 2x$$

$$x + 180 = 219$$

$$x = 39$$

The measure of the angle is 39° . The complement is $90^\circ - 39^\circ = 51^\circ$. Now 39° more than twice its complement is $39^\circ + 2(51^\circ) = 141^\circ$, which is the supplement of 39° since $180^\circ - 39^\circ = 141^\circ$.

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

Angle's supplement is	three times	angle's complement	less 38°
\downarrow \downarrow	\downarrow	\downarrow	\downarrow
$180 - x =$	3	$\cdot (90 - x)$	$- 38$
			$180 - x = 270 - 3x - 38$
			$180 - x = 232 - 3x$
			$180 + 2x = 232$
			$2x = 52$
			$x = 26$

The measure of the angle is 26° .

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

	The difference	
between the measure of its supplement and	\downarrow	three times the measure of its complement
\downarrow	\downarrow	\downarrow
$(180 - x)$	$-$	$3(90 - x)$
	is	10° .
	\downarrow	\downarrow
	$=$	10

Solve the equation.

$$\begin{aligned}(180 - x) - 3(90 - x) &= 10 \\ 180 - x - 270 + 3x &= 10 \\ 2x - 90 &= 10 \\ 2x &= 100 \\ x &= 50\end{aligned}$$

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

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

The sum of the measures of its complement and supplement is 160° can be written as

$$(90 - x) + (180 - x) = 160.$$

Solve the equation.

$$\begin{aligned}-2x + 270 &= 160 \\ -2x &= -110 \\ x &= 55\end{aligned}$$

The measure of the angle is 55° . The sum of the measures of its complement ($90^\circ - 55^\circ = 35^\circ$) and its supplement ($180^\circ - 55^\circ = 125^\circ$) is 160° ($35^\circ + 125^\circ = 160^\circ$).

59. $L = 6$ and $W = 4$, so $LW = 6 \cdot 4 = 24$.
 60. $r = 25$ and $t = 4.5$, so $rt = 25(4.5) = 112.5$.
 61. $L = 8$ and $W = 2$, so
 $2L + 2W = 2(8) + 2(2) = 16 + 4 = 20$.
 62. $h = 10$, $b = 4$, and $B = 12$,
 so $\frac{1}{2}h(b + B) = \frac{1}{2}(10)(4 + 12) = 5(16) = 80$.

2.5 Formulas and Additional Applications from Geometry

2.5 Classroom Examples, Now Try Exercises

1. $P = 2L + 2W$
 $126 = 2L + 2(25)$ Let $P = 126$ and $W = 25$.
 $126 = 2L + 50$
 $76 = 2L$ Subtract 50.
 $38 = L$ Divide by 2.

- N1. $P = 2a + 2b$
 $78 = 2(12) + 2b$ Let $P = 78$ and $a = 12$.
 $78 = 24 + 2b$
 $54 = 2b$ Subtract 24.
 $27 = b$ Divide by 2.

2. The fence will enclose the perimeter of the rectangular field, so use the formula for the perimeter of a rectangle. Find the length of the field by substituting $P = 800$ and $W = L - 50$ into the formula and solving for L .

$$\begin{aligned}P &= 2L + 2W \\ 800 &= 2L + 2(L - 50) \\ 800 &= 2L + 2L - 100 \\ 900 &= 4L \\ 225 &= L\end{aligned}$$

Since $L = 225$, $W = 225 - 50 = 175$. The dimensions of the field are 225 m by 175 m.

- N2. The fence will enclose the perimeter of the rectangular garden, so use the formula for the perimeter of a rectangle. Find the width of the garden by substituting $P = 160$ and $L = 2W - 10$ into the formula and solving for W .

$$\begin{aligned}P &= 2L + 2W \\ 160 &= 2(2W - 10) + 2W \\ 160 &= 4W - 20 + 2W \\ 180 &= 6W \\ 30 &= W\end{aligned}$$

Since $W = 30$, $L = 2(30) - 10 = 50$. The dimensions of the garden are 50 ft by 30 ft.

3. Let s = the length of the shortest side, in inches;
 $s + 5$ = the length of the medium side, and,
 $(s + 5) + 1 = s + 6$ = the length of the longest side.

The perimeter is 32 inches, so

$$\begin{aligned}s + (s + 5) + (s + 6) &= 32. \\ 3s + 11 &= 32 \\ 3s &= 21 \\ s &= 7\end{aligned}$$

Since $s = 7$, $s + 5 = 12$, and $s + 6 = 13$. The lengths of the sides are 7, 12, and 13 inches. The perimeter is $7 + 12 + 13 = 32$, as required.

- N3. Let s = the length of the medium side, in feet;
 $s + 1$ = the length of the longest side, and,
 $s - 7$ = the length of the shortest side.

The perimeter is 30 feet, so

$$\begin{aligned}s + (s + 1) + (s - 7) &= 30. \\ 3s - 6 &= 30 \\ 3s &= 36 \\ s &= 12\end{aligned}$$

Since $s = 12$, $s + 1 = 13$, and $s - 7 = 5$. The lengths of the sides are 5, 12, and 13 feet. The perimeter is $5 + 12 + 13 = 30$, as required.

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

$$\begin{aligned}A &= \frac{1}{2}bh \\ 120 &= \frac{1}{2}b(24) \text{ Let } A = 120, h = 24. \\ 120 &= 12b \\ 10 &= b\end{aligned}$$

The length of the base is 10 meters.

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

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

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

$$77 = 7h$$

$$11 = h$$

The length of the height is 11 centimeters.

5. The sum of the measures of the two angles is 180° because together they form a straight angle.

$$(6x + 29) + (x + 11) = 180$$

$$7x + 40 = 180$$

$$7x = 140$$

$$x = 20$$

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

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

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

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

$$2 = 2x - 8$$

$$10 = 2x$$

$$5 = x$$

If $x = 5$, $6x + 2 = 6(5) + 2 = 32$
and $8x - 8 = 8(5) - 8 = 32$.

The measure of the angles is 32° .

6. Solve $I = prt$ for t .

$$\frac{I}{pr} = \frac{prt}{pr} \quad \text{Divide by } pr.$$

$$\frac{I}{pr} = t, \text{ or } t = \frac{I}{pr}$$

N6. Solve $W = Fd$ for F .

$$\frac{W}{d} = \frac{Fd}{d} \quad \text{Divide by } d.$$

$$\frac{W}{d} = F, \text{ or } F = \frac{W}{d}$$

7. Solve $S = 2\pi rh + 2\pi r^2$ for h .

$$S - 2\pi r^2 = 2\pi rh \quad \text{Subtract } 2\pi r^2.$$

$$\frac{S - 2\pi r^2}{2\pi r} = h, \quad \text{Divide by } 2\pi r.$$

$$\text{or } h = \frac{S - 2\pi r^2}{2\pi r}$$

N7. Solve $Ax + By = C$ for A .

$$Ax = C - By \quad \text{Subtract } By.$$

$$\frac{Ax}{x} = \frac{C - By}{x} \quad \text{Divide by } x.$$

$$A = \frac{C - By}{x}$$

8. Solve $A = p + prt$ for t .

$$A - p = p + prt - p \quad \text{Subtract } p.$$

$$A - p = prt$$

$$\frac{A - p}{pr} = \frac{prt}{pr} \quad \text{Divide by } pr.$$

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

N8. Solve $x = u + zs$ for z .

$$x - u = u + zs - u \quad \text{Subtract } u.$$

$$x - u = zs$$

$$\frac{x - u}{s} = \frac{zs}{s} \quad \text{Divide by } s.$$

$$\frac{x - u}{s} = z, \text{ or } z = \frac{x - u}{s}$$

9. Solve $A = \frac{1}{2}h(b + B)$ for h .

$$2A = h(b + B) \quad \text{Multiply by } 2.$$

$$\frac{2A}{b + B} = h \quad \text{Divide by } b + B.$$

N9. Solve $S = \frac{1}{2}(a + b + c)$ for a .

$$2S = a + b + c \quad \text{Multiply by } 2.$$

$$2S - b - c = a \quad \text{Subtract } b \text{ and } c.$$

2.5 Section Exercises

- (a) The perimeter of a plane geometric figure is the distance around the figure. It can be found by adding up the lengths of all the sides. Perimeter is a one-dimensional (linear) measurement, so it is given in linear units (inches, centimeters, feet, etc.).

(b) The area of a plane geometric figure is the measure of the surface covered or enclosed by the figure. Area is a two-dimensional measurement, so it is given in square units (square centimeters, square feet, etc.).
- (a) *Area* is given in square feet.

(b) *Perimeter* is given in linear yards.

(c) *Volume* is given in cubic meters.
- (a) The measure of a straight angle is 180° .

(b) Vertical angles have the same measures.
- You would need to be given 4 values in a formula with 5 variables to find the value of any one variable.
- Carpeting for a bedroom covers the surface of the bedroom floor, so *area* would be used.
- Sod for a lawn covers the surface of the lawn, so *area* would be used.

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

In Exercises 13–32, substitute the given values into the formula and then solve for the remaining variable.

13. $P = 2L + 2W$; $L = 8$, $W = 5$
- $$\begin{aligned} P &= 2L + 2W \\ &= 2(8) + 2(5) \\ &= 16 + 10 \\ P &= 26 \end{aligned}$$
14. $P = 2L + 2W$; $L = 6$, $W = 4$
- $$\begin{aligned} P &= 2L + 2W \\ &= 2(6) + 2(4) \\ &= 12 + 8 \\ P &= 20 \end{aligned}$$
15. $A = \frac{1}{2}bh$; $b = 8$, $h = 16$
- $$\begin{aligned} A &= \frac{1}{2}bh \\ &= \frac{1}{2}(8)(16) \\ A &= 64 \end{aligned}$$
16. $A = \frac{1}{2}bh$; $b = 10$, $h = 14$
- $$\begin{aligned} A &= \frac{1}{2}bh \\ &= \frac{1}{2}(10)(14) \\ &= (5)(14) \\ A &= 70 \end{aligned}$$
17. $P = a + b + c$; $P = 12$, $a = 3$, $c = 5$
- $$\begin{aligned} P &= a + b + c \\ 12 &= 3 + b + 5 \\ 12 &= b + 8 \\ 4 &= b \end{aligned}$$
18. $P = a + b + c$; $P = 15$, $a = 3$, $b = 7$
- $$\begin{aligned} P &= a + b + c \\ 15 &= 3 + 7 + c \\ 15 &= 10 + c \\ 5 &= c \end{aligned}$$
19. $d = rt$; $d = 252$, $r = 45$
- $$\begin{aligned} d &= rt \\ 252 &= 45t \\ \frac{252}{45} &= \frac{45t}{45} \\ 5.6 &= t \end{aligned}$$
20. $d = rt$; $d = 100$, $t = 2.5$
- $$\begin{aligned} d &= rt \\ 100 &= r(2.5) \\ 100 &= 2.5r \\ \frac{100}{2.5} &= \frac{2.5r}{2.5} \\ 40 &= r \end{aligned}$$
21. $I = prt$; $p = 7500$, $r = 0.035$, $t = 6$
- $$\begin{aligned} I &= prt \\ &= (7500)(0.035)(6) \\ I &= 1575 \end{aligned}$$
22. $I = prt$; $p = 5000$, $r = 0.025$, $t = 7$
- $$\begin{aligned} I &= prt \\ &= (5000)(0.025)(7) \\ I &= 875 \end{aligned}$$
23. $A = \frac{1}{2}h(b + B)$; $A = 91$, $h = 7$, $b = 12$
- $$\begin{aligned} A &= \frac{1}{2}h(b + B) \\ 91 &= \frac{1}{2}(7)(12 + B) \\ 182 &= (7)(12 + B) \\ 12 + B &= \frac{1}{7}(182) \\ B &= 26 - 12 = 14 \end{aligned}$$
24. $A = \frac{1}{2}h(b + B)$; $A = 75$, $b = 19$, $B = 31$
- $$\begin{aligned} A &= \frac{1}{2}h(b + B) \\ 75 &= \frac{1}{2}h(19 + 31) \\ 150 &= h(50) \\ h &= \frac{150}{50} = 3 \end{aligned}$$
25. $C = 2\pi r$; $C = 16.328$, $\pi = 3.14$
- $$\begin{aligned} C &= 2\pi r \\ 16.328 &= 2(3.14)r \\ 16.328 &= 6.28r \\ 2.6 &= r \end{aligned}$$

26. $C = 2\pi r$; $C = 8.164$, $\pi = 3.14$

$$\begin{aligned} C &= 2\pi r \\ 8.164 &= 2(3.14)r \\ 8.164 &= 6.28r \\ 1.3 &= r \end{aligned}$$

27. $C = 2\pi r$; $C = 20\pi$

$$\begin{aligned} C &= 2\pi r \\ 20\pi &= 2\pi r \\ 10 &= r \quad \text{Divide by } 2\pi. \end{aligned}$$

28. $C = 2\pi r$; $C = 100\pi$

$$\begin{aligned} C &= 2\pi r \\ 100\pi &= 2\pi r \\ 50 &= r \quad \text{Divide by } 2\pi. \end{aligned}$$

29. $A = \pi r^2$; $r = 4$, $\pi = 3.14$

$$\begin{aligned} A &= \pi r^2 \\ &= 3.14(4)^2 \\ &= 3.14(16) \\ A &= 50.24 \end{aligned}$$

30. $A = \pi r^2$; $r = 12$, $\pi = 3.14$

$$\begin{aligned} A &= \pi r^2 \\ &= 3.14(12)^2 \\ &= 3.14(144) \\ A &= 452.16 \end{aligned}$$

31. $S = 2\pi rh$; $S = 120\pi$, $h = 10$

$$\begin{aligned} S &= 2\pi rh \\ 120\pi &= 2\pi r(10) \\ 120\pi &= 20\pi r \\ 6 &= r \quad \text{Divide by } 20\pi. \end{aligned}$$

32. $S = 2\pi rh$; $S = 720\pi$, $h = 30$

$$\begin{aligned} S &= 2\pi rh \\ 720\pi &= 2\pi r(30) \\ 720\pi &= 60\pi r \\ 12 &= r \quad \text{Divide by } 60\pi. \end{aligned}$$

In Exercises 33–38, substitute the given values into the formula and then evaluate V .

33. $V = LWH$; $L = 10$, $W = 5$, $H = 3$

$$\begin{aligned} V &= LWH \\ &= (10)(5)(3) \\ V &= 150 \end{aligned}$$

34. $V = LWH$; $L = 12$, $W = 8$, $H = 4$

$$\begin{aligned} V &= LWH \\ &= (12)(8)(4) \\ V &= 384 \end{aligned}$$

35. $V = \frac{1}{3}Bh$; $B = 12$, $h = 13$

$$\begin{aligned} V &= \frac{1}{3}Bh \\ &= \frac{1}{3}(12)(13) \\ V &= 52 \end{aligned}$$

36. $V = \frac{1}{3}Bh$; $B = 36$, $h = 4$

$$\begin{aligned} V &= \frac{1}{3}Bh \\ &= \frac{1}{3}(36)(4) \\ V &= 48 \end{aligned}$$

37. $V = \frac{4}{3}\pi r^3$; $r = 12$, $\pi = 3.14$

$$\begin{aligned} V &= \frac{4}{3}\pi r^3 \\ &= \frac{4}{3}(3.14)(12)^3 \\ &= \frac{4}{3}(3.14)(1728) \\ V &= 7234.56 \end{aligned}$$

38. $V = \frac{4}{3}\pi r^3$; $r = 6$, $\pi = 3.14$

$$\begin{aligned} V &= \frac{4}{3}\pi r^3 \\ &= \frac{4}{3}(3.14)(6)^3 \\ &= \frac{4}{3}(3.14)(216) \\ V &= 904.32 \end{aligned}$$

39. $P = 2L + 2W$

$$54 = 2(W + 9) + 2W \quad \text{Let } L = W + 9.$$

$$54 = 2W + 18 + 2W$$

$$54 = 4W + 18$$

$$36 = 4W$$

$$9 = W$$

The width is 9 inches and the length is $9 + 9 = 18$ inches.

40. $P = 2L + 2W$

$$62 = 2L + 2(L - 3) \quad \text{Let } W = L - 3.$$

$$62 = 2L + 2L - 6$$

$$62 = 4L - 6$$

$$68 = 4L$$

$$17 = L$$

The length is 17 feet and the width is $17 - 3 = 14$ feet.

41. $P = 2l + 2w$

$$36 = 2(3w + 2) + 2w \quad \text{Let } l = 3w + 2.$$

$$36 = 6w + 4 + 2w$$

$$36 = 8w + 4$$

$$32 = 8w$$

$$4 = w$$

The width is 4 meters and the length is $3(4) + 2 = 14$ meters.

$$\begin{aligned}
 42. \quad P &= 2l + 2w \\
 36 &= 2l + 2(2l - 18) \quad \text{Let } w = 2l - 18. \\
 36 &= 2l + 4l - 36 \\
 36 &= 6l - 36 \\
 72 &= 6l \\
 12 &= l
 \end{aligned}$$

The length is 12 yards and the width is $2(12) - 18 = 6$ yards.

43. Let s = the length of the shortest side, in inches;
 $s + 2$ = the length of the medium side, and,
 $s + 3$ = the length of the longest side.

The perimeter is 20 inches, so

$$\begin{aligned}
 s + (s + 2) + (s + 3) &= 20. \\
 3s + 5 &= 20 \\
 3s &= 15 \\
 s &= 5
 \end{aligned}$$

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

44. Let s = the length of the shortest side, in feet.
 $s + 4$ = the length of the medium side, and,
 $2s$ = the length of the longest side.

The perimeter is 28 feet, so

$$\begin{aligned}
 s + (s + 4) + (2s) &= 28. \\
 4s + 4 &= 28 \\
 4s &= 24 \\
 s &= 6
 \end{aligned}$$

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

45. Let s = the length of the two sides that have equal length, in meters; and $2s - 4$ = the length of the third side.

The perimeter is 24 meters, so

$$\begin{aligned}
 s + s + (2s - 4) &= 24. \\
 4s - 4 &= 24 \\
 4s &= 28 \\
 s &= 7
 \end{aligned}$$

Since $s = 7$, $2s - 4 = 10$. The lengths of the sides are 7, 7, and 10 meters. The perimeter is $7 + 7 + 10 = 24$, as required.

46. Let s = the length of the shortest side, in yards;
 $2s$ = the length of the medium side, and,
 $3s - 7$ = the length of the longest side.

The perimeter is 47 yards, so

$$\begin{aligned}
 s + 2s + (3s - 7) &= 47. \\
 6s - 7 &= 47 \\
 6s &= 54 \\
 s &= 9
 \end{aligned}$$

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

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

$$\begin{aligned}
 \mathcal{A} &= \pi r^2 \\
 &= \pi(221.5)^2 \\
 &\approx 154,133.6 \text{ ft}^2,
 \end{aligned}$$

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

48. The diameter of the circular dome is 630 feet, so its radius is $\frac{630}{2} = 315$ ft. Use the circumference of a circle formula.

$$\begin{aligned}
 C &= 2\pi r \\
 &= 2\pi(315) \\
 &\approx 1979.2 \text{ ft}
 \end{aligned}$$

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

49. The page is a rectangle with length 1.5 m and width 1.2 m, so use the formulas for the perimeter and area of a rectangle.

$$\begin{aligned}
 P &= 2L + 2W \\
 &= 2(1.5) + 2(1.2) \\
 &= 3 + 2.4 \\
 P &= 5.4 \text{ meters}
 \end{aligned}$$

$$\begin{aligned}
 \mathcal{A} &= LW \\
 &= (1.5)(1.2) \\
 \mathcal{A} &= 1.8 \text{ square meters}
 \end{aligned}$$

50. Since the sand painting is a square with side 12.24 m, use the formulas for the perimeter and area of a square.

$$\begin{aligned}
 P &= 4s \\
 &= 4(12.24) \\
 P &= 48.96 \text{ meters}
 \end{aligned}$$

$$\begin{aligned}
 \mathcal{A} &= s^2 \\
 &= (12.24)^2 \\
 \mathcal{A} &= 149.8176 \text{ square meters}
 \end{aligned}$$

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

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

$$\begin{aligned} \mathcal{A} &= \frac{1}{2}bh \\ 70 &= \frac{1}{2}(14)h \\ 70 &= 7h \\ 10 &= h \end{aligned}$$

The height of the sign is 10 feet.

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

$$\begin{aligned} \mathcal{A} &= \frac{1}{2}bh \\ 96 &= \frac{1}{2}b(12) \\ 96 &= 6b \\ 16 &= b \end{aligned}$$

The base of the banner is 16 feet.

53. To find the area of the drum face, use the formula for the area of a circle, $\mathcal{A} = \pi r^2$. Since the diameter of the circle is 15.74 feet, the radius is $(\frac{1}{2})(15.74) = 7.87$ feet.

$$\begin{aligned} \mathcal{A} &= \pi r^2 \\ &\approx (3.14)(7.87)^2 \\ &= (3.14)(61.9369) \\ \mathcal{A} &\approx 194.48 \end{aligned}$$

The area of the drum face is about 194.48 square feet.

Use the circumference of a circle formula.

$$\begin{aligned} C &\approx 2(3.14)(7.87) \\ &= 49.4236 \end{aligned}$$

The circumference is about 49.42 feet.

54. To find the area of the drum face, use the formula for the area of a circle, $A = \pi r^2$. Since the diameter of the circle is 13 feet, the radius is $(\frac{1}{2})(13) = 6.5$ feet.

$$\begin{aligned} \mathcal{A} &= \pi r^2 \\ &\approx (3.14)(6.5)^2 \\ &= (3.14)(42.25) \\ \mathcal{A} &= 132.665 \end{aligned}$$

The area of the drum face is about 132.665 square feet.

Use the circumference of a circle formula.

$$\begin{aligned} C &= 2\pi r \\ &= 2\pi(6.5) \\ &\approx 40.84 \text{ ft} \end{aligned}$$

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

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

$$\begin{aligned} \mathcal{A} &= \frac{1}{2}(B + b)h \\ &= \frac{1}{2}(115.80 + 171.00)(165.97) \\ &= \frac{1}{2}(286.80)(165.97) \\ &= 23,800.098 \end{aligned}$$

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

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

$$\begin{aligned} \mathcal{A} &= \frac{1}{2}(B + b)h \\ &= \frac{1}{2}(82.05 + 26.84)(165.97) \\ &= 9036.23665 \end{aligned}$$

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

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

$$\begin{aligned} L + G &= 108 \\ L + 72 &= 108 \\ L &= 36 \text{ in.} \end{aligned}$$

The volume of the box is

$$\begin{aligned} V &= LWH \\ &= (36)(18)(18) \\ &= 11,664 \text{ in.}^3 \end{aligned}$$

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

$$\begin{aligned} V &= LWH \\ &= (12)(12)(1\frac{11}{24}) \\ &= \frac{\cancel{12}}{1} \cdot \frac{\cancel{12}}{1} \cdot \frac{35}{\cancel{24}} \\ &= 210 \end{aligned}$$

The volume of the sandwich was 210 cubic feet.

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

$$\begin{aligned} (x + 1) + (4x - 56) &= 180 \\ 5x - 55 &= 180 \\ 5x &= 235 \\ x &= 47 \end{aligned}$$

Since $x = 47$, $x + 1 = 47 + 1 = 48$, and $4x - 56 = 4(47) - 56 = 132$.

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

60. In the figure, the two angles are supplementary, so their sum is 180° .

$$\begin{aligned}(10x + 7) + (7x + 3) &= 180 \\ 17x + 10 &= 180 \\ 17x &= 170 \\ x &= 10\end{aligned}$$

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

The two angle measures are 107° and 73° .

61. In the figure, the two angles are complementary, so their sum is 90° .

$$\begin{aligned}(8x - 1) + 5x &= 90 \\ 13x - 1 &= 90 \\ 13x &= 91 \\ x &= 7\end{aligned}$$

Since $x = 7$, $8x - 1 = 8(7) - 1 = 55$, and $5x = 5(7) = 35$.

The two angle measures are 55° and 35° .

62. In the figure, the two angles are complementary, so their sum is 90° .

$$\begin{aligned}4x + (3x + 13) &= 90 \\ 7x + 13 &= 90 \\ 7x &= 77 \\ x &= 11\end{aligned}$$

Since $x = 11$, $4x = 4(11) = 44$, and $3x + 13 = 3(11) + 13 = 46$.

The two angle measures are 44° and 46° .

