INSTRUCTOR'S SOLUTIONS MANUAL

CHRISTINE VERITY

INTERMEDIATE ALGEBRA

ELEVENTH EDITION

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CHAPTER 1 LINEAR EQUATIONS AND APPLICATIONS

1.1 Linear Equations in One Variable

1.1 Margin Exercises

1. **(a)** $9x = 10$ is an *equation* because it contains an equality symbol.

(b) $9x + 10$ is an *expression* because it does not contain an equality symbol.

(c) $3 + 5x - 8x + 9$ is an *expression* because it does not contain an equality symbol.

(d) $3 + 5x = -8x + 9$ is an *equation* because it contains an equality symbol.

2. **(a)**

$3p + 2p + 1 = -24$	*Original equation*
$\underline{5p} + 1 = -24$	*Combine terms.*
$5p + 1 - \underline{1} = -24 - \underline{1}$	*Subtract 1.*
$5p = -25$	*Combine terms.*
$\frac{5p}{5} = \frac{-25}{5}$	*Divide by 5.*
$p = \underline{-5}$	*Proposed solution*

Check by substituting $\underline{-5}$ for p in the *original* equation.

$3p + 2p + 1 = -24$	*Original equation*
$3(-5) + 2(-5) + 1 \stackrel{?}{=} -24$	*Let p = −5.*
$-15 - 10 + 1 \stackrel{?}{=} -24$	
$-24 = -24$	*True*

The true statement indicates that $\{\underline{-5}\}$ is the solution set.

(b)

$3p = 2p + 4p + 5$	*Original equation*
$3p = 6p + 5$	*Combine terms.*
$3p - 6p = 6p + 5 - 6p$	*Subtract 6p.*
$-3p = 5$	*Combine terms.*
$\frac{-3p}{-3} = \frac{5}{-3}$	*Divide by −3.*
$p = -\frac{5}{3}$	*Proposed solution*

Check by substituting $-\frac{5}{3}$ for p in the *original* equation.

$3p = 2p + 4p + 5$	*Original equation*
$3(-\frac{5}{3}) \stackrel{?}{=} 2(-\frac{5}{3}) + 4(-\frac{5}{3}) + 5$	*Let $p = -\frac{5}{3}$.*
$-5 \stackrel{?}{=} -\frac{10}{3} - \frac{20}{3} + 5$	
$-5 \stackrel{?}{=} -\frac{30}{3} + 5$	
$-5 \stackrel{?}{=} -10 + 5$	
$-5 = -5$	*True*

Solution set: $\{-\frac{5}{3}\}$

(c)

$4x + 8x = 17x - 9 - 1$	*Original equation*
$12x = 17x - 10$	*Combine terms.*
$12x - 17x = 17x - 10 - 17x$	*Subtract 17x.*
$-5x = -10$	*Combine terms.*
$\frac{-5x}{-5} = \frac{-10}{-5}$	*Divide by −5.*
$x = 2$	*Proposed solution*

Check by substituting 2 for x in the *original* equation.

$4x + 8x = 17x - 9 - 1$	*Original equation*
$4(2) + 8(2) \stackrel{?}{=} 17(2) - 9 - 1$	*Let x = 2.*
$8 + 16 \stackrel{?}{=} 34 - 9 - 1$	
$24 = 24$	*True*

Solution set: $\{2\}$

(d)

$-7 + 3t - 9t = 12t - 5$

$-7 - 6t = 12t - 5$ *Combine terms.*

$-7 - 6t + 6t + 5 = 12t - 5 + 6t + 5$ *Add 6t; add 5.*

$-2 = 18t$

$\frac{-2}{18} = \frac{18t}{18}$ *Divide by 18.*

$-\frac{1}{9} = t$ *Proposed solution*

We will use the following notation to indicate the value of each side of the original equation after we have substituted the proposed solution and simplified.

Check $t = -\frac{1}{9}$: $-\frac{19}{3} = -\frac{19}{3}$ *True*

Solution set: $\{-\frac{1}{9}\}$

3. **(a)** $5p + 4(3 - 2p) = 2 + p - 10$

$5p + 12 - 8p = 2 + p - 10$ *Distributive property*

$12 - 3p = p - 8$ *Combine terms.*

(continued)

$$12 - 3p + 3p + 8 = p - 8 + 3p + 8$$ *Add 3p; add 8.*

$20 = 4p$ *Combine terms.*

$\frac{20}{4} = \frac{4p}{4}$ *Divide by 4.*

$5 = p$ *Proposed solution*

Check $p = 5$: $-3 = -3$ *True*

Solution set: $\{5\}$

(b) $3(z - 2) + 5z = 2$

$3z - 6 + 5z = 2$ *Distributive property*

$8z - 6 = 2$ *Combine terms.*

$8z - 6 + 6 = 2 + 6$ *Add 6.*

$8z = 8$ *Combine terms.*

$\frac{8z}{8} = \frac{8}{8}$ *Divide by 8.*

$z = 1$ *Proposed solution*

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

Solution set: $\{1\}$

(c) $-2 + 3(x + 4) = 8x$

$-2 + 3x + 12 = 8x$ *Distributive property*

$3x + 10 = 8x$ *Combine terms.*

$3x + 10 - 3x = 8x - 3x$ *Subtract 3x.*

$10 = 5x$ *Combine terms.*

$\frac{10}{5} = \frac{5x}{5}$ *Divide by 5.*

$2 = x$ *Proposed solution*

Check $x = 2$: $16 = 16$ *True*

Solution set: $\{2\}$

4. **(a)** $2(2x + 1) - 3(2x - 1) = 9$

$2(\underline{2x}) + 2(1) - 3(2x) - 3(\underline{-1}) = 9$ *Distributive property*

$4x + 2 - \underline{6x} + \underline{3} = 9$ *Multiply.*

$\underline{-2x} + 5 = 9$ *Combine terms.*

$-2x + 5 - 5 = 9 - 5$ *Subtract 5.*

$-2x = 4$ *Combine terms.*

$\frac{-2x}{-2} = \frac{4}{-2}$ *Divide by −2.*

$x = -2$ *Proposed solution*

Check $x = -2$