63. The two angles are vertical angles, which have equal measures. Set their measures equal to each other and solve for x .

$$\begin{aligned}5x - 129 &= 2x - 21 \\ 3x - 129 &= -21 \\ 3x &= 108 \\ x &= 36\end{aligned}$$

Since $x = 36$, $5x - 129 = 5(36) - 129 = 51$, and $2x - 21 = 2(36) - 21 = 51$.

The measure of each angle is 51° .

64. The two angles are vertical angles, which have equal measures. Set their measures equal to each other and solve for x .

$$\begin{aligned}7x + 5 &= 3x + 45 \\ 4x + 5 &= 45 \\ 4x &= 40 \\ x &= 10\end{aligned}$$

The measure of the first angle is $7(10) + 5 = 75^\circ$; the measure of the second angle is $3(10) + 45$, which is also 75° .

65. The angles are vertical angles, so their measures are equal.

$$\begin{aligned}12x - 3 &= 10x + 15 \\ 2x - 3 &= 15 \\ 2x &= 18 \\ x &= 9\end{aligned}$$

Since $x = 9$, $12x - 3 = 12(9) - 3 = 105$, and $10x + 15 = 10(9) + 15 = 105$.

The measure of each angle is 105° .

66. The angles are vertical angles, which have equal measures. Set $11x - 37$ equal to $7x + 27$ and solve.

$$\begin{aligned}11x - 37 &= 7x + 27 \\ 4x - 37 &= 27 \\ 4x &= 64 \\ x &= 16\end{aligned}$$

Since $x = 16$, $11x - 37 = 11(16) - 37 = 139$, and $7x + 27 = 7(16) + 27 = 139$.

The angles both measure 139° .

67. $d = rt$ for t

$$\begin{aligned}\frac{d}{r} &= \frac{rt}{r} && \text{Divide by } r. \\ \frac{d}{r} &= t && \text{or } t = \frac{d}{r}\end{aligned}$$

68. $d = rt$ for r

$$\begin{aligned}\frac{d}{t} &= \frac{rt}{t} && \text{Divide by } t. \\ \frac{d}{t} &= r && \text{or } r = \frac{d}{t}\end{aligned}$$

69. $A = bh$ for b

$$\begin{aligned}\frac{A}{h} &= \frac{bh}{h} && \text{Divide by } h. \\ \frac{A}{h} &= b && \text{or } b = \frac{A}{h}\end{aligned}$$

70. $A = LW$ for L

$$\begin{aligned}\frac{A}{W} &= \frac{LW}{W} && \text{Divide by } W. \\ \frac{A}{W} &= L && \text{or } L = \frac{A}{W}\end{aligned}$$

71. $C = \pi d$ for d

$$\begin{aligned}\frac{C}{\pi} &= \frac{\pi d}{\pi} && \text{Divide by } \pi. \\ \frac{C}{\pi} &= d && \text{or } d = \frac{C}{\pi}\end{aligned}$$

72. $P = 4s$ for s

$$\frac{P}{4} = \frac{4s}{4} \quad \text{Divide by 4.}$$

$$\frac{P}{4} = s \quad \text{or} \quad s = \frac{P}{4}$$

73. $V = LWH$ for H

$$\frac{V}{LW} = \frac{LWH}{LW} \quad \text{Divide by } LW.$$

$$\frac{V}{LW} = H \quad \text{or} \quad H = \frac{V}{LW}$$

74. $V = LWH$ for W

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

$$\frac{V}{LH} = W \quad \text{or} \quad W = \frac{V}{LH}$$

75. $I = prt$ for r

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

$$\frac{I}{pt} = r \quad \text{or} \quad r = \frac{I}{pt}$$

76. $I = prt$ for p

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

$$\frac{I}{rt} = p \quad \text{or} \quad p = \frac{I}{rt}$$

77. $A = \frac{1}{2}bh$ for h

$$2A = 2\left(\frac{1}{2}bh\right) \quad \text{Multiply by 2.}$$

$$2A = bh$$

$$\frac{2A}{b} = \frac{bh}{b} \quad \text{Divide by } b.$$

$$\frac{2A}{b} = h \quad \text{or} \quad h = \frac{2A}{b}$$

78. $A = \frac{1}{2}bh$ for b

$$2A = 2\left(\frac{1}{2}bh\right) \quad \text{Multiply by 2.}$$

$$2A = bh$$

$$\frac{2A}{h} = \frac{bh}{h} \quad \text{Divide by } h.$$

$$\frac{2A}{h} = b \quad \text{or} \quad b = \frac{2A}{h}$$

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

$$3V = 3\left(\frac{1}{3}\pi r^2 h\right) \quad \text{Multiply by 3.}$$

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

$$\frac{3V}{\pi r^2} = \frac{\pi r^2 h}{\pi r^2} \quad \text{Divide by } \pi r^2.$$

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

80. $V = \pi r^2 h$ for h

$$\frac{V}{\pi r^2} = \frac{\pi r^2 h}{\pi r^2} \quad \text{Divide by } \pi r^2.$$

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

81. $P = a + b + c$ for b

$$P - a - c = a + b + c - a - c$$

Subtract a and c.

$$P - a - c = b \quad \text{or} \quad b = P - a - c$$

82. $P = a + b + c$ for a

$$P - b - c = a + b + c - b - c$$

Subtract b and c.

$$P - b - c = a \quad \text{or} \quad a = P - b - c$$

83. $P = 2L + 2W$ for W

$$P - 2L = 2L + 2W - 2L \quad \text{Subtract } 2L.$$

$$P - 2L = 2W$$

$$\frac{P - 2L}{2} = \frac{2W}{2} \quad \text{Divide by 2.}$$

$$\frac{P - 2L}{2} = W \quad \text{or} \quad W = \frac{P - 2L}{2}$$

84. $A = p + prt$ for r

$$A - p = p + prt - p \quad \text{Subtract } p.$$

$$A - p = prt$$

$$\frac{A - p}{pt} = \frac{prt}{pt} \quad \text{Divide by } pt.$$

$$\frac{A - p}{pt} = r \quad \text{or} \quad r = \frac{A - p}{pt}$$

85. $y = mx + b$ for m

$$y - b = mx + b - b \quad \text{Subtract } b.$$

$$y - b = mx$$

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

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

86. $y = mx + b$ for x

$$y - b = mx + b - b \quad \text{Subtract } b.$$

$$y - b = mx$$

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

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

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

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

89. $M = C(1 + r)$ for r
 $M = C + Cr$ Distributive Property
 $M - C = Cr$ Subtract C .
 $\frac{M - C}{C} = \frac{Cr}{C}$ Divide by C .
 $\frac{M - C}{C} = r$ or $r = \frac{M - C}{C}$

Alternative solution:

$M = C(1 + r)$
 $\frac{M}{C} = 1 + r$ Divide by C .
 $\frac{M}{C} - 1 = r$ Subtract 1.

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

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

92. $P = 2(a + b)$ for b
 $\frac{P}{2} = \frac{2(a + b)}{2}$ Divide by 2.
 $\frac{P}{2} = a + b$
 $\frac{P}{2} - a = b$ Subtract a .
 $\frac{P}{2} - a = b$ or $b = \frac{P - 2a}{2}$

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

93. $0.06x = 300$
 $x = \frac{300}{0.06} = 5000$

The solution set is $\{5000\}$.

94. $0.4x = 80$
 $x = \frac{80}{0.4} = 200$

The solution set is $\{200\}$.

95. $\frac{3}{4}x = 21$
 $\frac{4}{3}(\frac{3}{4}x) = \frac{4}{3}(21)$
 $x = 28$

The solution set is $\{28\}$.

96. $-\frac{5}{6}x = 30$
 $-\frac{6}{5}(-\frac{5}{6}x) = -\frac{6}{5}(30)$
 $x = -36$

The solution set is $\{-36\}$.

97. $-3x = \frac{1}{4}$
 $\frac{-3x}{-3} = \frac{\frac{1}{4}}{-3}$
 $x = \frac{1}{4}(-\frac{1}{3}) = -\frac{1}{12}$

The solution set is $\{-\frac{1}{12}\}$.

98. $4x = \frac{1}{3}$
 $\frac{4x}{4} = \frac{\frac{1}{3}}{4}$
 $x = \frac{1}{3} \cdot \frac{1}{4} = \frac{1}{12}$

The solution set is $\{\frac{1}{12}\}$.

2.6 Ratio, Proportion, and Percent

2.6 Classroom Examples, Now Try Exercises

1. (a) To find the ratio of 3 days to 2 weeks, first convert 2 weeks to days.

$2 \text{ weeks} = 2 \cdot 7 = 14 \text{ days}$

The ratio of 3 days to 2 weeks is then

$\frac{3 \text{ days}}{2 \text{ weeks}} = \frac{3 \text{ days}}{14 \text{ days}} = \frac{3}{14}$.

- (b) $4 \text{ days} = 4 \cdot 24 = 96 \text{ hours}$

The ratio of 12 hr to 4 days is then

$\frac{12 \text{ hr}}{4 \text{ days}} = \frac{12 \text{ hr}}{96 \text{ hr}} = \frac{12}{96} = \frac{1}{8}$.

- N1. (a) The ratio of 7 inches to 4 inches is

$\frac{7 \text{ inches}}{4 \text{ inches}} = \frac{7}{4}$.

(b) $45 \text{ seconds} = \frac{45}{60} = \frac{3}{4} \text{ minute}$

The ratio of 45 seconds to 2 minutes is then

$$\frac{45 \text{ seconds}}{2 \text{ minutes}} = \frac{3}{4} \div 2 = \frac{3}{4} \cdot \frac{1}{2} = \frac{3}{8}$$

2. The results in the following table are rounded to the nearest thousandth.

Size	Unit Cost (dollars per oz)
36 oz	$\frac{\$3.89}{36} = \0.108 (*)
24 oz	$\frac{\$2.79}{24} = \0.116
12 oz	$\frac{\$1.89}{12} = \0.158

Because the 36 oz size produces the lowest unit cost, it is the best buy. The unit cost, to the nearest thousandth, is \$0.108 per oz.

- N2. The results in the following table are rounded to the nearest thousandth.

Size	Unit Cost (dollars per oz)
150 oz	$\frac{\$19.97}{150} = \0.133
100 oz	$\frac{\$13.97}{100} = \0.140
75 oz	$\frac{\$8.94}{75} = \0.119 (*)

Because the 75 oz size produces the lowest unit cost, it is the best buy. The unit cost, to the nearest thousandth, is \$0.119 per oz.

3. (a) $\frac{21}{15} = \frac{62}{45}$

Compare the cross products.

$$\begin{aligned} 21 \cdot 45 &= 945 \\ 15 \cdot 62 &= 930 \end{aligned}$$

The cross products are *different*, so the proportion is *false*.

(b) $\frac{13}{17} = \frac{91}{119}$

Check to see whether the cross products are equal.

$$\begin{aligned} 13 \cdot 119 &= 1547 \\ 17 \cdot 91 &= 1547 \end{aligned}$$

The cross products are *equal*, so the proportion is *true*.

N3. (a) $\frac{1}{3} = \frac{33}{100}$

Compare the cross products.

$$\begin{aligned} 1 \cdot 100 &= 100 \\ 3 \cdot 33 &= 99 \end{aligned}$$

The cross products are *different*, so the proportion is *false*.

(b) $\frac{4}{13} = \frac{16}{52}$

Check to see whether the cross products are equal.

$$4 \cdot 52 = 208$$

$$13 \cdot 16 = 208$$

The cross products are *equal*, so the proportion is *true*.

4. $\frac{x}{6} = \frac{35}{42}$

$$42x = 6 \cdot 35 \quad \text{Cross products}$$

$$x = \frac{6 \cdot 35}{42} \quad \text{Divide by 42.}$$

$$= \frac{6 \cdot 5 \cdot 7}{6 \cdot 7} \quad \text{Factor.}$$

$$= 5 \quad \text{Cancel.}$$

The solution set is {5}.

Note: We could have multiplied $6 \cdot 35$ to get 210 and then divided 210 by 42 to get 5. This may be the best approach if you are doing these calculations on a calculator. The factor and cancel method is preferable if you're not using a calculator.

N4. $\frac{9}{7} = \frac{x}{56}$

$$7x = 9 \cdot 56 \quad \text{Cross products}$$

$$x = \frac{9 \cdot 56}{7} \quad \text{Divide by 7.}$$

$$= \frac{9 \cdot 7 \cdot 8}{7} \quad \text{Factor.}$$

$$= 72 \quad \text{Cancel.}$$

The solution set is {72}.

Note: We could have multiplied $9 \cdot 56$ to get 504 and then divided 504 by 7 to get 72. This may be the best approach if you are doing these calculations on a calculator. The factor and cancel method is preferable if you're not using a calculator.

5. $\frac{x+6}{2} = \frac{2}{5}$

$$5(x+6) = 2(2) \quad \text{Cross products}$$

$$5x+30 = 4 \quad \text{Distributive property}$$

$$5x = -26 \quad \text{Subtract 30.}$$

$$x = -\frac{26}{5} \quad \text{Divide by 5.}$$

The solution set is $\{-\frac{26}{5}\}$.

N5.

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

$$4(k-3) = 6(3k+2) \quad \text{Cross products}$$

$$4k-12 = 18k+12 \quad \text{Distributive property}$$

$$-14k-12 = 12 \quad \text{Subtract 18k.}$$

$$-14k = 24 \quad \text{Add 12.}$$

$$a = -\frac{24}{14} = -\frac{12}{7} \quad \text{Divide by -14.}$$

The solution set is $\{-\frac{12}{7}\}$.

6. Let x = the cost for 16.5 gallons.

$$\begin{aligned}\frac{\$37.68}{12} &= \frac{x}{16.5} \\ 12x &= 16.5(37.68) && \text{Cross products} \\ 12x &= 621.72 && \text{Multiply.} \\ x &= 51.81 && \text{Divide by 12.}\end{aligned}$$

It would cost \$51.81.

- N6.** Let x = the cost for 27 gallons.

$$\begin{aligned}\frac{\$49.80}{20} &= \frac{x}{27} \\ 20x &= 27(49.80) && \text{Cross products} \\ 20x &= 1344.60 && \text{Multiply.} \\ x &= 67.23 && \text{Divide by 20.}\end{aligned}$$

It would cost \$67.23

7. (a) $310\% = 310 \cdot 1\% = 310 \cdot 0.01 = 3.1$
 (b) $8\% = 8 \cdot 1\% = 8 \cdot 0.01 = 0.08$
 (c) $0.685 = 68.5 \cdot 0.01 = 68.5 \cdot 1\% = 68.5\%$
- N7.** (a) $16\% = 16 \cdot 1\% = 16 \cdot 0.01 = 0.16$
 (b) $1.5 = 150 \cdot 0.01 = 150 \cdot 1\% = 150\%$
8. (a) What is 6% of 80?

$$6\% \cdot 80 = 0.06 \cdot 80 = 4.8$$

- (b) 16% of what number is 12?

As in Example 8(b), let n denote the number.

$$\begin{aligned}0.16 \cdot n &= 12 \\ n &= \frac{12}{0.16} && \text{Divide by 0.16.} \\ &= 75 && \text{Simplify.}\end{aligned}$$

16% of 75 is 12.

- (c) What percent of 75 is 90?

As in Example 8(c), let p denote the percent.

$$\begin{aligned}90 &= p \cdot 75 \\ p &= \frac{90}{75} = 1.2 = 120\%\end{aligned}$$

90 is 120% of 75.

- N8.** (a) What is 20% of 70?

$$20\% \cdot 70 = 0.20 \cdot 70 = 14$$

- (b) 40% of what number is 130?

As in Example 8(b), let n denote the number.

$$\begin{aligned}0.40 \cdot n &= 130 \\ n &= \frac{130}{0.40} && \text{Divide by 0.40.} \\ &= 325 && \text{Simplify.}\end{aligned}$$

40% of 325 is 130.

- (c) 121 is what percent of 484?

As in Example 8(c), let p denote the percent.

$$\begin{aligned}121 &= p \cdot 484 \\ p &= \frac{121}{484} = 0.25 = 25\%\end{aligned}$$

121 is 25% of 484.

9. We can think of this problem as

85% of what number is 34?

Let n denote the number.

$$\begin{aligned}0.85 \cdot n &= 34 \\ n &= \frac{34}{0.85} && \text{Divide by 0.85.} \\ &= 40 && \text{Simplify.}\end{aligned}$$

There were 40 possible points on the test.

- N9.** We can think of this problem as

48 is what percent of 120?

Let p denote the percent.

$$\begin{aligned}48 &= p \cdot 120 \\ p &= \frac{48}{120} = 0.40 = 40\%\end{aligned}$$

The coat cost 40% of the regular price, so the savings is $100\% - 40\% = 60\%$ of the regular price.

2.6 Section Exercises

1. (a) 75 to 100 is $\frac{75}{100} = \frac{3}{4}$ or 3 to 4.

The answer is **C**.

- (b) 5 to 4 or $\frac{5}{4} = \frac{5 \cdot 3}{4 \cdot 3} = \frac{15}{12}$ or 15 to 12.

The answer is **D**.

- (c) $\frac{1}{2} = \frac{1 \cdot 50}{2 \cdot 50} = \frac{50}{100}$ or 50 to 100

The answer is **B**.

- (d) 4 to 5 or $\frac{4}{5} = \frac{4 \cdot 20}{5 \cdot 20} = \frac{80}{100}$ or 80 to 100.

The answer is **A**.

2. Since there are 14 days in 2 weeks, the ratio of 3 days to 2 weeks can be represented by $\frac{3}{14}$, choice **D**.

3. The ratio of 40 miles to 30 miles is

$$\frac{40 \text{ miles}}{30 \text{ miles}} = \frac{40}{30} = \frac{4}{3}$$

4. The ratio of 60 feet to 70 feet is

$$\frac{60 \text{ feet}}{70 \text{ feet}} = \frac{60}{70} = \frac{6}{7}$$

5. The ratio of 120 people to 90 people is

$$\frac{120 \text{ people}}{90 \text{ people}} = \frac{4 \cdot 30}{3 \cdot 30} = \frac{4}{3}$$

6. The ratio of 72 dollars to 220 dollars is

$$\frac{72 \text{ dollars}}{220 \text{ dollars}} = \frac{72}{220} = \frac{18 \cdot 4}{55 \cdot 4} = \frac{18}{55}$$

7. To find the ratio of 20 yards to 8 feet, first convert 20 yards to feet.

$$20 \text{ yards} = 20 \text{ yards} \cdot \frac{3 \text{ feet}}{1 \text{ yard}} = 60 \text{ feet}$$

The ratio of 20 yards to 8 feet is then

$$\frac{60 \text{ feet}}{8 \text{ feet}} = \frac{60}{8} = \frac{15 \cdot 4}{2 \cdot 4} = \frac{15}{2}$$

8. First convert 8 feet to inches.

$$8 \text{ feet} = 8 \cdot 12 = 96 \text{ inches}$$

The ratio of 30 inches to 8 feet is then

$$\frac{30 \text{ inches}}{96 \text{ inches}} = \frac{30}{96} = \frac{5 \cdot 6}{16 \cdot 6} = \frac{5}{16}$$

9. Convert 2 hours to minutes.

$$\begin{aligned} 2 \text{ hours} &= 2 \text{ hours} \cdot \frac{60 \text{ minutes}}{1 \text{ hour}} \\ &= 120 \text{ minutes} \end{aligned}$$

The ratio of 24 minutes to 2 hours is then

$$\frac{24 \text{ minutes}}{120 \text{ minutes}} = \frac{24}{120} = \frac{1 \cdot 24}{5 \cdot 24} = \frac{1}{5}$$

10. To find the ratio of 16 minutes to 1 hour, first convert 1 hour to minutes.

$$1 \text{ hour} = 60 \text{ minutes}$$

The ratio of 16 minutes to 1 hour is then

$$\frac{16 \text{ minutes}}{60 \text{ minutes}} = \frac{16}{60} = \frac{4 \cdot 4}{15 \cdot 4} = \frac{4}{15}$$

11. 2 yards = 2 · 3 = 6 feet

$$6 \text{ feet} = 6 \cdot 12 = 72 \text{ inches}$$

The ratio of 60 inches to 2 yards is then

$$\frac{60 \text{ inches}}{72 \text{ inches}} = \frac{5 \cdot 12}{6 \cdot 12} = \frac{5}{6}$$

12. 5 days = 5 · 24 = 120 hours

The ratio of 5 days to 40 hours is then

$$\frac{120 \text{ hours}}{40 \text{ hours}} = \frac{3 \cdot 40}{1 \cdot 40} = \frac{3}{1}, \text{ or } 3.$$

In Exercises 13–22, to find the best buy, divide the price by the number of units to get the unit cost. Each result was found by using a calculator and rounding the answer to three decimal places. The *best buy* (based on price per unit) is the smallest unit cost.

13. Size	Unit Cost (dollars per lb)
4 lb	$\frac{\$1.78}{4} = \0.445
10 lb	$\frac{\$4.29}{10} = \0.429 (*)

The 10 lb size is the best buy.

14. Size	Unit Cost (dollars per oz)
15 oz	$\frac{\$3.43}{15} = \0.229
34.5 oz	$\frac{\$6.98}{34.5} = \0.202 (*)

The 34.5-oz size is the best buy.

15. Size	Unit Cost (dollars per oz)
16 oz	$\frac{\$2.44}{16} = \0.153
32 oz	$\frac{\$2.98}{32} = \0.093 (*)
48 oz	$\frac{\$4.95}{48} = \0.103

The 32 oz size is the best buy.

16. Size	Unit Cost (dollars per oz)
2 oz	$\frac{\$2.23}{2} = \1.115
4 oz	$\frac{\$2.49}{4} = \0.623 (*)
8 oz	$\frac{\$6.59}{8} = \0.824

The 4 oz size is the best buy.

17. Size	Unit Cost (dollars per oz)
16 oz	$\frac{\$1.66}{16} = \0.104
32 oz	$\frac{\$2.59}{32} = \0.081
64 oz	$\frac{\$4.29}{64} = \0.067
128 oz	$\frac{\$6.49}{128} = \0.051 (*)

The 128-oz size is the best buy.

18. Size	Unit Cost (dollars per oz)
8.5 oz	$\frac{\$0.99}{8.5} = \0.116
16.9 oz	$\frac{\$1.87}{16.9} = \0.111
33.8 oz	$\frac{\$2.49}{33.8} = \0.074
50.7 oz	$\frac{\$2.99}{50.7} = \0.059 (*)

The 50.7 oz size is the best buy.

19. Size	Unit Cost (dollars per oz)
14 oz	$\frac{\$1.39}{14} = \0.099
24 oz	$\frac{\$1.55}{24} = \0.065
36 oz	$\frac{\$1.78}{36} = \0.049 (*)
64 oz	$\frac{\$3.99}{64} = \0.062

The 36 oz size is the best buy.

20. Size	Unit Cost (dollars per oz)
12 oz	$\frac{\$1.05}{12} = \0.088
18 oz	$\frac{\$1.73}{18} = \0.096
32 oz	$\frac{\$1.84}{32} = \0.058 (*)
48 oz	$\frac{\$2.88}{48} = \0.060

The 32 oz size is the best buy.

21. Size	Unit Cost (dollars per oz)
87 oz	$\frac{\$7.88}{87} = \0.091
131 oz	$\frac{\$10.98}{131} = \0.084
263 oz	$\frac{\$19.96}{263} = \0.076 (*)

The 263 oz size is the best buy.

22. Size	Unit Cost (dollars per oz)
15.5 oz	$\frac{\$1.19}{15.5} = \0.077
32 oz	$\frac{\$1.69}{32} = \0.053 (*)
48 oz	$\frac{\$2.69}{48} = \0.056

The 32-oz size is the best buy.

23. $\frac{5}{35} = \frac{8}{56}$

Check to see whether the cross products are equal.

$$5 \cdot 56 = 280$$

$$35 \cdot 8 = 280$$

The cross products are *equal*, so the proportion is *true*.

24. $\frac{4}{12} = \frac{7}{21}$

Check to see whether the cross products are equal.

$$4 \cdot 21 = 84$$

$$12 \cdot 7 = 84$$

The cross products are *equal*, so the proportion is *true*.

25. $\frac{120}{82} = \frac{7}{10}$

Compare the cross products.

$$120 \cdot 10 = 1200$$

$$82 \cdot 7 = 574$$

The cross products are *different*, so the proportion is *false*.

26. $\frac{27}{160} = \frac{18}{110}$

Compare the cross products.

$$27 \cdot 110 = 2970$$

$$160 \cdot 18 = 2880$$

The cross products are *different*, so the proportion is *false*.

27. $\frac{1}{5} = \frac{1}{10}$

Compare the cross products.

$$\frac{1}{2} \cdot 10 = 5$$

$$5 \cdot 1 = 5$$

The cross products are *equal*, so the proportion is *true*.

28. $\frac{1}{6} = \frac{1}{18}$

Compare the cross products.

$$\frac{1}{3} \cdot 18 = 6$$

$$6 \cdot 1 = 6$$

The cross products are *equal*, so the proportion is *true*.

29. $\frac{k}{4} = \frac{175}{20}$

$20k = 4(175)$ *Cross products are equal.*

$$20k = 700$$

$$\frac{20k}{20} = \frac{700}{20} \quad \text{Divide by 20.}$$

$$k = 35$$

The solution set is {35}.

30. $\frac{x}{6} = \frac{18}{4}$

$x \cdot 4 = 6 \cdot 18$ *Cross products are equal.*

$$4x = 108$$

$$\frac{4x}{4} = \frac{108}{4} \quad \text{Divide by 4.}$$

$$x = 27$$

The solution set is {27}.

31. $\frac{49}{56} = \frac{z}{8}$

$56z = 49(8)$ *Cross products are equal.*

$$56z = 392$$

$$\frac{56z}{56} = \frac{392}{56} \quad \text{Divide by 56.}$$

$$z = 7$$

The solution set is {7}.

32. $\frac{20}{100} = \frac{z}{80}$
 $100 \cdot z = 20 \cdot 80$ *Cross products are equal.*
 $100z = 1600$
 $\frac{100z}{100} = \frac{1600}{100}$ *Divide by 100.*
 $z = 16$

The solution set is {16}.

33. $\frac{x}{24} = \frac{15}{16}$
 $16x = 24(15)$ *Cross products are equal.*
 $16x = 360$
 $\frac{16x}{16} = \frac{360}{16}$ *Divide by 16.*
 $x = \frac{45 \cdot 8}{2 \cdot 8} = \frac{45}{2}$

The solution set is $\{\frac{45}{2}\}$.

34. $\frac{x}{4} = \frac{12}{30}$
 $30x = 4(12)$ *Cross products are equal.*
 $30x = 48$
 $\frac{30x}{30} = \frac{48}{30}$ *Divide by 30.*
 $x = \frac{8 \cdot 6}{5 \cdot 6} = \frac{8}{5}$

The solution set is $\{\frac{8}{5}\}$.

35. $\frac{z}{2} = \frac{z+1}{3}$
 $3z = 2(z+1)$ *Cross products are equal.*
 $3z = 2z + 2$ *Distributive property*
 $z = 2$ *Subtract 2z.*

The solution set is {2}.

36. $\frac{m}{5} = \frac{m-2}{2}$
 $2m = 5(m-2)$ *Cross products are equal.*
 $2m = 5m - 10$ *Distributive property*
 $-3m = -10$ *Subtract 5m.*
 $m = \frac{10}{3}$ *Divide by -3.*

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

37. $\frac{3y-2}{5} = \frac{6y-5}{11}$
 $11(3y-2) = 5(6y-5)$ *Cross products are equal.*
 $33y - 22 = 30y - 25$ *Dist. prop.*
 $3y - 22 = -25$ *Subtract 30y.*
 $3y = -3$ *Add 22.*
 $y = -1$ *Divide by 3.*

The solution set is {-1}.

38. $\frac{2r+8}{4} = \frac{3r-9}{3}$
 $3(2r+8) = 4(3r-9)$ *Cross products are equal.*
 $6r + 24 = 12r - 36$ *Dist. prop.*
 $-6r + 24 = -36$ *Subtract 12r.*
 $-6r = -60$ *Subtract 24.*
 $r = 10$ *Divide by -6.*

The solution set is {10}.

39. $\frac{5k+1}{6} = \frac{3k-2}{3}$
 $3(5k+1) = 6(3k-2)$ *Cross products*
 $15k + 3 = 18k - 12$ *Dist. prop.*
 $-3k + 3 = -12$ *Subtract 18k.*
 $-3k = -15$ *Subtract 3.*
 $k = 5$ *Divide by -3.*

The solution set is {5}.

40. $\frac{x+4}{6} = \frac{x+10}{8}$
 $8(x+4) = 6(x+10)$ *Cross products*
 $8x + 32 = 6x + 60$ *Dist. prop.*
 $2x + 32 = 60$ *Subtract 6x.*
 $2x = 28$ *Subtract 32.*
 $x = 14$ *Divide by 2.*

The solution set is {14}.

41. $\frac{2p+7}{3} = \frac{p-1}{4}$
 $4(2p+7) = 3(p-1)$ *Cross products*
 $8p + 28 = 3p - 3$ *Dist. prop.*
 $5p + 28 = -3$ *Subtract 3p.*
 $5p = -31$ *Subtract 28.*
 $p = -\frac{31}{5}$ *Divide by 5.*

The solution set is $\{-\frac{31}{5}\}$.

42. $\frac{3m-2}{5} = \frac{4-m}{3}$
 $3(3m-2) = 5(4-m)$ *Cross products*
 $9m - 6 = 20 - 5m$ *Dist. prop.*
 $14m - 6 = 20$ *Add 5m.*
 $14m = 26$ *Add 6.*
 $m = \frac{26}{14} = \frac{13}{7}$ *Divide by 14.*

The solution set is $\{\frac{13}{7}\}$.

43. Let x = the cost of 24 candy bars.
 Set up a proportion.

$$\frac{x}{24} = \frac{\$20.00}{16}$$

$$16x = 24(20)$$

$$16x = 480$$

$$x = 30$$

The cost of 24 candy bars is \$30.00.

44. Let x = the cost of 8 ring tones.
Set up a proportion.

$$\begin{aligned}\frac{x}{8} &= \frac{\$30.00}{12} \\ 12x &= 8(30) \\ 12x &= 240 \\ x &= 20\end{aligned}$$

The cost of 8 ring tones is \$20.00.

45. Let x = the cost of 5 quarts of oil.
Set up a proportion.

$$\begin{aligned}\frac{x}{5} &= \frac{\$14.00}{8} \\ 8x &= 5(14) \\ 8x &= 70 \\ x &= 8.75\end{aligned}$$

The cost of five quarts of oil is \$8.75.

46. Let x = the cost of 7 tires.
Set up a proportion.

$$\begin{aligned}\frac{x}{7} &= \frac{\$398.00}{4} \\ 4x &= 7(398) \\ 4x &= 2786 \\ x &= 696.50\end{aligned}$$

The cost of seven tires is \$696.50.

47. Let x = the cost of five pairs of jeans.

$$\begin{aligned}\frac{9 \text{ pairs}}{\$121.50} &= \frac{5 \text{ pairs}}{x} \\ 9x &= 5(121.50) \\ 9x &= 607.5 \\ \frac{9x}{9} &= \frac{607.5}{9} \\ x &= 67.5\end{aligned}$$

The cost of five pairs is \$67.50.

48. Let x = the cost of 11 shirts.

$$\begin{aligned}\frac{7 \text{ shirts}}{\$87.50} &= \frac{11 \text{ shirts}}{x} \\ 7x &= 11(87.50) \\ 7x &= 962.5 \\ \frac{7x}{7} &= \frac{962.5}{7} \\ x &= 137.5\end{aligned}$$

The cost of 11 shirts is \$137.50.

49. Let x = the cost for filling a 15-gallon tank.
Set up a proportion.

$$\begin{aligned}\frac{x \text{ dollars}}{\$19.56} &= \frac{15 \text{ gallons}}{6 \text{ gallons}} \\ 6x &= 15(19.56) \\ 6x &= 293.4 \\ x &= 48.90\end{aligned}$$

It would cost \$48.90 to completely fill a 15-gallon tank.

50. Let x = the sales tax on a \$120.00 compact disc player.

$$\begin{aligned}\frac{\$1.32}{\$x} &= \frac{\$16}{\$120} \\ \frac{1.32}{x} &= \frac{16}{120} \\ 16x &= 120(1.32) \\ 16x &= 158.4 \\ x &= 9.90\end{aligned}$$

The sales tax on a \$120 compact disc player would be \$9.90.

51. Let x = the distance between Memphis and Philadelphia on the map (in feet).

Set up a proportion with one ratio involving map distances and the other involving actual distances.

$$\begin{aligned}\frac{x \text{ feet}}{2.4 \text{ feet}} &= \frac{1000 \text{ miles}}{600 \text{ miles}} \\ \frac{x}{2.4} &= \frac{1000}{600} \\ 600x &= (2.4)(1000) \\ 600x &= 2400 \\ x &= 4\end{aligned}$$

The distance on the map between Memphis and Philadelphia would be 4 feet.

52. Let x = the number of inches between Mexico City and Cairo on the map.

Set up a proportion.

$$\begin{aligned}\frac{11 \text{ inches}}{x \text{ inches}} &= \frac{3300 \text{ miles}}{7700 \text{ miles}} \\ \frac{11}{x} &= \frac{3300}{7700} \\ 3300x &= 11(7700) \\ 3300x &= 84,700 \\ x &= \frac{84,700}{3300} \\ &= \frac{847}{33} = \frac{77}{3}, \text{ or } 25\frac{2}{3}\end{aligned}$$

Mexico City and Cairo are $25\frac{2}{3}$ inches apart on the map.

53. Let x = the number of inches between St. Louis and Des Moines on the map.

Set up a proportion.

$$\begin{aligned}\frac{8.5 \text{ inches}}{x \text{ inches}} &= \frac{1040 \text{ miles}}{333 \text{ miles}} \\ 1040x &= 8.5(333) \\ 1040x &= 2830.5 \\ x &\approx 2.72\end{aligned}$$

St. Louis and Des Moines are about 2.7 inches apart on the map.

54. Let x = the number of inches between Milwaukee and Seattle on the map.
Set up a proportion.

$$\begin{aligned} \frac{8.0 \text{ inches}}{x \text{ inches}} &= \frac{912 \text{ miles}}{1940 \text{ miles}} \\ 912x &= 8.0(1940) \\ 912x &= 15,520 \\ x &\approx 17.0 \end{aligned}$$

Milwaukee and Seattle are about 17.0 inches apart on the map.

55. Let x = the number of inches between Moscow and Berlin on the globe.
Set up a proportion.

$$\begin{aligned} \frac{12.4 \text{ inches}}{x \text{ inches}} &= \frac{10,080 \text{ km}}{1610 \text{ km}} \\ 10,080x &= 12.4(1610) \\ 10,080x &= 19,964 \\ x &\approx 1.98 \end{aligned}$$

Moscow and Berlin are about 2.0 inches apart on the globe.

56. Let x = the number of inches between Paris and Stockholm on the globe.
Set up a proportion.

$$\begin{aligned} \frac{21.5 \text{ inches}}{x \text{ inches}} &= \frac{17,615 \text{ km}}{1605 \text{ km}} \\ 17,615x &= 21.5(1605) \\ 17,615x &= 34,507.5 \\ x &\approx 1.96 \end{aligned}$$

Paris and Stockholm are about 2.0 inches apart on the globe.

57. Let x = the number of cups of cleaner.
Set up a proportion with one ratio involving the number of cups of cleaner and the other involving the number of gallons of water.

$$\begin{aligned} \frac{x \text{ cups}}{\frac{1}{4} \text{ cup}} &= \frac{10\frac{1}{2} \text{ gallons}}{1 \text{ gallon}} \\ x \cdot 1 &= \frac{1}{4}(10\frac{1}{2}) \\ x &= \frac{1}{4}(\frac{21}{2}) = \frac{21}{8} \end{aligned}$$

The amount of cleaner needed is $2\frac{5}{8}$ cups.

58. Let x = the number of cups of cleaner.
Set up a proportion with one ratio involving the number of cups of cleaner and the other involving the number of gallons of water.

$$\begin{aligned} \frac{x \text{ cups}}{\frac{1}{2} \text{ cup}} &= \frac{15\frac{1}{2} \text{ gallons}}{1 \text{ gallon}} \\ x \cdot 1 &= \frac{1}{2}(15\frac{1}{2}) \\ x &= \frac{1}{2}(\frac{31}{2}) = \frac{31}{4} \end{aligned}$$

The amount of cleaner needed is $7\frac{3}{4}$ cups.

59. Let x = the number of U.S. dollars Ashley exchanged.
Set up a proportion.

$$\begin{aligned} \frac{\$1.4294}{x \text{ dollars}} &= \frac{1 \text{ euro}}{300 \text{ euros}} \\ x \cdot 1 &= 1.4294(300) \\ x &= 428.82 \end{aligned}$$

She exchanged \$428.82.

60. Let x = the number of pesos that can be obtained for \$65.
Set up a proportion.

$$\begin{aligned} \frac{103.0 \text{ pesos}}{x \text{ pesos}} &= \frac{8 \text{ dollars}}{65 \text{ dollars}} \\ x \cdot 8 &= 103.0(65) \\ 8x &= 6695 \\ x &= 836.875 \end{aligned}$$

To the nearest tenth, one can obtain 836.9 pesos for \$65.

61. Let x = the number of fish in North Bay.
Set up a proportion with one ratio involving the sample and the other involving the total number of fish.

$$\begin{aligned} \frac{7 \text{ fish}}{700 \text{ fish}} &= \frac{500 \text{ fish}}{x \text{ fish}} \\ 7x &= (700)(500) \\ 7x &= 350,000 \\ x &= 50,000 \end{aligned}$$

We estimate that there are 50,000 fish in North Bay.

62. Let x = the number of fish in West Okoboji Lake.
Set up a proportion with one ratio involving the sample and the other involving the total number of fish.

$$\begin{aligned} \frac{18 \text{ fish}}{1000 \text{ fish}} &= \frac{840 \text{ fish}}{x \text{ fish}} \\ 18x &= (1000)(840) \\ 18x &= 840,000 \\ x &= 46,666.\bar{6} \end{aligned}$$

The approximate fish population of West Okoboji Lake, to the nearest hundred, is 46,700 fish.

63. $\frac{x}{12} = \frac{3}{9}$
 $9x = 12 \cdot 3 = 36$
 $x = 4$

Other possibilities for the proportion are:

$$\frac{12}{x} = \frac{9}{3}, \quad \frac{x}{12} = \frac{5}{15}, \quad \frac{12}{x} = \frac{15}{5}$$

64. $\frac{x}{2} = \frac{12}{3}$
 $3x = 2 \cdot 12 = 24$
 $x = 8$

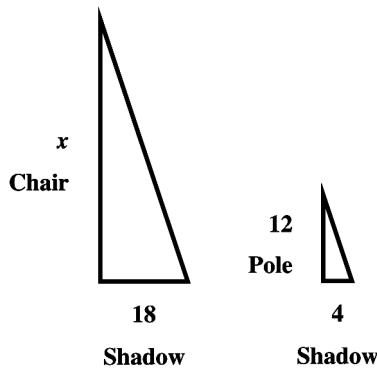
65. Ratios of corresponding sides are equal, so
 $\frac{2}{3} = \frac{x}{3}$, and we must have $x = 2$.

66. $\frac{x}{4} = \frac{6}{8}$
 $8x = 4 \cdot 6 = 24$
 $x = 3$

67. $\frac{x}{3} = \frac{2}{6}$ $\frac{y}{\frac{4}{3}} = \frac{6}{2}$
 $6x = 3 \cdot 2 = 6$ $2y = 6(\frac{4}{3}) = 8$
 $x = 1$ $y = 4$

68. $\frac{x}{15} = \frac{12}{8}$ $\frac{y}{17} = \frac{12}{8}$
 $8x = 15(12) = 180$ $8y = 17(12) = 204$
 $x = 22.5$ $y = 25.5$

69. (a)



(b) These two triangles are similar, so their sides are proportional.

$$\frac{x}{12} = \frac{18}{4}$$

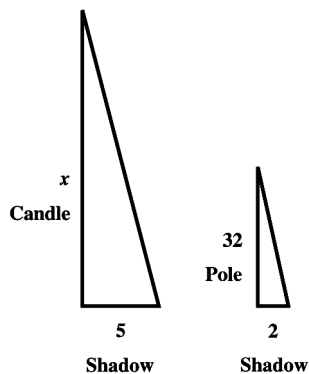
$$4x = 18(12)$$

$$4x = 216$$

$$x = 54$$

The chair is 54 feet tall.

70. (a)



(b) These two triangles are similar, so their sides are proportional.

$$\frac{x}{32} = \frac{5}{2}$$

$$2x = 5(32)$$

$$2x = 160$$

$$x = 80$$

The candle was 80 feet tall.

71. Let $x =$ the 1997 price of electricity.

$$\frac{\text{1995 price}}{\text{1995 index}} = \frac{\text{1997 price}}{\text{1997 index}}$$

$$\frac{225}{152.4} = \frac{x}{160.5}$$

$$152.4x = 225(160.5)$$

$$x = \frac{225(160.5)}{152.4} \approx 236.96$$

The 1997 price would be about \$237.

72. Let $x =$ the 1999 price of electricity.

$$\frac{\text{1995 price}}{\text{1995 index}} = \frac{\text{1999 price}}{\text{1999 index}}$$

$$\frac{225}{152.4} = \frac{x}{166.6}$$

$$152.4x = 225(166.6)$$

$$x = \frac{225(166.6)}{152.4} \approx 245.96$$

The 1999 price would be about \$246.

73. Let $x =$ the 2003 price of electricity.

$$\frac{\text{1995 price}}{\text{1995 index}} = \frac{\text{2003 price}}{\text{2003 index}}$$

$$\frac{225}{152.4} = \frac{x}{184.0}$$

$$152.4x = 225(184.0)$$

$$x = \frac{225(184.0)}{152.4} \approx 271.65$$

The 2003 price would be about \$272.

74. Let $x =$ the 2007 price of electricity.

$$\frac{\text{1995 price}}{\text{1995 index}} = \frac{\text{2007 price}}{\text{2007 index}}$$

$$\frac{225}{152.4} = \frac{x}{207.3}$$

$$152.4x = 225(207.3)$$

$$x = \frac{225(207.3)}{152.4} \approx 306.05$$

The 2007 price would be about \$306.

75. $53\% = 53 \cdot 1\% = 53(0.01) = 0.53$

An alternative method is

$$53 = 53 \cdot 1\% = 53\left(\frac{1}{100}\right) = \frac{53}{100} = 0.53.$$

76. $38\% = 38 \cdot 1\% = 38(0.01) = 0.38$

77. $96\% = 96 \cdot 1\% = 96(0.01) = 0.96$

78. $11\% = 11 \cdot 1\% = 11(0.01) = 0.11$

79. $9\% = 9 \cdot 1\% = 9(0.01) = 0.09$

80. $7\% = 7 \cdot 1\% = 7(0.01) = 0.07$

81. $129\% = 129 \cdot 1\% = 129(0.01) = 1.29$

82. $174\% = 174 \cdot 1\% = 174(0.01) = 1.74$

83. $0.80 = 80(0.01) = 80 \cdot 1\% = 80\%$

84. $0.75 = 75(0.01) = 75 \cdot 1\% = 75\%$

85. $0.02 = 2(0.01) = 2 \cdot 1\% = 2\%$

86. $0.06 = 6(0.01) = 6 \cdot 1\% = 6\%$

87. $0.125 = 12.5(0.01) = 12.5 \cdot 1\% = 12.5\%$

88. $0.983 = 98.3(0.01) = 98.3 \cdot 1\% = 98.3\%$

89. $2.2 = 220(0.01) = 220 \cdot 1\% = 220\%$

90. $1.4 = 140(0.01) = 140 \cdot 1\% = 140\%$

91. What is 14% of 780?

$$14\% \cdot 780 = 0.14 \cdot 780 = 109.2$$

92. What is 26% of 480?

$$26\% \cdot 480 = 0.26 \cdot 480 = 124.8$$

93. 42% of what number is 294?

As in Example 8(b), let n denote the number.

$$0.42 \cdot n = 294$$

$$n = \frac{294}{0.42} \quad \text{Divide by } 0.42.$$
$$= 700 \quad \text{Simplify.}$$

42% of 700 is 294.

94. 18% of what number is 108?

As in Example 8(b), let n denote the number.

$$0.18 \cdot n = 108$$

$$n = \frac{108}{0.18} \quad \text{Divide by } 0.18.$$
$$= 600 \quad \text{Simplify.}$$

18% of 600 is 108.

95. 120% of what number is 510?

As in Example 8(b), let n denote the number.

$$1.20 \cdot n = 510$$

$$n = \frac{510}{1.20} \quad \text{Divide by } 1.20.$$
$$= 425 \quad \text{Simplify.}$$

120% of 425 is 510.

96. 140% of what number is 315?

As in Example 8(b), let n denote the number.

$$1.40 \cdot n = 315$$

$$n = \frac{315}{1.40} \quad \text{Divide by } 1.40.$$
$$= 225 \quad \text{Simplify.}$$

140% of 225 is 315.

97. 4 is what percent of 50?

As in Example 8(c), let p denote the percent.

$$4 = p \cdot 50$$

$$p = \frac{4}{50} = 0.08 = 8\%$$

4 is 8% of 50.

98. 8 is what percent of 64?

As in Example 8(c), let p denote the percent.

$$8 = p \cdot 64$$

$$p = \frac{8}{64} = 0.125 = 12.5\%$$

8 is 12.5% of 64.

99. What percent of 30 is 36?

As in Example 8(c), let p denote the percent.

$$36 = p \cdot 30$$

$$p = \frac{36}{30} = 1.2 = 120\%$$

36 is 120% of 30.

100. What percent of 48 is 96?

As in Example 8(c), let p denote the percent.

$$96 = p \cdot 48$$

$$p = \frac{96}{48} = 2 = 200\%$$

96 is 200% of 48.

101. The discount is 15% of \$795.

$$15\% \cdot 795 = 0.15 \cdot 795 = 119.25$$

The discount is \$119.25.

The sale price is $\$795 - \$119.25 = \$675.75$.

102. The discount is 20% of \$597.

$$20\% \cdot 597 = 0.20 \cdot 597 = 119.40$$

The discount is \$119.40.

The sale price is $\$597 - \$119.40 = \$477.60$.

103. 48 is what percent of 60?

As in Example 8(c), let p denote the percent.

$$48 = p \cdot 60$$

$$p = \frac{48}{60} = 0.8 = 80\%$$

He earned 80% of the total points.

104. 63 is what percent of 75?

As in Example 8(c), let p denote the percent.

$$\begin{aligned} 63 &= p \cdot 75 \\ p &= \frac{63}{75} = 0.84 = 84\% \end{aligned}$$

She scored 84% of the total points.

105. 65% of what number is 1950?

As in Example 8(b), let n denote the number.

$$\begin{aligned} 0.65 \cdot n &= 1950 \\ n &= \frac{1950}{0.65} \quad \text{Divide by 0.65.} \\ &= 3000 \quad \text{Simplify.} \end{aligned}$$

She needs \$3000 for the car.

106. 70% of what number is 525?

As in Example 8(b), let n denote the number.

$$\begin{aligned} 0.70 \cdot n &= 525 \\ n &= \frac{525}{0.70} \quad \text{Divide by 0.70.} \\ &= 750 \quad \text{Simplify.} \end{aligned}$$

She needs \$750 for the car.

107. $0.15x + 0.30(3) = 0.20(3 + x)$
 $100[0.15x + 0.30(3)] = 100[0.20(3 + x)]$
 $15x + 30(3) = 20(3 + x)$
 $15x + 90 = 60 + 20x$
 $90 = 60 + 5x$
 $30 = 5x$
 $6 = x$

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

108. $0.20(60) + 0.05x = 0.10(60 + x)$
 $100[0.20(60) + 0.05x] = 100[0.10(60 + x)]$
 $20(60) + 5x = 10(60 + x)$
 $1200 + 5x = 600 + 10x$
 $1200 = 600 + 5x$
 $600 = 5x$
 $120 = x$

The solution set is $\{120\}$.

109. $0.92x + 0.98(12 - x) = 0.96(12)$
 $100[0.92x + 0.98(12 - x)] = 100[0.96(12)]$
 $92x + 98(12 - x) = 96(12)$
 $92x + 1176 - 98x = 1152$
 $1176 - 6x = 1152$
 $-6x = -24$
 $x = 4$

The solution set is $\{4\}$.

110. $0.10(7) + 1.00x = 0.30(7 + x)$
 $10[0.10(7) + 1.00x] = 10[0.30(7 + x)]$
 $1(7) + 10x = 3(7 + x)$
 $7 + 10x = 21 + 3x$
 $7 + 7x = 21$
 $7x = 14$
 $x = 2$

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

2.7 Further Applications of Linear Equations

2.7 Classroom Examples, Now Try Exercises

1. (a) The amount of pure acid in 40 L of a 16% acid solution is

$$\begin{array}{ccccc} 40 \text{ L} & \times & 0.16 & = & 6.4 \text{ L.} \\ \uparrow & & \uparrow & & \uparrow \\ \text{Amount} & & \text{Rate} & & \text{Amount} \\ \text{of} & & \text{of} & & \text{of pure} \\ \text{solution} & & \text{concentration} & & \text{acid} \end{array}$$

- (b) If \$5000 is invested for one year at 4% simple interest, the amount of interest earned is

$$\begin{array}{ccccc} \$5000 & \times & 0.04 & = & \$200. \\ \uparrow & & \uparrow & & \uparrow \\ \text{Principal} & & \text{Interest} & & \text{Interest} \\ & & \text{Rate} & & \text{earned} \end{array}$$

- N1. (a) The amount of pure alcohol in 70 L of a 20% alcohol solution is

$$\begin{array}{ccccc} 70 \text{ L} & \times & 0.20 & = & 14 \text{ L.} \\ \uparrow & & \uparrow & & \uparrow \\ \text{Amount} & & \text{Rate} & & \text{Amount} \\ \text{of} & & \text{of} & & \text{of pure} \\ \text{solution} & & \text{concentration} & & \text{alcohol} \end{array}$$

- (b) If \$3200 is invested for one year at 2% simple interest, the amount of interest earned is

$$\begin{array}{ccccc} \$3200 & \times & 0.02 & = & \$64. \\ \uparrow & & \uparrow & & \uparrow \\ \text{Principal} & & \text{Interest} & & \text{Interest} \\ & & \text{Rate} & & \text{earned} \end{array}$$

2. Let x = the number of kilograms of metal that is 40% copper.
 Then $x + 80$ = the number of kilograms of metal that is 50% copper.

Number of kilograms of metal	x	+	80	=	$x + 80$
Percent of copper in metal	0.40		0.70		0.50

$$\begin{array}{rcc}
 \text{Copper in} & \text{plus} & \text{copper in} \\
 40\% \text{ metal} & & 70\% \text{ metal} \\
 \downarrow & & \downarrow \\
 0.40x & + & 0.70(80) \\
 \\
 \text{is} & & \text{copper in} \\
 & & 50\% \text{ metal.} \\
 \downarrow & & \downarrow \\
 = & & 0.50(x + 80)
 \end{array}$$

Solve the equation.

$$0.40x + 0.70(80) = 0.50x + 40$$

Multiply by 10 to clear decimals.

$$4x + 7(80) = 5x + 400$$

$$4x + 560 = 5x + 400$$

$$560 = x + 400$$

$$160 = x$$

160 kilograms of metal that is 40% copper are needed.

Check $x = 160$:

LS and RS refer to the left side and right side of the original equation.

$$\text{LS: } 0.40(160) + 0.70(80) = 64 + 56 = 120$$

$$\text{RS: } 0.50(160 + 80) = 0.50(240) = 120$$

- N2.** Let x = the number of ounces of seasoning that is 70% salt.

Then $x + 30$ = the number of ounces of seasoning that is 50% salt.

$$\begin{array}{rcc}
 \text{Number of} & & \\
 \text{ounces} & & \\
 \text{of seasoning} & & \\
 \\
 \text{Percent of} & & \\
 \text{salt in seasoning} & & \\
 \\
 \boxed{x} & + & \boxed{30} & = & \boxed{x + 30} \\
 \boxed{0.70} & & \boxed{0.10} & & \boxed{0.50}
 \end{array}$$

$$\begin{array}{rcc}
 \text{Salt in} & \text{plus} & \text{salt in} \\
 70\% \text{ seasoning} & & 10\% \text{ seasoning} \\
 \downarrow & & \downarrow \\
 0.70x & + & 0.10(30)
 \end{array}$$

$$0.70x + 0.10(30)$$

$$\text{is salt in } 50\% \text{ seasoning.}$$

$$= 0.50(x + 30)$$

Solve the equation.

$$0.70x + 0.10(30) = 0.50x + 15$$

Multiply by 10 to clear decimals.

$$7x + 1(30) = 5x + 150$$

$$7x + 30 = 5x + 150$$

$$2x + 30 = 150$$

$$2x = 120$$

$$x = 60$$

60 ounces of seasoning that is 70% salt are needed.

Check $x = 60$:

LS and RS refer to the left side and right side of the original equation.

$$\text{LS: } 0.70(60) + 0.10(30) = 42 + 3 = 45$$

$$\text{RS: } 0.50(60 + 30) = 0.50(90) = 45$$

- 3.** Let x = the amount invested at 5%.
Then $2x + 3000$ = the amount invested at 8%.

Amount invested (in dollars)	Rate of interest	Interest for one year
x	0.05	$0.05x$
$2x + 3000$	0.08	$0.08(2x + 3000)$

Since the total annual interest was \$1710, the equation is

$$0.05x + 0.08(2x + 3000) = 1710.$$

Multiply both sides by 100 to eliminate the decimals.

$$5x + 8(2x + 3000) = 100(1710)$$

$$5x + 16x + 24,000 = 171,000$$

$$21x + 24,000 = 171,000$$

$$21x = 147,000$$

$$x = 7000$$

The engineer invested \$7000 at 5%.

- N3.** Let x = the amount invested at 3%.
Then $x + 5000$ = the amount invested at 4%.

Amount invested (in dollars)	Rate of interest	Interest for one year
x	0.03	$0.03x$
$x + 5000$	0.04	$0.04(x + 5000)$

Since the total annual interest is \$410, the equation is

$$0.03x + 0.04(x + 5000) = 410.$$

Multiply both sides by 100 to eliminate the decimals.

$$3x + 4(x + 5000) = 100(410)$$

$$3x + 4x + 20,000 = 41,000$$

$$7x + 20,000 = 41,000$$

$$7x = 21,000$$

$$x = 3000$$

The financial advisor should invest \$3000 at 3% and \$8000 at 4%.

- 4.** Let x = the number of quarters.
Then $x + 9$ = the number of nickels.

The value of quarters plus the value of nickels is \$2.55.

$$\begin{array}{ccccccc} \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & & \\ 0.25x & + & 0.05(x+9) & = & 2.55 & & \end{array}$$

Multiply by 100.

$$25x + 5(x+9) = 255$$

$$25x + 5x + 45 = 255$$

$$30x + 45 = 255$$

$$30x = 210$$

$$x = 7$$

Since $x = 7$, $x + 9 = 16$.

The man has 16 nickels and 7 quarters.

N4. Let $x =$ the number of dimes.

Then $x + 10 =$ the number of quarters.

The value of dimes plus the value of quarters is \$5.65.

$$\begin{array}{ccccccc} \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & & \\ 0.10x & + & 0.25(x+10) & = & 5.65 & & \end{array}$$

Multiply by 100.

$$10x + 25(x+10) = 565$$

$$10x + 25x + 250 = 565$$

$$35x + 250 = 565$$

$$35x = 315$$

$$x = 9$$

Since $x = 9$, $x + 10 = 19$.

Clayton has 19 quarters and 9 dimes.

5. $r = \frac{d}{t} = \frac{100 \text{ meters}}{9.69 \text{ seconds}} \approx 10.3199$

His rate was about 10.32 meters per second.

N5. $r = \frac{d}{t} = \frac{400 \text{ miles}}{6 \text{ hours}} \approx 66.6667$

The rate was about 66.67 miles per hour.

6. Let $t =$ the time it takes for the planes to be 3290 miles apart. Use the formula $d = rt$.

$$d_{\text{faster}} + d_{\text{slower}} = d_{\text{total}}$$

$$530t + 410t = 3290$$

$$940t = 3290$$

$$t = \frac{3290}{940} = 3.5$$

It will take 3.5 hours for the planes to be 3290 miles apart.

N6. Let $t =$ the time it takes for the bicyclists to be 5 miles apart. Use the formula $d = rt$.

$$d_{\text{faster}} - d_{\text{slower}} = d_{\text{total}}$$

$$20t - 18t = 5$$

$$2t = 5$$

$$t = \frac{5}{2} = 2.5$$

It will take 2.5 hours for the bicyclists to be 5 miles apart.

7. Let $x =$ the rate of the slower bus.

Then $x + 10 =$ the rate of the faster bus.

Use the formula $d = rt$ and the fact that each bus travels for $\frac{1}{5}$ hour.

$$d_{\text{slower}} + d_{\text{faster}} = d_{\text{total}}$$

$$(x+10)\left(\frac{1}{5}\right) + x\left(\frac{1}{5}\right) = 12$$

$$\frac{1}{5}x + 2 + \frac{1}{5}x = 12$$

$$\frac{2}{5}x + 2 = 12$$

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

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

$$x = 25$$

Since $x = 25$, $x + 10 = 35$. The slower bus had a rate of 25 mph and the faster bus had a rate of 35 mph.

Check: The slower bus traveled $25\left(\frac{1}{5}\right) = 5$ miles and the faster bus traveled $35\left(\frac{1}{5}\right) = 7$ miles. The total miles traveled is $5 + 7 = 12$, as required.

N7. Let $x =$ the rate of the slower car.

Then $x + 6 =$ the rate of the faster car.

Use the formula $d = rt$ and the fact that each car travels for $\frac{1}{4}$ hour.

$$d_{\text{slower}} + d_{\text{faster}} = d_{\text{total}}$$

$$(x+6)\left(\frac{1}{4}\right) + x\left(\frac{1}{4}\right) = 35$$

$$\frac{1}{4}x + \frac{3}{2} + \frac{1}{4}x = \frac{70}{2}$$

$$\frac{2}{4}x + \frac{3}{2} = \frac{70}{2}$$

$$\frac{1}{2}x = \frac{67}{2}$$

$$\frac{2}{1}\left(\frac{1}{2}x\right) = \frac{2}{1}\left(\frac{67}{2}\right)$$

$$x = 67$$

Since $x = 67$, $x + 6 = 73$. The slower car had a rate of 67 mph and the faster car had a rate of 73 mph.

Check: The slower car traveled $67\left(\frac{1}{4}\right) = \frac{67}{4}$ miles and the faster car traveled $73\left(\frac{1}{4}\right) = \frac{73}{4}$ miles. The total miles traveled is $\frac{67}{4} + \frac{73}{4} = \frac{140}{4} = 35$, as required.

2.7 Section Exercises

1. The amount of pure alcohol in 150 liters of a 30% alcohol solution is

$$150 \quad \times \quad 0.30 \quad = \quad 45 \text{ liters.}$$

↑	↑	↑
Amount	Rate	Amount
of	of	of pure
solution	concentration	alcohol

2. The amount of pure acid in 250 milliliters of a 14% acid solution is

$$\begin{array}{ccccccc} 250 & \times & 0.14 & = & 35 & \text{milliliters.} & \\ \uparrow & & \uparrow & & \uparrow & & \\ \text{Amount} & & \text{Rate} & & \text{Amount} & & \\ \text{of} & & \text{of} & & \text{of pure} & & \\ \text{solution} & & \text{concentration} & & \text{acid} & & \end{array}$$

3. If \$25,000 is invested at 3% simple interest for one year, the amount of interest earned is

$$\begin{array}{ccccccc} \$25,000 & \times & 0.03 & \times & 1 & = & \$750. \\ \uparrow & & \uparrow & & \uparrow & & \uparrow \\ \text{Principal} & & \text{Interest} & & \text{Time} & & \text{Interest} \\ & & \text{Rate} & & & & \text{earned} \end{array}$$

4. If \$10,000 is invested for one year at 3.5% simple interest, the amount of interest earned is

$$\begin{array}{ccccccc} \$10,000 & \times & 0.035 & = & \$350. & & \\ \uparrow & & \uparrow & & \uparrow & & \\ \text{Principal} & & \text{Interest} & & \text{Interest} & & \\ & & \text{Rate} & & \text{earned} & & \end{array}$$

5. The monetary value of 35 half-dollars is

$$\begin{array}{ccccccc} 35 & \times & \$0.50 & = & \$17.50. & & \\ \uparrow & & \uparrow & & \uparrow & & \\ \text{Number} & & \text{Denomination} & & \text{Monetary} & & \\ \text{of coins} & & & & \text{value} & & \end{array}$$

6. The monetary value of 283 nickels is

$$\begin{array}{ccccccc} 283 & \times & \$0.05 & = & \$14.15. & & \\ \uparrow & & \uparrow & & \uparrow & & \\ \text{Number} & & \text{Denomination} & & \text{Monetary} & & \\ \text{of coins} & & & & \text{value} & & \end{array}$$

7. 44.4% is about 45%. The population of 1,917,000 is about 1.9 million, and 45% of 1.9 million is 855,000. So choice **A** is the correct answer.

8. 26.5% is about 25% or $\frac{1}{4}$. The population of 4,628,000 is about 4.6 million, and $\frac{1}{4}$ of 4.6 million is 1.15 million. So choice **C** is the correct answer.

9. (a) 14% of 3.8 million = $0.14(3,800,000)$ = 532,000 white cars.

(b) 21% of 3.8 million = $0.21(3,800,000)$ = 798,000 silver cars.

(c) 13% of 3.8 million = $0.13(3,800,000)$ = 494,000 red cars.

10. (a) 33% of \$221,190 = $0.33(\$221,190)$ = \$72,992.70 \approx \$72,993 for housing.

(b) 17% of \$221,190 = $0.17(\$221,190)$ = \$37,602.30 \approx \$37,602 for food.

(c) 8% of \$221,190 = $0.08(\$221,190)$ = \$17,695.20 \approx \$17,695 for health care.

11. The concentration of the new solution could not be more than the strength of the stronger of the original solutions, so the correct answer is **D**, since 32% is stronger than both 20% and 30%.

12. Because pure alcohol (100% concentration) is to be added, the new solution must be stronger than the original one. Therefore, the concentration of the new solution must be greater than 24%, so the correct answer is **A**, 22%.

13. *Step 2*

Let x = the number of liters of 25% acid solution to be used.

Step 3

Use the box diagram in the textbook to write the equation.

Pure acid in 25% solution	+	Pure acid in 40% solution	=	Pure acid in 30% solution
↓		↓		↓
$0.25x$		$+ 0.40(80)$		$= 0.30(x + 80)$

Step 4

Multiply by 100 to clear decimals.

$$\begin{aligned} 25x + 40(80) &= 30(x + 80) \\ 25x + 3200 &= 30x + 2400 \\ 25x + 800 &= 30x \\ 800 &= 5x \\ 160 &= x \end{aligned}$$

Step 5

160 liters of 25% acid solution must be added.

Step 6

25% of 160 liters plus 40% of 80 liters is 40 liters plus 32 liters, or 72 liters, of pure acid; which is equal to 30% of (160 + 80) liters.

$$[0.30(240) = 72]$$

14. *Step 2*

Let x = the number of gallons of 50% solution needed. Then

$x + 80$ = the number of gallons of 40% solution.

Step 3

Use the box diagram in the textbook to write the equation.

Pure antifreeze in 50% solution	plus	pure antifreeze in 20% solution
↓		↓
$0.50x$	+	$0.20(80)$

$$\begin{array}{l} \text{is pure antifreeze} \\ \text{in 40\% solution.} \\ \downarrow \qquad \downarrow \\ = 0.40(x + 80) \end{array}$$

Step 4

Solve the equation.

$$0.50x + 0.20(80) = 0.40(x + 80)$$

Multiply by 10 to clear decimals.

$$5x + 2(80) = 4(x + 80)$$

$$5x + 160 = 4x + 320$$

$$x + 160 = 320$$

$$x = 160$$

Step 5

160 gallons of 50% antifreeze are needed.

Step 6

50% of 160 gallons plus 20% of 80 gallons is 80 gallons plus 16 gallons, or 96 gallons, of pure antifreeze; which is equal to 40% of (160 + 80) gallons. [0.40(240) = 96]

15. Let x = the number of liters of 5% drug solution.

Number of liters of solution	20	+	x	=	$x + 20$
Strength of solution	0.10		0.05		0.08

Pure drug solution in 10% solution plus pure drug solution in 5% solution

$$\begin{array}{ccc} \downarrow & & \downarrow \\ 0.10(20) & + & 0.05x \end{array}$$

is pure drug solution in 8% solution.

$$\begin{array}{ccc} \downarrow & & \downarrow \\ = & & 0.08(x + 20) \end{array}$$

Solve the equation.

$$0.10(20) + 0.05x = 0.08(x + 20)$$

$$10(20) + 5x = 8(x + 20)$$

$$200 + 5x = 8x + 160$$

$$200 = 3x + 160$$

$$40 = 3x$$

$$x = \frac{40}{3} = 13\frac{1}{3}$$

The pharmacist needs $13\frac{1}{3}$ liters of 5% drug solution.

Check $x = 13\frac{1}{3}$:

LS and RS refer to the left side and right side of the original equation.

$$\text{LS: } 0.10(20) + 0.05(13\frac{1}{3}) = 2\frac{2}{3}$$

$$\text{RS: } 0.08(13\frac{1}{3} + 20) = 2\frac{2}{3}$$

16. Let x = the number of kilograms of metal that is 20% tin.

Then $x + 80$ = the number of kilograms of metal that is 50% tin.

Number of kilograms of metal	x	+	80	=	$x + 80$
Percent of tin in metal	0.20		0.70		0.50
	Tin in 20% metal	plus	tin in 70% metal		
	↓		↓		↓
	0.20x	+	0.70(80)		
	is		tin in 50% metal.		
	↓		↓		↓
	=		0.50(x + 80)		

Solve the equation.

$$0.20x + 0.70(80) = 0.50x + 40$$

Multiply by 10 to clear decimals.

$$2x + 7(80) = 5x + 400$$

$$2x + 560 = 5x + 400$$

$$560 = 3x + 400$$

$$160 = 3x$$

$$x = \frac{160}{3} = 53\frac{1}{3}$$

$53\frac{1}{3}$ kilograms of metal that is 20% tin are needed.

Check $x = 53\frac{1}{3}$:

LS and RS refer to the left side and right side of the original equation.

$$\text{LS: } 0.20(53\frac{1}{3}) + 0.70(80) = 66\frac{2}{3}$$

$$\text{RS: } 0.50(53\frac{1}{3} + 80) = 66\frac{2}{3}$$

17. Let x = the number of liters of the 20% alcohol solution.

Complete the table.

Strength	Liters of solution	Liters of pure alcohol
12%	12	$0.12(12) = 1.44$
20%	x	$0.20x$
14%	$x + 12$	$0.14(x + 12)$

From the last column, we can formulate an equation that compares the number of liters of pure alcohol.

$$\begin{array}{ccccc} \text{Alcohol} & \text{alcohol} & \text{alcohol} & & \\ \text{in 12\%} & + & \text{in 20\%} & = & \text{in 14\%} \\ \text{solution} & & \text{solution} & & \text{solution.} \end{array}$$

$$\begin{aligned}
 1.44 + 0.20x &= 0.14(x + 12) \\
 1.44 + 0.20x &= 0.14x + 1.68 \\
 0.06x &= 0.24 \\
 x &= 4
 \end{aligned}$$

4 L of the 20% alcohol solution are needed.

18. Let x = the number of liters of the 10% solution.

Strength	Liters of solution	Liters of pure alcohol
10%	x	$0.10x$
50%	40	$0.50(40) = 20$
40%	$x + 40$	$0.40(x + 40)$

$$\begin{aligned}
 \text{Alcohol in } 10\% \text{ solution} + \text{alcohol in } 50\% \text{ solution} &= \text{alcohol in } 40\% \text{ solution.} \\
 0.10x + 20 &= 0.40(x + 40)
 \end{aligned}$$

$$\begin{aligned}
 1x + 200 &= 4(x + 40) && \text{Multiply by } 10. \\
 x + 200 &= 4x + 160 \\
 -3x &= -40 \\
 x &= \frac{-40}{-3} = \frac{40}{3} \text{ or } 13\frac{1}{3}
 \end{aligned}$$

$13\frac{1}{3}$ L of 10% alcohol solution should be added.

19. Let x = the amount of water to be added.
Then $20 + x$ = the amount of 2% solution.

There is no minoxidil in water.

Number of milliliters of solution	x	+	20	=	$20 + x$
Concentration of solution	0		0.04		0.02

$$\begin{aligned}
 \text{Pure minoxidil in } x \text{ milliliters of water} & \text{ plus } \text{pure minoxidil in } 4\% \text{ solution} & \text{ is } & \text{pure minoxidil in } 2\% \text{ solution} \\
 \downarrow & \downarrow & & \downarrow & \downarrow \\
 0(x) & + & 0.04(20) & = & 0.02(20 + x)
 \end{aligned}$$

Solve the equation.

$$\begin{aligned}
 0x + 0.04(20) &= 0.02(20 + x) \\
 4(20) &= 2(20 + x) \\
 80 &= 40 + 2x \\
 40 &= 2x \\
 20 &= x
 \end{aligned}$$

20 milliliters of water should be used.

Check $x = 20$:

$$\begin{aligned}
 \text{LS: } 0(20) + 0.04(20) &= 0.8 \\
 \text{RS: } 0.02(20 + 20) &= 0.8
 \end{aligned}$$

This answer should make common sense; that is, equal amounts of 0% and 4% solutions should produce a 2% solution.

20. Let x = the number of milliliters of 4% solution.

Milliliters of solution	50	+	x	=	$50 + x$
Concentration of minoxidil	0.01		0.04		0.02

$$\begin{aligned}
 \text{Pure minoxidil in } 1\% \text{ solution} & \text{ plus } \text{pure minoxidil in } 4\% \text{ solution} & = & \text{pure minoxidil in } 2\% \text{ solution} \\
 \downarrow & \downarrow & & \downarrow \\
 0.01(50) & + & 0.04x & = & 0.02(50 + x)
 \end{aligned}$$

$$\begin{aligned}
 1(50) + 4x &= 2(50 + x) \\
 50 + 4x &= 100 + 2x \\
 50 + 2x &= 100 \\
 2x &= 50 \\
 x &= 25
 \end{aligned}$$

The pharmacist must add 25 milliliters of 4% solution.

Check $x = 25$:

$$\begin{aligned}
 \text{LS: } 0.01(50) + 0.04(25) &= 1.5 \\
 \text{RS: } 0.02(50 + 25) &= 1.5
 \end{aligned}$$

21. Let x = the number of liters of 60% acid solution.
Then $20 - x$ = the number of liters of 75% acid solution.

Number of liters of solution	x	+	$20 - x$	=	20
Concentration of acid	0.60		0.75		0.72

$$\begin{aligned}
 \text{Pure acid in } 60\% \text{ solution} & \text{ plus } \text{pure acid in } 75\% \text{ solution} \\
 \downarrow & \downarrow & & \downarrow \\
 0.60x & + & 0.75(20 - x) \\
 \text{is } & \text{pure acid in } 72\% \text{ solution.} \\
 \downarrow & \downarrow \\
 = & 0.72(20)
 \end{aligned}$$

Solve the equation.

$$\begin{aligned}
 0.60x + 0.75(20 - x) &= 0.72(20) \\
 60x + 75(20 - x) &= 72(20) \\
 60x + 1500 - 75x &= 1440 \\
 1500 - 15x &= 1440 \\
 -15x &= -60 \\
 x &= 4
 \end{aligned}$$

4 liters of 60% acid solution must be used.

Check $x = 4$:

$$\begin{aligned}
 \text{LS: } 0.60(4) + 0.75(20 - 4) &= 14.4 \\
 \text{RS: } 0.72(20) &= 14.4
 \end{aligned}$$

22. Let x = the number of gallons of 12% indicator solution.

Then $10 - x$ = the number of gallons of 20% indicator solution.

Gallons of solution	x	+	$10 - x$	=	10
Strength of solution	0.12		0.20		0.14

Indicator in 12% solution	indicator in 20% solution	indicator in 14% solution
------------------------------	------------------------------	------------------------------

$$\begin{array}{ccc} \downarrow & & \downarrow \\ 0.12x & + & 0.20(10 - x) = 0.14(10) \end{array}$$

$$12x + 20(10 - x) = 14(10)$$

$$12x + 200 - 20x = 140$$

$$200 - 8x = 140$$

$$-8x = -60$$

$$x = \frac{-60}{-8}$$

$$x = \frac{15}{2} \text{ or } 7\frac{1}{2}$$

$7\frac{1}{2}$ gallons of 12% indicator solution must be used.

Check $x = 7\frac{1}{2}$:

$$\text{LS: } 0.12(7\frac{1}{2}) + 0.20(10 - 7\frac{1}{2}) = 1.4$$

$$\text{RS: } 0.14(10) = 1.4$$

23. Let x = the amount invested at 5% (in dollars).
Then $x - 1200$ = the amount invested at 4% (in dollars).

Amount invested (in dollars)	Rate of interest	Interest for one year
x	0.05	$0.05x$
$x - 1200$	0.04	$0.04(x - 1200)$

Since the total annual interest was \$141, the equation is

$$0.05x + 0.04(x - 1200) = 141.$$

$$5x + 4(x - 1200) = 100(141)$$

$$5x + 4x - 4800 = 14,100$$

$$9x - 4800 = 14,100$$

$$9x = 18,900$$

$$x = 2100$$

Since $x = 2100$, $x - 1200 = 900$.
Arlene invested \$2100 at 5% and \$900 at 4%.

24. Let x = the amount invested at 4%.
Then $x + 3000$ = the amount invested at 6%.

Amount invested (in dollars)	Rate of interest	Interest for one year
x	0.04	$0.04x$
$x + 3000$	0.06	$0.06(x + 3000)$

Since the total annual interest was \$780, the equation is

$$0.04x + 0.06(x + 3000) = 780.$$

$$4x + 6(x + 3000) = 100(780)$$

$$4x + 6x + 18,000 = 78,000$$

$$10x + 18,000 = 78,000$$

$$10x = 60,000$$

$$x = 6000$$

Since $x = 6000$, $x + 3000 = 9000$.
Margaret deposited \$6000 at 4% and \$9000 at 6%.

25. Let x = the amount invested at 6%.
Then $3x + 6000$ = the amount invested at 5%.

$$0.06x + 0.05(3x + 6000) = 825$$

$$6x + 5(3x + 6000) = 100(825)$$

$$6x + 15x + 30,000 = 82,500$$

$$21x + 30,000 = 82,500$$

$$21x = 52,500$$

$$x = 2500$$

Since $x = 2500$, $3x + 6000 = 13,500$.
The artist invested \$2500 at 6% and \$13,500 at 5%.

26. Let x = the amount invested at 3%.
Then $2x + 30,000$ = the amount invested at 4%.

$$0.03x + 0.04(2x + 30,000) = 5600$$

$$3x + 4(2x + 30,000) = 100(5600)$$

$$3x + 8x + 120,000 = 560,000$$

$$11x + 120,000 = 560,000$$

$$11x = 440,000$$

$$x = 40,000$$

Since $x = 40,000$, $2x + 30,000 = 110,000$.
The actor invested \$40,000 at 3% and \$110,000 at 4%.

27. Let x = the number of nickels.
Then $x + 2$ = the number of dimes.

The value of nickels plus the value of dimes is \$1.70

$$\begin{array}{ccc} \downarrow & & \downarrow \\ 0.05x & + & 0.10(x + 2) = 1.70 \end{array}$$

$$5x + 10(x + 2) = 100(1.70)$$

$$5x + 10x + 20 = 170$$

$$15x + 20 = 170$$

$$15x = 150$$

$$x = 10$$

The collector has 10 nickels.

28. Let x = the number of five-dollar bills.
Then $x + 5$ = the number of twenty-dollar bills.

The value of fives plus the value of twenties is \$725

$$\begin{array}{ccc} \downarrow & & \downarrow \\ 5x & + & 20(x + 5) = 725 \end{array}$$

$$\begin{aligned} 5x + 20x + 100 &= 725 \\ 25x + 100 &= 725 \\ 25x &= 625 \\ x &= 25 \end{aligned}$$

The teller has 25 five-dollar bills.

29. Let x = the number of 44-cent stamps.
Then $45 - x$ = the number of 17-cent stamps.
The value of the 44-cent stamps is $0.44x$ and the value of the 17-cent stamps is $0.17(45 - x)$. The total value is \$14.40, so

$$\begin{aligned} 0.44x + 0.17(45 - x) &= 14.40 \\ 44x + 17(45 - x) &= 1440 \\ 44x + 765 - 17x &= 1440 \\ 27x + 765 &= 1440 \\ 27x &= 675 \\ x &= 25 \end{aligned}$$

Since $x = 25$, $45 - x = 20$. She bought 25 44-cent stamps valued at \$11.00 and 20 17-cent stamps valued at \$3.40, for a total value of \$14.40.

30. Let x = the number of adult tickets sold.
Then $600 - x$ = the number of children's tickets sold.

The value of the adult tickets is $8x$ and the value of the children's tickets is $5(600 - x)$. The total value was \$4116, so

$$\begin{aligned} 8x + 5(600 - x) &= 4116 \\ 8x + 3000 - 5x &= 4116 \\ 3x + 3000 &= 4116 \\ 3x &= 1116 \\ x &= 372 \end{aligned}$$

Since $x = 372$, $600 - x = 228$. There were 372 adult tickets valued at \$2976 and 228 children's tickets valued at \$1140, for a total value of \$4116.

31. Let x = the number of pounds of Colombian Decaf beans.
Then $2x$ = the number of pounds of Arabian Mocha beans.

Number of Pounds	Cost per Pound	Total Value (in \$)
x	\$8.00	$8x$
$2x$	\$8.50	$8.5(2x)$

The total value is \$87.50, so

$$\begin{aligned} 8x + 8.5(2x) &= 87.50 \\ 8x + 17x &= 87.50 \\ 25x &= 87.50 \\ x &= 3.5 \end{aligned}$$

Since $x = 3.5$, $2x = 7$. She can buy 3.5 pounds of Colombian Decaf and 7 pounds of Arabian Mocha.

32. Let x = the number of pounds of Kona Deluxe beans.

	Number of Pounds	Cost per Pound	Total Value (in \$)
Kona Deluxe	x	\$11.50	$11.50x$
French Roast	12	\$7.50	$7.50(12)$
Mixture	$x + 12$	\$10	$10(x + 12)$

The sum of the values of the Kona Deluxe beans and the French Roast beans must equal the value of the mixture, so

$$\begin{aligned} 11.50x + 7.50(12) &= 10(x + 12) \\ 115x + 75(12) &= 10[10(x + 12)] \\ 115x + 900 &= 100x + 1200 \\ 15x + 900 &= 1200 \\ 15x &= 300 \\ x &= 20 \end{aligned}$$

Mixing 20 pounds of Kona Deluxe (value \$230) with 12 pounds of French Roast (value \$90) yields a mixture of 32 pounds that sells for \$10 per pound (value \$320).

33. To estimate the average rate of the trip, round 405 to 400 and 8.2 to 8.

Use $r = \frac{d}{t}$ with $d = 400$ and $t = 8$.

$$r = \frac{d}{t} = \frac{400}{8} = 50$$

The best estimate is **A**, 50 miles per hour.

34. The distance traveled cannot be found by multiplying 45 and 30 because the rate is given in miles per hour, while the time is given in minutes. To find the correct distance, start by converting the time to hours.

$$\begin{aligned} 30 \text{ minutes} &= \frac{1}{2} \text{ hour} \\ d &= rt \\ &= 45\left(\frac{1}{2}\right) \\ &= 22.5 \end{aligned}$$

The car traveled 22.5 (or $22\frac{1}{2}$) miles.

35. Use the formula $d = rt$ with $r = 53$ and $t = 10$.

$$\begin{aligned} d &= rt \\ &= (53)(10) \\ &= 530 \end{aligned}$$

The distance between Memphis and Chicago is 530 miles.

Distance traveled by faster boat	minus	distance traveled by slower boat	is	9.
$24t$		$18t$	=	9
↓		↓		↓ ↓

$$24t - 18t = 9$$

$$6t = 9$$

$$t = \frac{3}{2} \text{ or } 1\frac{1}{2}$$

In $1\frac{1}{2}$ hours, the steamboats will be 9 miles apart.

49. Let x = the rate of the westbound plane.
Then $x - 150$ = the rate of the eastbound plane.
Using the formula $d = rt$ and the chart in the text, we see that

$$d_{\text{west}} + d_{\text{east}} = d_{\text{total}}$$

$$x(3) + (x - 150)(3) = 2250$$

$$3x + 3x - 450 = 2250$$

$$6x = 2700$$

$$x = 450$$

Since $x = 450$, $x - 150 = 300$.

The rate of the westbound plane is 450 mph and the rate of the eastbound plane is 300 mph.

50. Let x = the rate of the northbound train.
Then $x + 20$ = the rate of the southbound train.
Using the formula $d = rt$ and the chart in the text, we see that

$$d_{\text{north}} + d_{\text{south}} = d_{\text{total}}$$

$$x(2) + (x + 20)(2) = 280$$

$$2x + 2x + 40 = 280$$

$$4x = 240$$

$$x = 60$$

Since $x = 60$, $x + 20 = 80$.

The rate of the northbound train is 60 mph and the rate of the southbound train is 80 mph.

51. Let x = the rate of the slower car.
Then $x + 20$ = the rate of the faster car.
Use the formula $d = rt$ and the fact that each car travels for 4 hours.

$$d_{\text{faster}} + d_{\text{slower}} = d_{\text{total}}$$

$$(x + 20)(4) + (x)(4) = 400$$

$$4x + 80 + 4x = 400$$

$$8x = 320$$

$$x = 40$$

The rate of the slower car is 40 mph and the rate of the faster car is 60 mph.

52. Let x = the rate of the faster car.
Then $x - 15$ = the rate of the slower car.
Use the formula $d = rt$ and the fact that each car travels for 2 hours.

$$d_{\text{faster}} + d_{\text{slower}} = d_{\text{total}}$$

$$x(2) + (x - 15)(2) = 230$$

$$2x + 2x - 30 = 230$$

$$4x = 260$$

$$x = 65$$

Since $x = 65$, $x - 15 = 50$.

The rate of the faster car is 65 km per hour and the rate of the slower car is 50 km per hour.

53. Let x = Bob's current age.
Then $3x$ = Kevin's current age.
Three years ago, Bob's age was $x - 3$ and Kevin's age was $3x - 3$, and this sum was 22.

$$(x - 3) + (3x - 3) = 22$$

$$4x - 6 = 22$$

$$4x = 28$$

$$x = 7$$

Bob is 7 years old and Kevin is $3(7) = 21$ years old.

54. Let x = the number of pint cartons.
Then $6x$ = the number of quart cartons.
Since 1 quart = 2 pints, 1 pint = $\frac{1}{2}$ quart, and $\frac{1}{2}x$ is the number of quarts contained in pint cartons. The total number of quarts is 39, so

$$\frac{1}{2}x + 6x = 39.$$

$$\frac{1}{2}x + \frac{12}{2}x = 39$$

$$\frac{13}{2}x = 39$$

$$\frac{2}{13}(\frac{13}{2}x) = \frac{2}{13}(39)$$

$$x = 6$$

There are 6 pint cartons and $6(6) = 36$ quart cartons.

55. Let w = the width of the table.
Then $3w$ = the length of the table.
If we subtract 3 feet from the length ($3w - 3$) and add 3 feet to the width ($w + 3$), then the length and the width would be equal.

$$3w - 3 = w + 3$$

$$3w = w + 6$$

$$2w = 6$$

$$w = 3$$

The width is 3 feet and the length is $3(3) = 9$ feet.

56. Let x = the number of hours worked.
Her gross pay (pay before deductions) is $6x$.

$$\begin{aligned} \text{gross pay} - \text{deductions} &= \text{take-home pay} \\ 6x - 0.25(6x) &= 450 \\ 6x - 1.5x &= 450 \\ 4.5x &= 450 \\ x &= \frac{450}{4.5} = 100 \end{aligned}$$

She must work 100 hours to take home \$450.

57. Let x = her gross pay (pay before deductions).

$$\begin{aligned} \text{gross pay} - \text{deductions} &= \text{take-home pay} \\ x - 0.10(x) &= 585 \\ 0.90x &= 585 \\ x &= \frac{585}{0.90} = 650 \end{aligned}$$

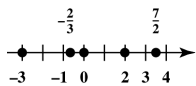
She was paid \$650 before deductions.

58. Let x = the amount of the sales.

$$\begin{aligned} \text{sales} + \text{tax} &= \text{total} \\ x + 0.05x &= 2394 \\ 1.05x &= 2394 \\ x &= \frac{2394}{1.05} = 2280 \end{aligned}$$

The amount of sales was \$2280.

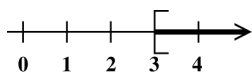
59. Since $6 = 6$, the statement $6 > 6$ is *false*.
60. Since $10 = 10$, the statement $10 \leq 10$ is *true*.
61. Since -4 is to the left of -3 on the real number line, the statement $-4 \leq -3$ is *true*.
62. Since -11 is to the left of -9 on the real number line, the statement $-11 > -9$ is *false*.
63. Since 0 is to the right of $-\frac{1}{2}$ on the real number line, the statement $0 > -\frac{1}{2}$ is *true*.
64. Graph the numbers $-3, -\frac{2}{3}, 0, 2, \frac{7}{2}$ on a number line.



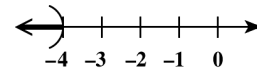
2.8 Solving Linear Inequalities

2.8 Classroom Examples, Now Try Exercises

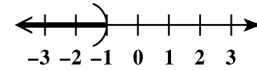
1. (a) The statement $x \geq 3$ says that x can represent any number greater than or equal to 3. The interval is written as $[3, \infty)$ [the parenthesis at ∞ shows that ∞ is *not* part of the graph]. To graph the inequality, place a bracket at 3 and draw an arrow extending to the right.



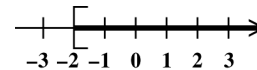
- (b) The statement $-4 > x$ is the same as $x < -4$. The interval is written as $(-\infty, -4)$. Graph this inequality by placing a parenthesis at -4 on a number line and drawing an arrow to the left.



- N1. (a) The statement $x < -1$ says that x can represent any number less than -1 . The interval is written as $(-\infty, -1)$. Graph this inequality by placing a parenthesis at -1 on a number line and drawing an arrow to the left.



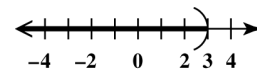
- (b) The statement $-2 \leq x$ is the same as $x \geq -2$. The interval is written as $[-2, \infty)$. Graph this inequality by placing a bracket at -2 on a number line and drawing an arrow to the right.



2. $-1 + 8x < 7x + 2$
 $-1 + 8x + 1 < 7x + 2 + 1$ *Add 1.*
 $8x < 7x + 3$
 $8x - 7x < 7x + 3 - 7x$ *Subtract 7x.*
 $x < 3$

Graph the solution set $(-\infty, 3)$.

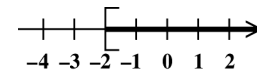
To graph this inequality, place a parenthesis at 3 on a number line and draw an arrow to the left.



- N2. $5 + 5x \geq 4x + 3$
 $5 + 5x - 5 \geq 4x + 3 - 5$ *Subtract 5.*
 $5x \geq 4x - 2$
 $5x - 4x \geq 4x - 2 - 4x$ *Subtract 4x.*
 $x \geq -2$

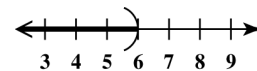
Graph the solution set $[-2, \infty)$.

To graph this inequality, place a bracket at -2 on a number line and draw an arrow to the right.



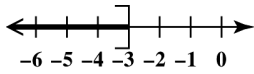
3. $-2r > -12$
 $\frac{-2r}{-2} < \frac{-12}{-2}$ *Divide by -2; reverse the symbol.*
 $r < 6$

Graph the solution set $(-\infty, 6)$.



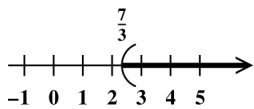
N3. $-5k \geq 15$
 $\frac{-5k}{-5} \leq \frac{15}{-5}$ *Divide by -5;*
 $k \leq -3$ *reverse the symbol.*

Graph the solution set $(-\infty, -3]$.



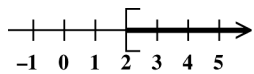
4. $5x - x + 2 < 7x - 5$
 $4x + 2 < 7x - 5$
 $4x + 2 - 7x < 7x - 5 - 7x$ *Subtract 7x.*
 $-3x + 2 < -5$
 $-3x + 2 - 2 < -5 - 2$ *Subtract 2.*
 $-3x < -7$
 $\frac{-3x}{-3} > \frac{-7}{-3}$ *Divide by -3;*
 $x > \frac{7}{3}$ *reverse the symbol.*

Graph the solution set $(\frac{7}{3}, \infty)$.



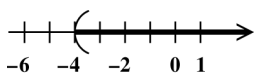
N4. $6 - 2t + 5t \leq 8t - 4$
 $3t + 6 \leq 8t - 4$
 $3t + 6 - 8t \leq 8t - 4 - 8t$ *Subtract 8t.*
 $-5t + 6 \leq -4$
 $-5t + 6 - 6 \leq -4 - 6$ *Subtract 6.*
 $-5t \leq -10$
 $\frac{-5t}{-5} \geq \frac{-10}{-5}$ *Divide by -5;*
 $t \geq 2$ *reverse the symbol.*

Graph the solution set $[2, \infty)$.



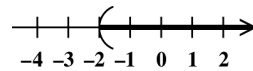
5. $4(x - 1) - 3x > -15 - (2x + 1)$
 $4x - 4 - 3x > -15 - 2x - 1$ *Distributive property*
 $x - 4 > -16 - 2x$
 $x - 4 + 2x > -16 - 2x + 2x$ *Add 2x.*
 $3x - 4 > -16$
 $3x - 4 + 4 > -16 + 4$ *Add 4.*
 $3x > -12$
 $\frac{3x}{3} > \frac{-12}{3}$ *Divide by 3.*
 $x > -4$

Graph the solution set $(-4, \infty)$.



N5. $2x - 3(x - 6) < 4(x + 7)$
 $2x - 3x + 18 < 4x + 28$ *Distributive property*
 $-x + 18 < 4x + 28$
 $-x + 18 + x < 4x + 28 + x$ *Add x.*
 $18 < 5x + 28$
 $18 - 28 < 5x + 28 - 28$ *Subtract 28.*
 $-10 < 5x$
 $\frac{-10}{5} < \frac{5x}{5}$ *Divide by 5.*
 $-2 < x$
 $x > -2$

Graph the solution set $(-2, \infty)$.



6. Let x = Maggie's score on the fourth test.

The average	is at least	90.
↓	↓	↓
$\frac{98 + 86 + 88 + x}{4}$	\geq	90

Solve the inequality.

$4\left(\frac{272 + x}{4}\right) \geq 4(90)$ *Add in the numerator; multiply by 4.*
 $272 + x \geq 360$
 $272 + x - 272 \geq 360 - 272$ *Subtract 272.*
 $x \geq 88$ *Combine terms.*

She must score 88 or more on the fourth test to have an average of *at least* 90.

N6. Let x = Kristine's score on the third test.

The average	is at least	90.
↓	↓	↓
$\frac{98 + 85 + x}{3}$	\geq	90

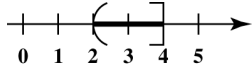
Solve the inequality.

$3\left(\frac{183 + x}{3}\right) \geq 3(90)$ *Add in the numerator; multiply by 3.*
 $183 + x \geq 270$
 $183 + x - 183 \geq 270 - 183$ *Subtract 183.*
 $x \geq 87$ *Combine terms.*

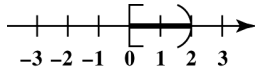
She must score 87 or more on the third test to have an average of *at least* 90.

7. The statement $2 < x \leq 4$ says that x can represent any number between 2 and 4, excluding 2 and including 4.

To graph the inequality, place a parenthesis at 2 and a bracket at 4 and draw a line segment between them. The interval is written as $(2, 4]$.



- N7.** The statement $0 \leq x < 2$ says that x can represent any number between 0 and 2, including 0 and excluding 2. To graph the inequality, place a bracket at 0 and a parenthesis at 2 and draw a line segment between them. The interval is written as $[0, 2)$.



8. $2 \leq 3x - 1 \leq 8$

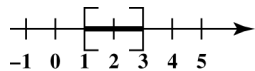
$$2 + 1 \leq 3x - 1 + 1 \leq 8 + 1 \quad \text{Add 1 to each part.}$$

$$3 \leq 3x \leq 9$$

$$\frac{3}{3} \leq \frac{3x}{3} \leq \frac{9}{3} \quad \text{Divide each part by 3.}$$

$$1 \leq x \leq 3$$

Graph the solution set $[1, 3]$.



N8. $-4 \leq \frac{3}{2}x - 1 \leq 0$

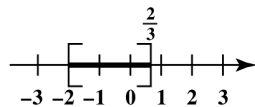
$$-4 + 1 \leq \frac{3}{2}x - 1 + 1 \leq 0 + 1 \quad \text{Add 1 to each part.}$$

$$-3 \leq \frac{3}{2}x \leq 1$$

$$\frac{2}{3}(-3) \leq \frac{2}{3}\left(\frac{3}{2}x\right) \leq \frac{2}{3}(1) \quad \text{Mult. each part by } \frac{2}{3}.$$

$$-2 \leq x \leq \frac{2}{3}$$

Graph the solution set $[-2, \frac{2}{3}]$.



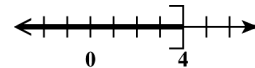
2.8 Section Exercises

- 1.** When graphing an inequality, use a parenthesis if the inequality symbol is \geq or \leq . Use a square bracket if the inequality symbol is $>$ or $<$.
Examples:

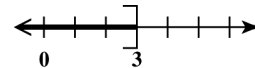
A parenthesis would be used for the inequalities $x < 2$ and $x > 3$. A square bracket would be used for the inequalities $x \leq 2$ and $x \geq 3$.

- 2.** *False.* A parenthesis is *always* used with the symbols $-\infty$ and ∞ .
- 3.** In interval notation, the set $\{x|x > 0\}$ is written $(0, \infty)$.

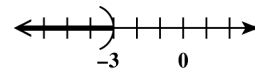
- 4.** The graph of $x \geq -7$ includes the endpoint, -7 , and therefore has a bracket at -7 . The graph of $x > -7$ does not include -7 and therefore has a parenthesis at -7 .
- 5.** The set of numbers graphed corresponds to the inequality $x > -4$.
- 6.** The set of numbers graphed corresponds to the inequality $x \geq -4$.
- 7.** The set of numbers graphed corresponds to the inequality $x \leq 4$.
- 8.** The set of numbers graphed corresponds to the inequality $x < 4$.
- 9.** The statement $z \leq 4$ says that z can represent any number less than or equal to 4. The interval is written as $(-\infty, 4]$. To graph the inequality, place a square bracket at 4 (to show that 4 is part of the graph) and draw an arrow extending to the left.



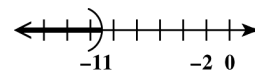
- 10.** The statement $x \leq 3$ can be written as $(-\infty, 3]$.



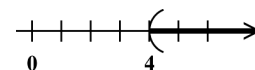
- 11.** The statement $x < -3$ says that x can represent any number less than -3 . The interval is written as $(-\infty, -3)$. To graph the inequality, place a parenthesis at -3 (to show that -3 is *not* part of the graph) and draw an arrow extending to the left.



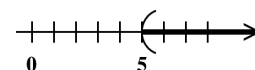
- 12.** The statement $r < -11$ says that r can represent any number less than -11 . The interval is written as $(-\infty, -11)$. To graph the inequality, place a parenthesis at -11 (to show that -11 is *not* part of the graph) and draw an arrow extending to the left.



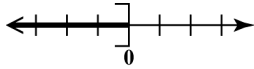
- 13.** The statement $t > 4$ says that t can represent any number greater than 4. The interval is written $(4, \infty)$. To graph the inequality, place a parenthesis at 4 (to show that 4 is *not* part of the graph) and draw an arrow extending to the right.



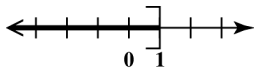
- 14.** The statement $m > 5$ can be written as $(5, \infty)$.



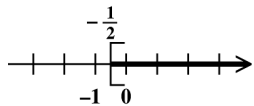
15. The statement $0 \geq x$ (or $x \leq 0$) says that x can represent any number less than or equal to 0. The interval is written as $(-\infty, 0]$. To graph the inequality, place a bracket at 0 (to show that 0 is part of the graph) and draw an arrow extending to the left.



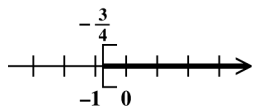
16. The statement $1 \geq x$ (or $x \leq 1$) says that x can represent any number less than or equal to 1. The interval is written as $(-\infty, 1]$. To graph the inequality, place a bracket at 1 (to show that 1 is part of the graph) and draw an arrow extending to the left.



17. The statement $-\frac{1}{2} \leq x$ (or $x \geq -\frac{1}{2}$) says that x can represent any number greater than or equal to $-\frac{1}{2}$. The interval is written $[-\frac{1}{2}, \infty)$. To graph the inequality, place a bracket at $-\frac{1}{2}$ (to show that $-\frac{1}{2}$ is part of the graph) and draw an arrow extending to the right.

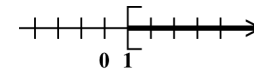


18. The statement $-\frac{3}{4} \leq x$ (or $x \geq -\frac{3}{4}$) says that x can represent any number greater than or equal to $-\frac{3}{4}$. The interval is written $[-\frac{3}{4}, \infty)$. To graph the inequality, place a bracket at $-\frac{3}{4}$ (to show that $-\frac{3}{4}$ is part of the graph) and draw an arrow extending to the right.



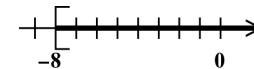
19. $z - 8 \geq -7$
 $z - 8 + 8 \geq -7 + 8$ *Add 8.*
 $z \geq 1$

Graph the solution set $[1, \infty)$.



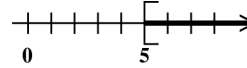
20. $p - 3 \geq -11$
 $p - 3 + 3 \geq -11 + 3$ *Add 3.*
 $p \geq -8$

Graph the solution set $[-8, \infty)$.



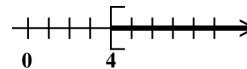
21. $2k + 3 \geq k + 8$
 $2k + 3 - k \geq k + 8 - k$ *Subtract k.*
 $k + 3 \geq 8$
 $k + 3 - 3 \geq 8 - 3$ *Subtract 3.*
 $k \geq 5$

Graph the solution set $[5, \infty)$.



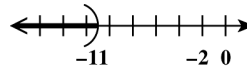
22. $3x + 7 \geq 2x + 11$
 $3x + 7 - 2x \geq 2x + 11 - 2x$ *Subtract 2x.*
 $x + 7 \geq 11$
 $x + 7 - 7 \geq 11 - 7$ *Subtract 7.*
 $x \geq 4$

Graph the solution set $[4, \infty)$.



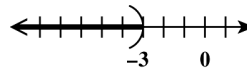
23. $3n + 5 < 2n - 6$
 $3n - 2n + 5 < 2n - 2n - 6$ *Subtract 2n.*
 $n + 5 < -6$
 $n + 5 - 5 < -6 - 5$ *Subtract 5.*
 $n < -11$

Graph the solution set $(-\infty, -11)$.



24. $5x - 2 < 4x - 5$
 $5x - 2 - 4x < 4x - 5 - 4x$ *Subtract 4x.*
 $x - 2 < -5$
 $x - 2 + 2 < -5 + 2$ *Add 2.*
 $x < -3$

Graph the solution set $(-\infty, -3)$.



25. The inequality symbol must be reversed when one is multiplying or dividing by a negative number.

26. $p < q$ and $r < 0$

A. $pr < qr$

The second part of the multiplication property of inequality states that when both sides of an inequality are multiplied by a negative number, the inequality symbol is reversed. Since r is negative, this statement is *false*.

B. $pr > qr$

Both sides of the inequality $p < q$ have been multiplied by the negative number r and the inequality symbol has been reversed, so this statement is *true*.

C. $p + r < q + r$

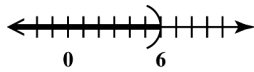
By the addition property of inequality, this statement is *true*. When the same number is added to both sides of an inequality, the inequality symbol is not reversed.

D. $p - r < q - r$

When the same number is subtracted from both sides of an inequality, the inequality symbol is not reversed. The statement is *true*. Therefore, only statement **A** is false.

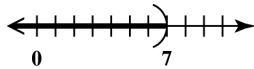
27. $3x < 18$
 $\frac{3x}{3} < \frac{18}{3}$ Divide by 3.
 $x < 6$

Graph the solution set $(-\infty, 6)$.



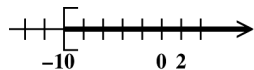
28. $5x < 35$
 $\frac{5x}{5} < \frac{35}{5}$ Divide by 5.
 $x < 7$

Graph the solution set $(-\infty, 7)$.



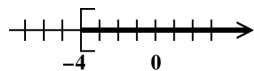
29. $2y \geq -20$
 $\frac{2y}{2} \geq \frac{-20}{2}$ Divide by 2.
 $y \geq -10$

Graph the solution set $[-10, \infty)$.



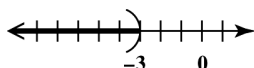
30. $6m \geq -24$
 $\frac{6m}{6} \geq \frac{-24}{6}$ Divide by 6.
 $m \geq -4$

Graph the solution set $[-4, \infty)$.



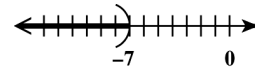
31. $-8t > 24$
 $\frac{-8t}{-8} < \frac{24}{-8}$ Divide by -8;
 reverse the symbol
 from $>$ to $<$.
 $t < -3$

Graph the solution set $(-\infty, -3)$.



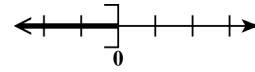
32. $-7x > 49$
 $\frac{-7x}{-7} < \frac{49}{-7}$ Divide by -7;
 reverse the symbol
 from $>$ to $<$.
 $x < -7$

Graph the solution set $(-\infty, -7)$.



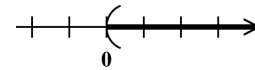
33. $-x \geq 0$
 $-1x \geq 0$
 $\frac{-1x}{-1} \leq \frac{0}{-1}$ Divide by -1;
 reverse the symbol
 from \geq to \leq .
 $x \leq 0$

Graph the solution set $(-\infty, 0]$.



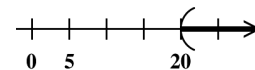
34. $-k < 0$
 $-1k < 0$
 $\frac{-1k}{-1} > \frac{0}{-1}$ Divide by -1;
 reverse the symbol
 from $<$ to $>$.
 $k > 0$

Graph the solution set $(0, \infty)$.



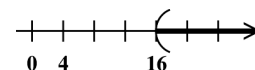
35. $-\frac{3}{4}r < -15$
 $(-\frac{4}{3})(-\frac{3}{4}r) > (-\frac{4}{3})(-15)$
 Multiply by $-\frac{4}{3}$ (the reciprocal of $-\frac{3}{4}$);
 reverse the symbol from $<$ to $>$.
 $r > 20$

Graph the solution set $(20, \infty)$.



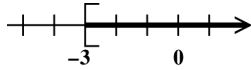
36. $-\frac{7}{8}t < -14$
 $(-\frac{8}{7})(-\frac{7}{8}t) > (-\frac{8}{7})(-14)$
 Multiply by $-\frac{8}{7}$ (the reciprocal of $-\frac{7}{8}$);
 reverse the symbol from $<$ to $>$.
 $t > 16$

Graph the solution set $(16, \infty)$.



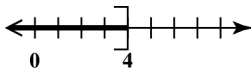
37. $-0.02x \leq 0.06$
 $\frac{-0.02x}{-0.02} \geq \frac{0.06}{-0.02}$ *Divide by -0.02 ;
 reverse the symbol
 from \leq to \geq .*
 $x \geq -3$

Graph the solution set $[-3, \infty)$.



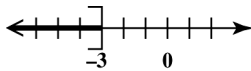
38. $-0.03v \geq -0.12$
 $\frac{-0.03v}{-0.03} \leq \frac{-0.12}{-0.03}$ *Divide by -0.03 ;
 reverse the symbol
 from \geq to \leq .*
 $v \leq 4$

Graph the solution set $(-\infty, 4]$.



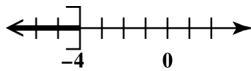
39. $8x + 9 \leq -15$
 $8x \leq -24$ *Subtract 9.*
 $\frac{8x}{8} \leq \frac{-24}{8}$ *Divide by 8.*
 $x \leq -3$

Graph the solution set $(-\infty, -3]$.



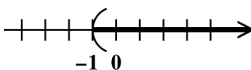
40. $6x + 7 \leq -17$
 $6x \leq -24$ *Subtract 7.*
 $\frac{6x}{6} \leq \frac{-24}{6}$ *Divide by 6.*
 $x \leq -4$

Graph the solution set $(-\infty, -4]$.



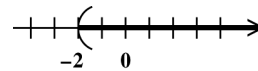
41. $-4x - 3 < 1$
 $-4x < 4$ *Add 3.*
 $\frac{-4x}{-4} > \frac{4}{-4}$ *Divide by -4 ;
 reverse the symbol
 from $<$ to $>$.*
 $x > -1$

Graph the solution set $(-1, \infty)$.



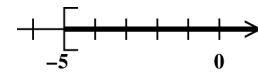
42. $-5x - 4 < 6$
 $-5x < 10$ *Add 4.*
 $\frac{-5x}{-5} > \frac{10}{-5}$ *Divide by -5 ;
 reverse the symbol
 from $<$ to $>$.*
 $x > -2$

Graph the solution set $(-2, \infty)$.



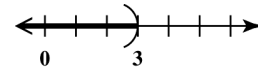
43. $5r + 1 \geq 3r - 9$
 $2r + 1 \geq -9$ *Subtract 3r.*
 $2r \geq -10$ *Subtract 1.*
 $r \geq -5$ *Divide by 2.*

Graph the solution set $[-5, \infty)$.



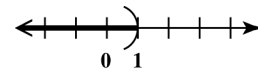
44. $6t + 3 < 3t + 12$
 $3t + 3 < 12$ *Subtract 3t.*
 $3t < 9$ *Subtract 3.*
 $t < 3$ *Divide by 3.*

Graph the solution set $(-\infty, 3)$.



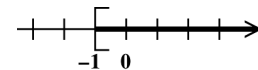
45. $6x + 3 + x < 2 + 4x + 4$
 $7x + 3 < 4x + 6$ *Combine like terms.*
 $3x + 3 < 6$ *Subtract 4x.*
 $3x < 3$ *Subtract 3.*
 $x < 1$ *Divide by 3.*

Graph the solution set $(-\infty, 1)$.



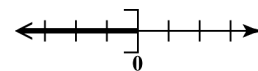
46. $-4w + 12 + 9w \geq w + 9 + w$
 $5w + 12 \geq 2w + 9$ *Combine like terms.*
 $3w + 12 \geq 9$ *Subtract 2w.*
 $3w \geq -3$ *Subtract 12.*
 $w \geq -1$ *Divide by 3.*

Graph the solution set $[-1, \infty)$.



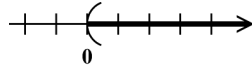
47. $-x + 4 + 7x \leq -2 + 3x + 6$
 $6x + 4 \leq 4 + 3x$
 $3x + 4 \leq 4$
 $3x \leq 0$
 $x \leq 0$

Graph the solution set $(-\infty, 0]$.



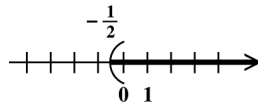
$$\begin{aligned}
 48. \quad & 14y - 6 + 7y > 4 + 10y - 10 \\
 & 21y - 6 > 10y - 6 \\
 & 11y - 6 > -6 \\
 & 11y > 0 \\
 & y > 0
 \end{aligned}$$

Graph the solution set $(0, \infty)$.



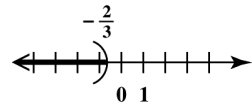
$$\begin{aligned}
 49. \quad & 5(t - 1) > 3(t - 2) \\
 & 5t - 5 > 3t - 6 \\
 & 2t - 5 > -6 \\
 & 2t > -1 \\
 & t > -\frac{1}{2}
 \end{aligned}$$

Graph the solution set $(-\frac{1}{2}, \infty)$.



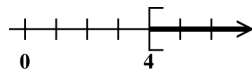
$$\begin{aligned}
 50. \quad & 7(m - 2) < 4(m - 4) \\
 & 7m - 14 < 4m - 16 \\
 & 3m - 14 < -16 \\
 & 3m < -2 \\
 & m < -\frac{2}{3}
 \end{aligned}$$

Graph the solution set $(-\infty, -\frac{2}{3})$.



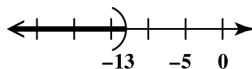
$$\begin{aligned}
 51. \quad & 5(x + 3) - 6x \leq 3(2x + 1) - 4x \\
 & 5x + 15 - 6x \leq 6x + 3 - 4x \\
 & -x + 15 \leq 2x + 3 \\
 & -3x + 15 \leq 3 \\
 & -3x \leq -12 \\
 & \frac{-3x}{-3} \geq \frac{-12}{-3} \quad \text{Divide by } -3; \\
 & \quad \quad \quad \text{reverse the symbol.} \\
 & x \geq 4
 \end{aligned}$$

Graph the solution set $[4, \infty)$.



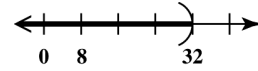
$$\begin{aligned}
 52. \quad & 2(x - 5) + 3x < 4(x - 6) + 1 \\
 & 2x - 10 + 3x < 4x - 24 + 1 \\
 & 5x - 10 < 4x - 23 \\
 & x - 10 < -23 \\
 & x < -13
 \end{aligned}$$

Graph the solution set $(-\infty, -13)$.



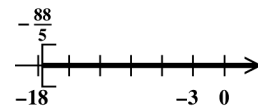
$$\begin{aligned}
 53. \quad & \frac{2}{3}(p + 3) > \frac{5}{6}(p - 4) \\
 & 6\left(\frac{2}{3}\right)(p + 3) > 6\left(\frac{5}{6}\right)(p - 4) \\
 & \quad \quad \quad \text{Multiply by 6, the LCD.} \\
 & 4(p + 3) > 5(p - 4) \\
 & 4p + 12 > 5p - 20 \\
 & -p + 12 > -20 \\
 & -p > -32 \\
 & \frac{-p}{-1} < \frac{-32}{-1} \quad \text{Divide by } -1; \\
 & \quad \quad \quad \text{reverse the symbol.} \\
 & p < 32
 \end{aligned}$$

Graph the solution set $(-\infty, 32)$.



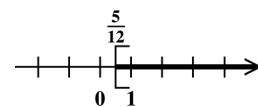
$$\begin{aligned}
 54. \quad & \frac{7}{9}(y - 4) \leq \frac{4}{3}(y + 5) \\
 & 9\left(\frac{7}{9}\right)(y - 4) \leq 9\left(\frac{4}{3}\right)(y + 5) \\
 & \quad \quad \quad \text{Multiply by 9, the LCD.} \\
 & 7(y - 4) \leq 12(y + 5) \\
 & 7y - 28 \leq 12y + 60 \\
 & -5y - 28 \leq 60 \\
 & -5y \leq 88 \\
 & \frac{-5y}{-5} \geq \frac{88}{-5} \quad \text{Divide by } -5; \\
 & \quad \quad \quad \text{reverse the symbol.} \\
 & y \geq -\frac{88}{5}
 \end{aligned}$$

Graph the solution set $[-\frac{88}{5}, \infty)$.



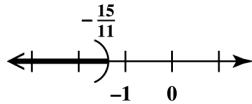
$$\begin{aligned}
 55. \quad & 4x - (6x + 1) \leq 8x + 2(x - 3) \\
 & 4x - 6x - 1 \leq 8x + 2x - 6 \\
 & -2x - 1 \leq 10x - 6 \\
 & -12x - 1 \leq -6 \\
 & -12x \leq -5 \\
 & \frac{-12x}{-12} \geq \frac{-5}{-12} \quad \text{Divide by } -12; \\
 & \quad \quad \quad \text{reverse the symbol.} \\
 & x \geq \frac{5}{12}
 \end{aligned}$$

Graph the solution set $[\frac{5}{12}, \infty)$.



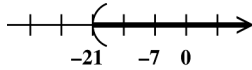
$$\begin{aligned}
 56. \quad & 2y - (4y + 3) > 6y + 3(y + 4) \\
 & 2y - 4y - 3 > 6y + 3y + 12 \\
 & -2y - 3 > 9y + 12 \\
 & -11y - 3 > 12 \\
 & -11y > 15 \\
 & \frac{-11y}{-11} < \frac{15}{-11} \quad \text{Divide by } -11; \\
 & \quad \quad \quad \text{reverse the symbol.} \\
 & y < -\frac{15}{11}
 \end{aligned}$$

Graph the solution set $(-\infty, -\frac{15}{11})$.



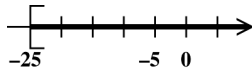
57. $5(2k + 3) - 2(k - 8) > 3(2k + 4) + k - 2$
 $10k + 15 - 2k + 16 > 6k + 12 + k - 2$
 $8k + 31 > 7k + 10$
 $k + 31 > 10$
 $k > -21$

Graph the solution set $(-21, \infty)$.



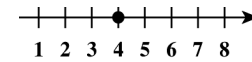
58. $2(3z - 5) + 4(z + 6) \geq 2(3z + 2) + 3z - 15$
 $6z - 10 + 4z + 24 \geq 6z + 4 + 3z - 15$
 $10z + 14 \geq 9z - 11$
 $z + 14 \geq -11$
 $z \geq -25$

Graph the solution set $[-25, \infty)$.



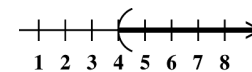
59. $3x + 2 = 14$
 $3x = 12$
 $x = 4$

Solution set: {4}



60. $3x + 2 > 14$
 $3x > 12$
 $x > 4$

Solution set: $(4, \infty)$



61. $3x + 2 < 14$
 $3x < 12$
 $x < 4$

Solution set: $(-\infty, 4)$



62. If you were to graph all the solutions from Exercises 59–61 on the same number line, the graph would be the complete number line, that is, all real numbers.

63. The statement "You must be at least 18 yr old to vote" translates as $x \geq 18$.

64. The statement "Less than 1 in. of rain fell" translates as $x < 1$.

65. The statement "Chicago received more than 5 in. of snow" translates as $x > 5$.

66. The statement "A full-time student must take at least 12 credits" translates as $x \geq 12$.

67. The statement "Tracy could spend at most \$20 on a gift" translates as $x \leq 20$.

68. The statement "The car's rate exceeded 60 mph" translates as $x > 60$.

69. Let x = the score on the third test.

The average of the three tests	is at least	80.
↓	↓	↓
$\frac{76 + 81 + x}{3}$	\geq	80
		$\frac{157 + x}{3} \geq 80$
		$3\left(\frac{157 + x}{3}\right) \geq 3(80)$
		$157 + x \geq 240$
		$x \geq 83$

In order to average at least 80, Christy's score on her third test must be 83 or greater.

70. Let x = the score on the third test.

The average of the three tests	is at least	90.
↓	↓	↓
$\frac{96 + 86 + x}{3}$	\geq	90
		$\frac{182 + x}{3} \geq 90$
		$3\left(\frac{182 + x}{3}\right) \geq 3(90)$
		$182 + x \geq 270$
		$x \geq 88$

In order to average at least 90, Joseph's score on his third test must be 88 or greater.

71. Let n = the number.

"When 2 is added to the difference between six times a number and 5, the result is greater than 13 added to five times the number" translates to

$$(6n - 5) + 2 > 5n + 13.$$

Solve the inequality.

$$6n - 5 + 2 > 5n + 13$$

$$6n - 3 > 5n + 13$$

$$n - 3 > 13 \quad \text{Subtract } 5n.$$

$$n > 16 \quad \text{Add } 3.$$

All numbers greater than 16 satisfy the given condition.

72. Let $n =$ the number.
 "When 8 is subtracted from the sum of three times a number and 6, the result is less than 4 more than the number" translates to

$$(3n + 6) - 8 < n + 4.$$

Solve the inequality.

$$\begin{aligned} 3n + 6 - 8 &< n + 4 \\ 3n - 2 &< n + 4 \\ 2n - 2 &< 4 && \text{Subtract } 1n. \\ 2n &< 6 && \text{Add } 2. \\ n &< 3 && \text{Divide by } 2. \end{aligned}$$

All numbers less than 3 satisfy the given condition.

73. The Fahrenheit temperature must correspond to a Celsius temperature that is greater than or equal to -25 degrees.

$$\begin{aligned} C = \frac{5}{9}(F - 32) &\geq -25 \\ \frac{9}{5}[\frac{5}{9}(F - 32)] &\geq \frac{9}{5}(-25) \\ F - 32 &\geq -45 \\ F &\geq -13 \end{aligned}$$

The temperature in Minneapolis on a certain winter day is never less than -13° Fahrenheit.

74. The Celsius temperature must give a Fahrenheit temperature that is less than or equal to 122 degrees.

$$\begin{aligned} F = \frac{9}{5}C + 32 &\leq 122 \\ \frac{9}{5}C &\leq 90 \\ \frac{5}{9}(\frac{9}{5}C) &\leq \frac{5}{9}(90) \\ C &\leq 50 \end{aligned}$$

The temperature of Phoenix has never exceeded 50° Celsius.

75. $P = 2L + 2W$; $P \geq 400$
 From the figure, we have $L = 4x + 3$ and $W = x + 37$. Thus, we have the inequality

$$2(4x + 3) + 2(x + 37) \geq 400.$$

Solve this inequality.

$$\begin{aligned} 8x + 6 + 2x + 74 &\geq 400 \\ 10x + 80 &\geq 400 \\ 10x &\geq 320 \\ x &\geq 32 \end{aligned}$$

The rectangle will have a perimeter of at least 400 if the value of x is 32 or greater.

76. $P = a + b + c$; $P \geq 72$
 From the figure, we have $a = x$, $b = x + 11$, and $c = 2x + 5$. Thus, we have the inequality

$$x + (x + 11) + (2x + 5) \geq 72.$$

Solve this inequality.

$$\begin{aligned} 4x + 16 &\geq 72 \\ 4x &\geq 56 \\ x &\geq \frac{56}{4} = 14 \end{aligned}$$

The triangle will have a perimeter of at least 72 if the value of x is 14 or greater.

77. $2 + 0.30x \leq 5.60$
 $10(2 + 0.30x) \leq 10(5.60)$
 $20 + 3x \leq 56$
 $3x \leq 36$
 $x \leq 12$

Alan can use the phone for a maximum of 12 minutes after the first three minutes. This means that the maximum *total* time he can use the phone is 15 minutes.

78. Let $x =$ the number of gallons.
 The amount she spends can be represented by $\$4.50 + \$3.20x$. This must be less than or equal to $\$38.10$.

$$\begin{aligned} 4.5 + 3.2x &\leq 38.10 \\ 3.2x &\leq 33.6 && \text{Subtract } 4.5. \\ \frac{3.2x}{3.2} &\leq \frac{33.6}{3.2} && \text{Divide by } 3.2. \\ x &\leq 10.5 \end{aligned}$$

She can purchase 10.5 gallons of gasoline.

79. "Revenue from the sales of the DVDs is \$5 per DVD less sales costs of \$100" translates to

$$R = 5x - 100,$$

where x represents the number of DVDs to be produced.

80. "Production costs are \$125 plus \$4 per DVD" translates to

$$C = 125 + 4x.$$

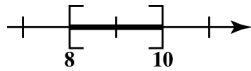
81. $P = R - C$
 $= (5x - 100) - (125 + 4x)$
 $= 5x - 100 - 125 - 4x$
 $= x - 225$

We can use this expression for P to solve the inequality.

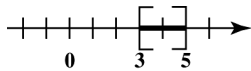
$$\begin{aligned} P &> 0 \\ x - 225 &> 0 \\ x &> 225 \end{aligned}$$

82. To make a profit, more than 225 DVDs must be produced and sold.
 83. The graph corresponds to the inequality $-1 < x < 2$, excluding both -1 and 2 .
 84. The graph corresponds to the inequality $-1 \leq x < 2$.

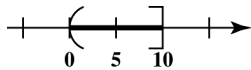
85. The graph corresponds to the inequality $-1 < x \leq 2$, excluding -1 but including 2 .
86. The graph corresponds to the inequality $-1 \leq x \leq 2$.
87. The statement $8 \leq x \leq 10$ says that x can represent any number between 8 and 10 , including 8 and 10 . To graph the inequality, place brackets at 8 and 10 (to show that 8 and 10 are part of the graph) and draw a line segment between the brackets. The interval is written as $[8, 10]$.



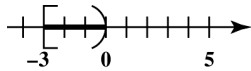
88. The statement $3 \leq x \leq 5$ can be written as $[3, 5]$.



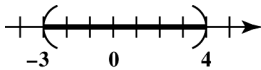
89. The statement $0 < y \leq 10$ says that y can represent any number between 0 and 10 , excluding 0 and including 10 . To graph the inequality, place a parenthesis at 0 and a bracket at 10 and draw a line segment between them. The interval is written as $(0, 10]$.



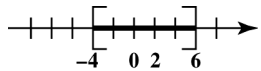
90. The statement $-3 \leq x < 0$ can be written as $[-3, 0)$.



91. The statement $4 > x > -3$ can be written as $-3 < x < 4$. Graph the solution set $(-3, 4)$.

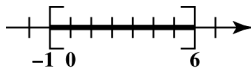


92. The statement $6 \geq x \geq -4$ can be written as $-4 \leq x \leq 6$. Graph the solution set $[-4, 6]$.



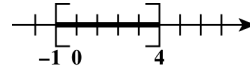
93. $-5 \leq 2x - 3 \leq 9$
 $-5 + 3 \leq 2x - 3 + 3 \leq 9 + 3$ *Add 3 to each part.*
 $-2 \leq 2x \leq 12$
 $\frac{-2}{2} \leq \frac{2x}{2} \leq \frac{12}{2}$ *Divide each part by 2.*
 $-1 \leq x \leq 6$

Graph the solution set $[-1, 6]$.



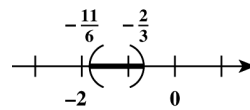
94. $-7 \leq 3x - 4 \leq 8$
 $-7 + 4 \leq 3x - 4 + 4 \leq 8 + 4$ *Add 4 to each part.*
 $-3 \leq 3x \leq 12$
 $-1 \leq x \leq 4$ *Divide each part by 3.*

Graph the solution set $[-1, 4]$.



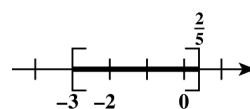
95. $5 < 1 - 6m < 12$
 $5 - 1 < 1 - 6m - 1 < 12 - 1$ *Subtract 1 from each part.*
 $4 < -6m < 11$
 $\frac{4}{-6} > \frac{-6m}{-6} > \frac{11}{-6}$ *Divide each part by -6; reverse both symbols.*
 $-\frac{2}{3} > m > -\frac{11}{6}$
 or $-\frac{11}{6} < m < -\frac{2}{3}$ *Equivalent inequality*

Graph the solution set $(-\frac{11}{6}, -\frac{2}{3})$.



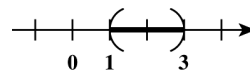
96. $-1 \leq 1 - 5q \leq 16$
 $-1 - 1 \leq 1 - 5q - 1 \leq 16 - 1$ *Subtract 1 from each part.*
 $-2 \leq -5q \leq 15$
 $\frac{-2}{-5} \geq \frac{-5q}{-5} \geq \frac{15}{-5}$ *Divide each part by -5; reverse both symbols.*
 $\frac{2}{5} \geq q \geq -3$
 or $-3 \leq q \leq \frac{2}{5}$ *Equivalent inequality*

Graph the solution set $[-3, \frac{2}{5}]$.



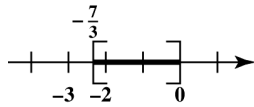
97. $10 < 7p + 3 < 24$
 $7 < 7p < 21$ *Subtract 3.*
 $1 < p < 3$ *Divide by 7.*

Graph the solution set $(1, 3)$.



$$\begin{aligned}
 98. \quad & -8 \leq 3r - 1 \leq -1 \\
 & -7 \leq 3r \leq 0 \quad \text{Add 1.} \\
 & -\frac{7}{3} \leq r \leq 0 \quad \text{Divide by 3.}
 \end{aligned}$$

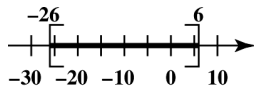
Graph the solution set $[-\frac{7}{3}, 0]$.



$$\begin{aligned}
 99. \quad & -12 \leq \frac{1}{2}z + 1 \leq 4 \\
 2(-12) & \leq 2(\frac{1}{2}z + 1) \leq 2(4) \quad \text{Multiply each} \\
 & \quad \quad \quad \text{part by 2.} \\
 -24 & \leq z + 2 \leq 8 \\
 -26 & \leq z \leq 6 \quad \text{Subtract 2.}
 \end{aligned}$$

Note: We could have started this solution by subtracting 1 from each part.

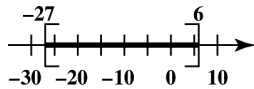
Graph the solution set $[-26, 6]$.



$$\begin{aligned}
 100. \quad & -6 \leq 3 + \frac{1}{3}x \leq 5 \\
 -9 & \leq \frac{1}{3}x \leq 2 \quad \text{Subtract 3.} \\
 3(-9) & \leq 3(\frac{1}{3}x) \leq 3(2) \quad \text{Multiply each} \\
 & \quad \quad \quad \text{part by 3.} \\
 -27 & \leq x \leq 6
 \end{aligned}$$

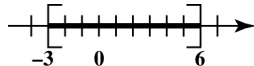
Note: We could have started this solution by multiplying each part by 3.

Graph the solution set $[-27, 6]$.



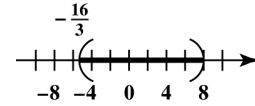
$$\begin{aligned}
 101. \quad & 1 \leq 3 + \frac{2}{3}p \leq 7 \\
 3(1) & \leq 3(3 + \frac{2}{3}p) \leq 3(7) \quad \text{Multiply by 3.} \\
 3 & \leq 9 + 2p \leq 21 \\
 -6 & \leq 2p \leq 12 \quad \text{Subtract 9.} \\
 -3 & \leq p \leq 6 \quad \text{Divide by 2.}
 \end{aligned}$$

Graph the solution set $[-3, 6]$.



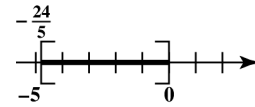
$$\begin{aligned}
 102. \quad & 2 < 6 + \frac{3}{4}x < 12 \\
 4(2) & < 4(6 + \frac{3}{4}x) < 4(12) \quad \text{Multiply by 4.} \\
 8 & < 24 + 3x < 48 \\
 -16 & < 3x < 24 \quad \text{Subtract 24.} \\
 -\frac{16}{3} & < x < 8 \quad \text{Divide by 3.}
 \end{aligned}$$

Graph the solution set $(-\frac{16}{3}, 8)$.



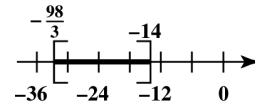
$$\begin{aligned}
 103. \quad & -7 \leq \frac{5}{4}r - 1 \leq -1 \\
 -6 & \leq \frac{5}{4}r \leq 0 \quad \text{Add 1.} \\
 \frac{4}{5}(-6) & \leq \frac{4}{5}(\frac{5}{4}r) \leq \frac{4}{5}(0) \quad \text{Multiply by 4/5.} \\
 -\frac{24}{5} & \leq r \leq 0
 \end{aligned}$$

Graph the solution set $[-\frac{24}{5}, 0]$.



$$\begin{aligned}
 104. \quad & -12 \leq \frac{3}{7}x + 2 \leq -4 \\
 7(-12) & \leq 7(\frac{3}{7}x + 2) \leq 7(-4) \quad \text{Multiply by 7.} \\
 -84 & \leq 3x + 14 \leq -28 \\
 -98 & \leq 3x \leq -42 \quad \text{Subtract 14.} \\
 -\frac{98}{3} & \leq x \leq -14 \quad \text{Divide by 3.}
 \end{aligned}$$

To graph the solution set $[-\frac{98}{3}, -14]$, note that $-\frac{98}{3} = -32\frac{2}{3}$.



In part (a) of Exercises 105–110, replace x with -2 . In part (b), replace x with 4 . Then use the order of operations.

$$\begin{array}{ll}
 105. \text{ (a)} & y = 5x + 3 \\
 & y = 5(-2) + 3 \\
 & y = -10 + 3 \\
 & y = -7 \\
 \text{ (b)} & y = 5x + 3 \\
 & y = 5(4) + 3 \\
 & y = 20 + 3 \\
 & y = 23
 \end{array}$$

$$\begin{array}{ll}
 106. \text{ (a)} & y = 4 - 3x \\
 & y = 4 - 3(-2) \\
 & y = 4 + 6 \\
 & y = 10 \\
 \text{ (b)} & y = 4 - 3x \\
 & y = 4 - 3(4) \\
 & y = 4 - 12 \\
 & y = -8
 \end{array}$$

$$\begin{array}{ll}
 107. \text{ (a)} & 6x - 2 = y \\
 & 6(-2) - 2 = y \\
 & -12 - 2 = y \\
 & -14 = y \\
 \text{ (b)} & 6x - 2 = y \\
 & 6(4) - 2 = y \\
 & 24 - 2 = y \\
 & 22 = y
 \end{array}$$

108. (a) $4x + 7y = 11$
 $4(-2) + 7y = 11$
 $-8 + 7y = 11$
 $7y = 19$
 $y = \frac{19}{7}$

(b) $4x + 7y = 11$
 $4(4) + 7y = 11$
 $16 + 7y = 11$
 $7y = -5$
 $y = -\frac{5}{7}$

109. (a) $2x - 5y = 10$
 $2(-2) - 5y = 10$
 $-4 - 5y = 10$
 $-5y = 14$
 $y = -\frac{14}{5}$

(b) $2x - 5y = 10$
 $2(4) - 5y = 10$
 $8 - 5y = 10$
 $-5y = 2$
 $y = -\frac{2}{5}$

110. (a) $y + 3x = 8$
 $y + 3(-2) = 8$
 $y - 6 = 8$
 $y = 14$

(b) $y + 3x = 8$
 $y + 3(4) = 8$
 $y + 12 = 8$
 $y = -4$

Chapter 2 Review Exercises

1. $x - 5 = 1$
 $x = 6$ *Add 5.*
 The solution set is $\{6\}$.

2. $x + 8 = -4$
 $x = -12$ *Subtract 8.*
 The solution set is $\{-12\}$.

3. $3t + 1 = 2t + 8$
 $t + 1 = 8$ *Subtract 2t.*
 $t = 7$ *Subtract 1.*
 The solution set is $\{7\}$.

4. $5z = 4z + \frac{2}{3}$
 $z = \frac{2}{3}$ *Subtract 4z.*
 The solution set is $\{\frac{2}{3}\}$.

5. $(4r - 2) - (3r + 1) = 8$
 $(4r - 2) - 1(3r + 1) = 8$ *Replace - with -1.*
 $4r - 2 - 3r - 1 = 8$ *Dist. prop.*
 $r - 3 = 8$
 $r = 11$ *Add 3.*
 The solution set is $\{11\}$.

6. $3(2x - 5) = 2 + 5x$
 $6x - 15 = 2 + 5x$ *Dist. prop.*
 $x - 15 = 2$ *Subtract 5x.*
 $x = 17$ *Add 15.*
 The solution set is $\{17\}$.

7. $7x = 35$
 $x = 5$ *Divide by 7.*
 The solution set is $\{5\}$.

8. $12r = -48$
 $r = -4$ *Divide by 12.*
 The solution set is $\{-4\}$.

9. $2p - 7p + 8p = 15$
 $3p = 15$
 $p = 5$ *Divide by 3.*
 The solution set is $\{5\}$.

10. $\frac{x}{12} = -1$
 $x = -12$ *Multiply by 12.*
 The solution set is $\{-12\}$.

11. $\frac{5}{8}q = 8$
 $\frac{8}{5}(\frac{5}{8}q) = \frac{8}{5}(8)$ *Multiply by $\frac{8}{5}$.*
 $q = \frac{64}{5}$
 The solution set is $\{\frac{64}{5}\}$.

12. $12m + 11 = 59$
 $12m = 48$ *Subtract 11.*
 $m = 4$ *Divide by 12.*
 The solution set is $\{4\}$.

13. $3(2x + 6) - 5(x + 8) = x - 22$
 $6x + 18 - 5x - 40 = x - 22$
 $x - 22 = x - 22$
 This is a true statement, so the solution set is $\{\text{all real numbers}\}$.

14. $5x + 9 - (2x - 3) = 2x - 7$
 $5x + 9 - 2x + 3 = 2x - 7$
 $3x + 12 = 2x - 7$
 $x + 12 = -7$
 $x = -19$
 The solution set is $\{-19\}$.

15. $\frac{1}{2}r - \frac{r}{3} = \frac{r}{6}$
 $6\left(\frac{1}{2}r\right) - 6\left(\frac{r}{3}\right) = 6\left(\frac{r}{6}\right)$ *Multiply by 6.*
 $3r - 2r = r$
 $r = r$
 This is a true statement, so the solution set is $\{\text{all real numbers}\}$.

16. $0.1(x + 80) + 0.2x = 14$
 $10[0.1(x + 80) + 0.2x] = 10(14)$ *Multiply by 10.*
 $(x + 80) + 2x = 140$ *Dist. prop.*
 $3x + 80 = 140$
 $3x = 60$
 $x = 20$
 The solution set is $\{20\}$.

$$\begin{aligned}
 17. \quad 3x - (-2x + 6) &= 4(x - 4) + x \\
 3x + 2x - 6 &= 4x - 16 + x \\
 5x - 6 &= 5x - 16 \\
 -6 &= -16
 \end{aligned}$$

This statement is false, so there is no solution set, symbolized by \emptyset .

$$\begin{aligned}
 18. \quad \frac{1}{2}(x + 3) - \frac{2}{3}(x - 2) &= 3 \\
 \text{Multiply both sides by 6 to eliminate fractions.} \\
 6\left[\frac{1}{2}(x + 3) - \frac{2}{3}(x - 2)\right] &= 6(3) \\
 6\left[\frac{1}{2}(x + 3)\right] - 6\left[\frac{2}{3}(x - 2)\right] &= 18 \\
 3(x + 3) - 4(x - 2) &= 18 \\
 3x + 9 - 4x + 8 &= 18 \\
 -x + 17 &= 18 \\
 -x &= 1 \\
 x &= -1
 \end{aligned}$$

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

$$\begin{aligned}
 19. \quad \text{Let } x \text{ represent the number.} \\
 5x + 7 &= 3x \\
 7 &= -2x \quad \text{Subtract } 5x. \\
 -\frac{7}{2} &= x \quad \text{Divide by } -2.
 \end{aligned}$$

The number is $-\frac{7}{2}$.

20. *Step 2*
 Let x = the number of Republicans.
 Then $x + 22$ = the number of Democrats.

$$\text{Step 3} \quad x + (x + 22) = 118$$

$$\begin{aligned}
 \text{Step 4} \quad 2x + 22 &= 118 \\
 2x &= 96 \\
 x &= 48
 \end{aligned}$$

Step 5
 Since $x = 48$, $x + 22 = 70$.
 There were 70 Democrats and 48 Republicans.

Step 6
 There are 22 more Democrats than Republicans and the total is 118.

21. *Step 2*
 Let x = the land area of Rhode Island.
 Then $x + 5213$ = land area of Hawaii.

Step 3
 The areas total 7637 square miles, so

$$x + (x + 5213) = 7637.$$

$$\begin{aligned}
 \text{Step 4} \quad 2x + 5213 &= 7637 \\
 2x &= 2424 \\
 x &= 1212
 \end{aligned}$$

Step 5
 Since $x = 1212$, $x + 5213 = 6425$. The land area of Rhode Island is 1212 square miles and that of Hawaii is 6425 square miles.

Step 6
 The land area of Hawaii is 5213 square miles greater than the land area of Rhode Island and the total is 7637 square miles.

22. *Step 2*
 Let x = the height of Twin Falls.
 Then $\frac{5}{2}x$ = the height of Seven Falls.

Step 3
 The sum of the heights is 420 feet, so

$$x + \frac{5}{2}x = 420.$$

$$\begin{aligned}
 \text{Step 4} \quad 2\left(x + \frac{5}{2}x\right) &= 2(420) \\
 2x + 5x &= 840 \\
 7x &= 840 \\
 x &= 120
 \end{aligned}$$

Step 5
 Since $x = 120$, $\frac{5}{2}x = \frac{5}{2}(120) = 300$. The height of Twin Falls is 120 feet and that of Seven Falls is 300 feet.

Step 6
 The height of Seven Falls is $\frac{5}{2}$ the height of Twin Falls and the sum is 420.

23. *Step 2*
 Let x = the measure of the angle.
 Then $90 - x$ = the measure of its complement and $180 - x$ = the measure of its supplement.

$$\text{Step 3} \quad 180 - x = 10(90 - x)$$

$$\begin{aligned}
 \text{Step 4} \quad 180 - x &= 900 - 10x \\
 9x + 180 &= 900 \\
 9x &= 720 \\
 x &= 80
 \end{aligned}$$

Step 5
 The measure of the angle is 80° .
 Its complement measures $90^\circ - 80^\circ = 10^\circ$, and its supplement measures $180^\circ - 80^\circ = 100^\circ$.

Step 6
 The measure of the supplement is 10 times the measure of the complement.

24. *Step 2*
 Let x = lesser odd integer.
 Then $x + 2$ = greater odd integer.

$$\text{Step 3} \quad x + 2(x + 2) = (x + 2) + 24$$

$$\begin{aligned}
 \text{Step 4} \quad x + 2x + 4 &= x + 26 \\
 3x + 4 &= x + 26 \\
 2x + 4 &= 26 \\
 2x &= 22 \\
 x &= 11
 \end{aligned}$$

Step 5
 Since $x = 11$, $x + 2 = 13$. The consecutive odd numbers are 11 and 13.

Step 6

The lesser plus twice the greater is
 $11 + 2(13) = 37$, which is 24 more than the
 greater.

In Exercises 25–28, substitute the given values into the
 given formula and then solve for the remaining variable.

25. $A = \frac{1}{2}bh$; $A = 44$, $b = 8$

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

$$44 = \frac{1}{2}(8)h$$

$$44 = 4h$$

$$11 = h$$

26. $A = \frac{1}{2}h(b + B)$; $h = 8$, $b = 3$, $B = 4$

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

$$A = \frac{1}{2}(8)(3 + 4)$$

$$= \frac{1}{2}(8)(7)$$

$$= (4)(7)$$

$$A = 28$$

27. $C = 2\pi r$; $C = 29.83$, $\pi = 3.14$

$$C = 2\pi r$$

$$29.83 = 2(3.14)r$$

$$29.83 = 6.28r$$

$$\frac{29.83}{6.28} = \frac{6.28r}{6.28}$$

$$4.75 = r$$

28. $V = \frac{4}{3}\pi r^3$; $r = 6$, $\pi = 3.14$

$$V = \frac{4}{3}\pi r^3$$

$$= \frac{4}{3}(3.14)(6)^3$$

$$= \frac{4}{3}(3.14)(216)$$

$$= \frac{4}{3}(678.24)$$

$$V = 904.32$$

29. $A = bh$ for h

$$\frac{A}{b} = \frac{bh}{b} \quad \text{Divide by } b.$$

$$\frac{A}{b} = h, \quad \text{or} \quad h = \frac{A}{b}$$

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

$$2A = 2\left[\frac{1}{2}h(b + B)\right] \quad \text{Multiply by } 2.$$

$$2A = h(b + B)$$

$$\frac{2A}{(b + B)} = \frac{h(b + B)}{(b + B)} \quad \text{Divide by } b + B.$$

$$\frac{2A}{b + B} = h, \quad \text{or} \quad h = \frac{2A}{b + B}$$

31. Because the two angles are supplementary,

$$(8x - 1) + (3x - 6) = 180.$$

$$11x - 7 = 180$$

$$11x = 187$$

$$x = 17$$

Since $x = 17$, $8x - 1 = 135$, and $3x - 6 = 45$.
 The measures of the two angles are 135° and 45° .

32. The angles are vertical angles, so their measures
 are equal.

$$3x + 10 = 4x - 20$$

$$10 = x - 20$$

$$30 = x$$

Since $x = 30$, $3x + 10 = 100$, and
 $4x - 20 = 100$. Each angle has a measure of
 100° .

33. Let W = the width of the rectangle.

Then $W + 12$ = the length of the rectangle.

The perimeter of the rectangle is 16 times the
 width can be written as

$$2L + 2W = 16W$$

since the perimeter is $2L + 2W$.

Because $L = W + 12$, we have

$$2(W + 12) + 2W = 16W.$$

$$2W + 24 + 2W = 16W$$

$$4W + 24 = 16W$$

$$-12W + 24 = 0$$

$$-12W = -24$$

$$W = 2$$

The width is 2 cm and the length is
 $2 + 12 = 14$ cm.

34. First, use the formula for the circumference of a
 circle to find the value of r .

$$C = 2\pi r$$

$$62.5 \approx 2(3.14)(r) \quad \text{Let } C = 62.5,$$

$$\pi = 3.14.$$

$$62.5 = 6.28r$$

$$\frac{62.5}{6.28} = \frac{6.28r}{6.28}$$

$$9.95 \approx r$$

The radius of the turntable is approximately 9.95
 feet. The diameter is twice the radius, so the
 diameter is approximately 19.9 feet.

Now use the formula for the area of a circle.

$$\begin{aligned} A &= \pi r^2 \\ &\approx (3.14)(9.95)^2 \quad \text{Let } \pi = 3.14, r = 9.95. \\ &= (3.14)(99.0025) \\ A &\approx 311 \end{aligned}$$

The area of the turntable is approximately 311 square feet.

35. The sum of the three marked angles in the triangle is 180° .

$$\begin{aligned} 45^\circ + (x + 12.2)^\circ + (3x + 2.8)^\circ &= 180^\circ \\ 4x + 60 &= 180 \\ 4x &= 120 \\ x &= 30 \end{aligned}$$

Since $x = 30$, $(x + 12.2)^\circ = 42.2^\circ$, and $(3x + 2.8)^\circ = 92.8^\circ$.

36. The ratio of 60 centimeters to 40 centimeters is

$$\frac{60 \text{ cm}}{40 \text{ cm}} = \frac{3 \cdot 20}{2 \cdot 20} = \frac{3}{2}$$

37. To find the ratio of 5 days to 2 weeks, first convert 2 weeks to days.

$$2 \text{ weeks} = 2 \cdot 7 = 14 \text{ days}$$

Thus, the ratio of 5 days to 2 weeks is $\frac{5}{14}$.

38. To find the ratio of 90 inches to 10 feet, first convert 10 feet to inches.

$$10 \text{ feet} = 10 \cdot 12 = 120 \text{ inches}$$

Thus, the ratio of 90 inches to 10 feet is

$$\frac{90}{120} = \frac{3 \cdot 30}{4 \cdot 30} = \frac{3}{4}$$

39. $\frac{p}{21} = \frac{5}{30}$

$$30p = 105 \quad \text{Cross products are equal.}$$

$$\frac{30p}{30} = \frac{105}{30} \quad \text{Divide by 30.}$$

$$p = \frac{105}{30} = \frac{7 \cdot 15}{2 \cdot 15} = \frac{7}{2}$$

The solution set is $\{\frac{7}{2}\}$.

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

$$6(5 + x) = 3(2 - x) \quad \text{Cross products are equal.}$$

$$30 + 6x = 6 - 3x \quad \text{Distributive property}$$

$$30 + 9x = 6 \quad \text{Add 3x.}$$

$$9x = -24 \quad \text{Subtract 30.}$$

$$x = \frac{-24}{9} = -\frac{8}{3}$$

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

41. Let $x =$ the tax on a \$36.00 item. Set up a proportion with one ratio involving sales tax and the other involving the costs of the items.

$$\begin{aligned} \frac{x \text{ dollars}}{\$2.04} &= \frac{\$36}{\$24} \\ 24x &= (2.04)(36) = 73.44 \\ x &= \frac{73.44}{24} = 3.06 \end{aligned}$$

The sales tax on a \$36.00 item is \$3.06.

42. Let $x =$ the actual distance between the second pair of cities (in kilometers).

Set up a proportion with one ratio involving map distances and the other involving actual distances.

$$\begin{aligned} \frac{x \text{ kilometers}}{150 \text{ kilometers}} &= \frac{80 \text{ centimeters}}{32 \text{ centimeters}} \\ 32x &= (150)(80) = 12,000 \\ x &= \frac{12,000}{32} = 375 \end{aligned}$$

The cities are 375 kilometers apart.

43. Let $x =$ the number of bronze medals earned by Japan.

$$\begin{aligned} \frac{x \text{ bronze medals}}{25 \text{ medals}} &= \frac{2 \text{ bronze medals}}{5 \text{ medals}} \\ 5x &= 2(25) = 50 \\ x &= 10 \end{aligned}$$

At the 2008 Olympics, 10 bronze medals were earned by Japan.

In Exercise 44, to find the best buy, divide the price by the number of units to get the unit cost. Each result was found by using a calculator and rounding the answer to three decimal places. The *best buy* (based on price per unit) is the smallest unit cost.

44. Size	Unit Cost (dollars per oz)
15 oz	$\frac{\$2.69}{15} = \0.179
20 oz	$\frac{\$3.29}{20} = \0.165
25.5 oz	$\frac{\$3.49}{25.5} = \0.137 (*)

The 25.5 oz size is the best buy.

45. What is 8% of 75?

$$8\% \cdot 75 = 0.08 \cdot 75 = 6$$

46. What percent of 12 is 21?

Let p denote the percent.

$$21 = p \cdot 12$$

$$p = \frac{21}{12} = 1.75 = 175\%$$

Thus, 175% of 12 is 21.

47. 36% of what number is 900?

Let n denote the number.

$$\begin{aligned} 0.36 \cdot n &= 900 \\ n &= \frac{900}{0.36} \quad \text{Divide by } 0.36. \\ &= 2500 \quad \text{Simplify.} \end{aligned}$$

Thus, 36% of 2500 is 900.

48. Let x = the number of liters of the 60% solution to be used.

Then $x + 15$ = the number of liters of the 20% solution.

Liters of solution	15	+	x	=	$x + 15$
Strength of solution	0.10		0.60		0.20

Drug amount in 10% solution	plus	drug amount in 60% solution	is	drug amount in 20% solution.
↓		↓		↓
$0.10(15)$	+	$0.60(x)$	=	$0.20(x + 15)$

Multiply by 10 to clear decimals.

$$\begin{aligned} 1(15) + 6x &= 2(x + 15) \\ 15 + 6x &= 2x + 30 \\ 15 + 4x &= 30 \\ 4x &= 15 \\ x &= \frac{15}{4} = 3.75 \end{aligned}$$

3.75 liters of 60% solution are needed.

49. Let x = the amount invested at 5%.
Then $10,000 - x$ = the amount invested at 6%.

Interest at 5%	plus	interest at 6%	equals \$550.
↓		↓	
$0.05x$	+	$0.06(10,000 - x)$	= 550

$$\begin{aligned} 5x + 6(10,000 - x) &= 100(550) \\ 5x + 60,000 - 6x &= 55,000 \\ -x &= -5000 \\ x &= 5000 \end{aligned}$$

Robert invested \$5000 at 5% and $10,000 - 5000 = \$5000$ at 6%.

50. Use the formula $d = rt$ or $r = \frac{d}{t}$.

$$r = \frac{d}{t} = \frac{3150}{384} \approx 8.203$$

Rounded to the nearest tenth, the *Yorkshire's* average rate was 8.2 mph.

51. Use the formula $d = rt$ or $t = \frac{d}{r}$.

$$t = \frac{d}{r} = \frac{819}{63} = 13$$

Janet drove for 13 hours.

52. Let t = the number of hours until the planes are 1925 miles apart.

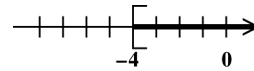
Use $d = rt$.

The distance one plane flies north	plus	the distance the other plane flies south	is	the distance between the planes.
↓		↓		↓
$350t$	+	$420t$	=	1925

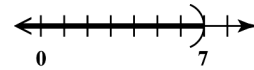
$$\begin{aligned} 770t &= 1925 \\ t &= \frac{1925}{770} = \frac{5}{2} = 2\frac{1}{2} \end{aligned}$$

The planes will be 1925 miles apart in $2\frac{1}{2}$ hours.

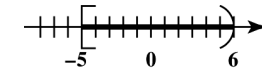
53. The statement $x \geq -4$ can be written as $[-4, \infty)$.



54. The statement $x < 7$ can be written as $(-\infty, 7)$.



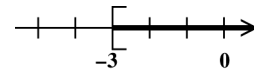
55. The statement $-5 \leq x < 6$ can be written as $[-5, 6)$.



56. By examining the choices, we see that $-4x \leq 36$ is the only inequality that has a negative coefficient of x . Thus, **B** is the only inequality that requires a reversal of the inequality symbol when it is solved.

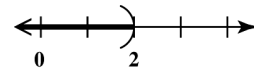
57. $x + 6 \geq 3$
 $x \geq -3$ Subtract 6.

Graph the solution set $[-3, \infty)$.



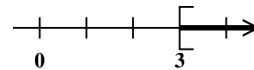
58. $5x < 4x + 2$
 $x < 2$ Subtract 4x.

Graph the solution set $(-\infty, 2)$.



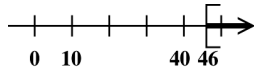
59. $-6x \leq -18$
 $\frac{-6x}{-6} \geq \frac{-18}{-6}$ Divide by -6 ; reverse the symbol.
 $x \geq 3$

Graph the solution set $[3, \infty)$.



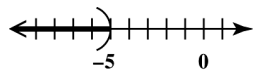
60. $8(x - 5) - (2 + 7x) \geq 4$
 $8x - 40 - 2 - 7x \geq 4$
 $x - 42 \geq 4$
 $x \geq 46$

Graph the solution set $[46, \infty)$.



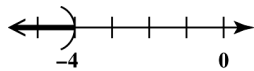
61. $4x - 3x > 10 - 4x + 7x$
 $x > 10 + 3x$
 $-2x > 10$
 $\frac{-2x}{-2} < \frac{10}{-2}$ *Divide by -2;*
reverse the symbol.
 $x < -5$

Graph the solution set $(-\infty, -5)$.



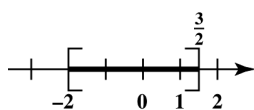
62. $3(2x + 5) + 4(8 + 3x) < 5(3x + 7)$
 $6x + 15 + 32 + 12x < 15x + 35$
 $18x + 47 < 15x + 35$
 $3x + 47 < 35$
 $3x < -12$
 $x < -4$

Graph the solution set $(-\infty, -4)$.



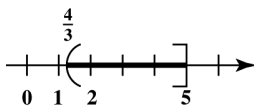
63. $-3 \leq 2x + 1 \leq 4$
 $-4 \leq 2x \leq 3$ *Subtract 1.*
 $-2 \leq x \leq \frac{3}{2}$ *Divide by 2.*

Graph the solution set $[-2, \frac{3}{2}]$.



64. $9 < 3x + 5 \leq 20$
 $4 < 3x \leq 15$ *Subtract 5.*
 $\frac{4}{3} < x \leq 5$ *Divide by 3.*

Graph the solution set $(\frac{4}{3}, 5]$.



65. Let x = the score on the third test.
 The average of the three tests is at least 90.

\downarrow	\downarrow	\downarrow
$\frac{94 + 88 + x}{3}$	\geq	90

$$\frac{182 + x}{3} \geq 90$$

$$3\left(\frac{182 + x}{3}\right) \geq 3(90)$$

$$182 + x \geq 270$$

$$x \geq 88$$

In order to average at least 90, Awilda's score on her third test must be 88 or more.

66. Let n = the number.
 "If nine times a number is added to 6, the result is at most 3" can be written as

$$9n + 6 \leq 3.$$

Solve the inequality.

$$9n \leq -3 \quad \text{Subtract 6.}$$

$$n \leq \frac{-3}{9} \quad \text{Divide by 9.}$$

All numbers less or equal to $-\frac{1}{3}$ satisfy the given condition.

67. [2.6] $\frac{x}{7} = \frac{x - 5}{2}$
 $2x = 7(x - 5)$ *Cross products are equal.*
 $2x = 7x - 35$
 $-5x = -35$
 $x = 7$

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

68. [2.5] $I = prt$ for r

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

$$\frac{I}{pt} = r \quad \text{or} \quad r = \frac{I}{pt}$$

69. [2.8] $-2x > -4$
 $\frac{-2x}{-2} < \frac{-4}{-2}$ *Divide by -2;*
reverse the symbol.
 $x < 2$

The solution set is $(-\infty, 2)$.

70. [2.3] $2k - 5 = 4k + 13$
 $-2k - 5 = 13$ *Subtract 4k.*
 $-2k = 18$ *Add 5.*
 $k = -9$ *Divide by -2.*

The solution set is $\{-9\}$.

71. [2.2] $0.05x + 0.02x = 4.9$
 To clear decimals, multiply both sides by 100.

$$100(0.05x + 0.02x) = 100(4.9)$$

$$5x + 2x = 490$$

$$7x = 490$$

$$x = 70$$

The solution set is $\{70\}$.

72. [2.3] $2 - 3(x - 5) = 4 + x$
 $2 - 3x + 15 = 4 + x$
 $17 - 3x = 4 + x$
 $17 - 4x = 4$
 $-4x = -13$
 $x = \frac{-13}{-4} = \frac{13}{4}$

The solution set is $\{\frac{13}{4}\}$.

73. [2.3] $9x - (7x + 2) = 3x + (2 - x)$
 $9x - 7x - 2 = 3x + 2 - x$
 $2x - 2 = 2x + 2$
 $-2 = 2$

Because $-2 = 2$ is a false statement, the given equation has no solution, symbolized by \emptyset .

74. [2.3] $\frac{1}{3}s + \frac{1}{2}s + 7 = \frac{5}{6}s + 5 + 2$
 $\frac{1}{3}s + \frac{1}{2}s = \frac{5}{6}s$ Subtract 7.

The least common denominator is 6.

$$6(\frac{1}{3}s + \frac{1}{2}s) = 6(\frac{5}{6}s)$$

$$2s + 3s = 5s$$

$$5s = 5s$$

Because $5s = 5s$ is a true statement, the solution set is {all real numbers}.

75. [2.6] The problem may be stated as follows:
 "What is 8% of \$3800?"

$$8\% \cdot 3800 = 0.08 \cdot 3800 = 304$$

The family plans to spend \$304 on entertainment.

76. [2.6] Let x = the number of calories a 175-pound athlete can consume.
 Set up a proportion with one ratio involving calories and the other involving pounds.

$$\frac{x \text{ calories}}{50 \text{ calories}} = \frac{175 \text{ pounds}}{2.2 \text{ pounds}}$$

$$2.2x = 50(175)$$

$$x = \frac{8750}{2.2} \approx 3977.3$$

To the nearest hundred calories, a 175-pound athlete in a vigorous training program can consume 4000 calories per day.

77. [2.4] Let x = the length of the Brooklyn Bridge.
 Then $x + 2604$ = the length of the Golden Gate Bridge.

$$x + (x + 2604) = 5796$$

$$2x + 2604 = 5796$$

$$2x = 3192$$

$$x = 1596$$

Since $x = 1596$, $x + 2604 = 4200$.

The length of the Brooklyn Bridge is 1596 feet and that of the Golden Gate Bridge is 4200 feet.

78. [2.6] Size	Unit Cost (dollars per oz)
50 oz	$\frac{\$4.69}{50} = \0.094
100 oz	$\frac{\$5.98}{100} = \0.060 (*)
200 oz	$\frac{\$13.68}{200} = \0.068

The 100-oz size is the best buy.

79. [2.6] Let x = the number of quarts of oil needed for 192 quarts of gasoline.
 Set up a proportion with one ratio involving oil and the other involving gasoline.

$$\frac{x \text{ quarts}}{1 \text{ quart}} = \frac{192 \text{ quarts}}{24 \text{ quarts}}$$

$$x \cdot 24 = 1 \cdot 192$$

Cross products

$$x = 8$$

Divide by 24.

The amount of oil needed is 8 quarts.

80. [2.7] Let x = the rate of the slower train.
 Then $x + 30$ = the rate of the faster train.

	r	t	d
Slower train	x	3	$3x$
Faster train	$x + 30$	3	$3(x + 30)$

The sum of the distances traveled by the two trains is 390 miles, so

$$3x + 3(x + 30) = 390.$$

$$3x + 3x + 90 = 390$$

$$6x + 90 = 390$$

$$6x = 300$$

$$x = 50$$

Since $x = 50$, $x + 30 = 80$.

The rate of the slower train is 50 miles per hour and the rate of the faster train is 80 miles per hour.

81. [2.5] Let x = the length of the first side.
 Then $2x$ = the length of the second side.

Use the formula for the perimeter of a triangle, $P = a + b + c$, with perimeter 96 and third side 30.

$$x + 2x + 30 = 96$$

$$3x + 30 = 96$$

$$3x = 66$$

$$x = 22$$

The sides have lengths 22 meters, 44 meters, and 30 meters. The length of the longest side is 44 meters.

82. [2.8] Let s = the length of a side of the square. The formula for the perimeter of a square is $P = 4s$.

$$\begin{array}{rcc} \text{The perimeter} & \text{cannot be greater than} & 200. \\ \downarrow & & \downarrow \\ 4s & \leq & 200 \\ & & \downarrow \\ & & 4s \leq 200 \\ & & s \leq 50 \end{array}$$

The length of a side is 50 meters or less.

Chapter 2 Test

1. $5x + 9 = 7x + 21$
 $-2x + 9 = 21$ *Subtract 7x.*
 $-2x = 12$ *Subtract 9.*
 $x = -6$ *Divide by -2.*

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

2. $-\frac{4}{7}x = -12$
 $(-\frac{7}{4})(-\frac{4}{7}x) = (-\frac{7}{4})(-12)$
 $x = 21$

The solution set is $\{21\}$.

3. $7 - (x - 4) = -3x + 2(x + 1)$
 $7 - x + 4 = -3x + 2x + 2$
 $-x + 11 = -x + 2$
 $11 = 2$

Because the last statement is false, the equation has no solution set, symbolized by \emptyset .

4. $0.6(x + 20) + 0.8(x - 10) = 46$
 To clear decimals, multiply both sides by 10.
 $10[0.6(x + 20) + 0.8(x - 10)] = 10(46)$
 $6(x + 20) + 8(x - 10) = 460$
 $6x + 120 + 8x - 80 = 460$
 $14x + 40 = 460$
 $14x = 420$
 $x = 30$

The solution set is $\{30\}$.

5. $-8(2x + 4) = -4(4x + 8)$
 $-16x - 32 = -16x - 32$

Because the last statement is true, the solution set is $\{\text{all real numbers}\}$.

6. Let x = the number of games the Angels lost. Then $2x - 24$ = the number of games the Angels won.

The total number of games played was 162.

$$\begin{array}{r} x + (2x - 24) = 162 \\ 3x - 24 = 162 \\ 3x = 186 \\ x = 62 \end{array}$$

Since $x = 62$, $2x - 24 = 100$.
 The Angels won 100 games and lost 62 games.

7. Let x = the area of Kauai (in square miles). Then $x + 177$ = the area of Maui (in square miles), and $(x + 177) + 3293 = x + 3470$ = the area of Hawaii.

$$\begin{array}{r} x + (x + 177) + (x + 3470) = 5300 \\ 3x + 3647 = 5300 \\ 3x = 1653 \\ x = 551 \end{array}$$

Since $x = 551$, $x + 177 = 728$, and $x + 3470 = 4021$.

The area of Hawaii is 4021 square miles, the area of Maui is 728 square miles, and the area of Kauai is 551 square miles.

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

$$\begin{array}{r} 180 - x = 3(90 - x) + 10 \\ 180 - x = 270 - 3x + 10 \\ 180 - x = 280 - 3x \\ 180 + 2x = 280 \\ 2x = 100 \\ x = 50 \end{array}$$

The measure of the angle is 50° . The measure of its supplement, 130° , is 10° more than three times its complement, 40° .

9. (a) Solve $P = 2L + 2W$ for W .

$$\begin{array}{r} P - 2L = 2W \\ \frac{P - 2L}{2} = W \quad \text{or} \quad W = \frac{P - 2L}{2} \end{array}$$

(b) Substitute 116 for P and 40 for L in the formula obtained in part (a).

$$\begin{array}{r} W = \frac{P - 2L}{2} \\ = \frac{116 - 2(40)}{2} \\ = \frac{116 - 80}{2} = \frac{36}{2} = 18 \end{array}$$

10. The angles are vertical angles, so their measures are equal.

$$\begin{array}{r} 3x + 15 = 4x - 5 \\ 15 = x - 5 \\ 20 = x \end{array}$$

Since $x = 20$, $3x + 15 = 75$ and $4x - 5 = 75$.

Both angles have measure 75° .

11. $\frac{z}{8} = \frac{12}{16}$
 $16z = 8(12)$ *Cross products are equal.*
 $16z = 96$
 $\frac{16z}{16} = \frac{96}{16}$ *Divide by 16.*
 $z = 6$

The solution set is {6}.

12. $\frac{x+5}{3} = \frac{x-3}{4}$
 $4(x+5) = 3(x-3)$
 $4x+20 = 3x-9$
 $x+20 = -9$
 $x = -29$

The solution set is {-29}.

13. The results in the following table are rounded to the nearest thousandth.

Size	Unit Cost (dollars per oz)
8 oz	$\frac{\$2.79}{8} = \0.349
16 oz	$\frac{\$4.99}{16} = \0.312
32 oz	$\frac{\$7.99}{32} = \0.250 (*)

The best buy is the 32-oz size.

14. Let x = the actual distance between Seattle and Cincinnati.

$$\frac{x \text{ miles}}{1050 \text{ miles}} = \frac{92 \text{ inches}}{42 \text{ inches}}$$

$$42x = 92(1050) = 96,600$$

$$x = \frac{96,600}{42} = 2300$$

The actual distance between Seattle and Cincinnati is 2300 miles.

15. Let x = the amount invested at 3%.
 Then $x + 6000$ = the amount invested at 4.5%.

Amount invested (in dollars)	Rate of interest	Interest for one year
x	0.03	$0.03x$
$x + 6000$	0.045	$0.045(x + 6000)$

$$0.03x + 0.045(x + 6000) = 870$$

$$1000(0.03x) + 1000[0.045(x + 6000)] = 1000(870)$$

$$30x + 45(x + 6000) = 870,000$$

$$30x + 45x + 270,000 = 870,000$$

$$75x + 270,000 = 870,000$$

$$75x = 600,000$$

$$x = 8000$$

Since $x = 8000$, $x + 6000 = 14,000$.

Carlos invested \$8000 at 3% and \$14,000 at 4.5%.

16. Use the formula $d = rt$ and let t be the number of hours they traveled.

	r	t	d
First car	50	t	$50t$
Second car	65	t	$65t$

$$\begin{array}{rcc} \text{First car's} & \text{and} & \text{second car's} \\ \text{distance} & & \text{distance} \\ \downarrow & & \downarrow \\ 50t & + & 65t \\ \text{is} & \text{total} & \\ & \text{distance.} & \\ \downarrow & & \downarrow \\ = & 460 & \end{array}$$

$$50t + 65t = 460$$

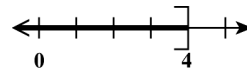
$$115t = 460$$

$$t = 4$$

The two cars will be 460 miles apart in 4 hours.

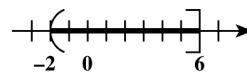
17. $-4x + 2(x - 3) \geq 4x - (3 + 5x) - 7$
 $-4x + 2x - 6 \geq 4x - 3 - 5x - 7$
 $-2x - 6 \geq -x - 10$
 $-x - 6 \geq -10$
 $-x \geq -4$
 $\frac{-1x}{-1} \leq \frac{-4}{-1}$ *Divide by -1;*
 $x \leq 4$ *reverse the symbol*

Graph the solution set $(-\infty, 4]$.



18. $-10 < 3x - 4 \leq 14$
 $-6 < 3x \leq 18$ *Add 4.*
 $-2 < x \leq 6$ *Divide by 3.*

Graph the solution set $(-2, 6]$.



19. Let x = the score on the third test.

The average of the three tests is at least 80.

$$\frac{76 + 81 + x}{3} \geq 80$$

$$\frac{157 + x}{3} \geq 80$$

$$3\left(\frac{157 + x}{3}\right) \geq 3(80)$$

$$157 + x \geq 240$$

$$x \geq 83$$

In order to average at least 80, Susan's score on her third test must be 83 or more.

20. When an inequality is multiplied or divided by a negative number, the direction of the inequality symbol must be reversed.

**Cumulative Review Exercises
(Chapters 1–2)**

$$1. \quad \frac{5}{6} + \frac{1}{4} - \frac{7}{15} = \frac{50}{60} + \frac{15}{60} - \frac{28}{60} \\ = \frac{65 - 28}{60} \\ = \frac{37}{60}$$

$$2. \quad \frac{9}{8} \cdot \frac{16}{3} \div \frac{5}{8} = \frac{9}{8} \cdot \frac{16}{3} \cdot \frac{8}{5} \\ = \frac{3 \cdot 3 \cdot 16 \cdot 8}{8 \cdot 3 \cdot 5} \\ = \frac{48}{5}$$

3. "The difference between half a number and 18" is written

$$\frac{1}{2}x - 18.$$

4. "The quotient of 6 and 12 more than a number is 2" is written

$$\frac{6}{x + 12} = 2.$$

$$5. \quad \frac{8(7) - 5(6 + 2)}{3 \cdot 5 + 1} \geq 1 \\ \frac{8(7) - 5(8)}{3 \cdot 5 + 1} \geq 1 \\ \frac{56 - 40}{15 + 1} \geq 1 \\ \frac{16}{16} \geq 1 \\ 1 \geq 1$$

The statement is *true*.

$$6. \quad \frac{-4(9)(-2)}{-3^2} = \frac{-36(-2)}{-1 \cdot 3^2} \\ = \frac{72}{-9} \\ = -8$$

$$7. \quad (-7 - 1)(-4) + (-4) = (-8)(-4) + (-4) \\ = 32 + (-4) \\ = 28$$

$$8. \quad \frac{3x^2 - y^3}{-4z} = \frac{3(-2)^2 - (-4)^3}{-4(3)} \quad \text{Let } x = -2, \\ y = -4, z = 3. \\ = \frac{3(4) - (-64)}{-12} \\ = \frac{12 + 64}{-12} \\ = \frac{76}{-12} \\ = -\frac{19}{3}$$

$$9. \quad 7(p + q) = 7p + 7q$$

The multiplication of 7 is distributed over the sum, which illustrates the distributive property.

$$10. \quad 3 + (5 + 2) = 3 + (2 + 5)$$

The order of the numbers added in the parentheses is changed, which illustrates the commutative property.

$$11. \quad 2r - 6 = 8r \\ -6 = 6r \\ -1 = r$$

Check $r = -1$: $-8 = -8$ *True*

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

$$12. \quad 4 - 5(s + 2) = 3(s + 1) - 1 \\ 4 - 5s - 10 = 3s + 3 - 1 \\ -5s - 6 = 3s + 2 \\ -8s - 6 = 2 \\ -8s = 8 \\ s = -1$$

Check $s = -1$: $-1 = -1$ *True*

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

$$13. \quad \frac{2}{3}x + \frac{3}{4}x = -17 \\ 12\left(\frac{2}{3}x + \frac{3}{4}x\right) = 12(-17) \quad \text{LCD} = 12 \\ 8x + 9x = -204 \\ 17x = -204 \\ x = -12$$

Check $x = -12$: $-17 = -17$ *True*

The solution set is $\{-12\}$.

$$14. \quad \frac{2x + 3}{5} = \frac{x - 4}{2} \\ (2x + 3)(2) = (5)(x - 4) \\ 4x + 6 = 5x - 20 \\ 6 = x - 20 \\ 26 = x$$

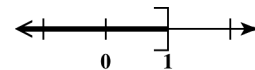
Check $x = 26$: $11 = 11$ *True*

The solution set is $\{26\}$.

$$15. \quad \text{Solve } 3x + 4y = 24 \quad \text{for } y. \\ 4y = 24 - 3x \\ y = \frac{24 - 3x}{4}$$

$$16. \quad 6(r - 1) + 2(3r - 5) \leq -4 \\ 6r - 6 + 6r - 10 \leq -4 \\ 12r - 16 \leq -4 \\ 12r \leq 12 \\ r \leq 1$$

Graph the solution set $(-\infty, 1]$.

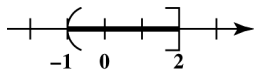


17. $-18 \leq -9z < 9$

$2 \geq z > -1$ *Divide by -9;
reverse the symbols.*

or $-1 < z \leq 2$

Graph the solution set $(-1, 2]$.



18. Let x = the length of the middle-sized piece.
Then $3x$ = the length of the longest piece, and
 $x - 5$ = the length of the shortest piece.

$$\begin{aligned} x + 3x + (x - 5) &= 40 \\ 5x - 5 &= 40 \\ 5x &= 45 \\ x &= 9 \end{aligned}$$

The length of the middle-sized piece is 9 centimeters, of the longest piece is 27 centimeters, and of the shortest piece is 4 centimeters.

19. Let r = the radius and use 3.14 for π .
Using the formula for circumference, $C = 2\pi r$,
and $C = 78$, we have

$$\begin{aligned} 2\pi r &= 78. \\ r &= \frac{78}{2\pi} \approx 12.4204 \end{aligned}$$

To the nearest hundredth, the radius is 12.42 cm.

20. Let x = rate of slower car.
Then $x + 20$ = rate of faster car.

Use the formula $d = rt$.

$$\begin{aligned} d_{\text{slower}} + d_{\text{faster}} &= d_{\text{total}} \\ (x)(4) + (x + 20)(4) &= 400 \\ 4x + 4x + 80 &= 400 \\ 8x + 80 &= 400 \\ 8x &= 320 \\ x &= 40 \end{aligned}$$

The rates are 40 mph and 60 mph.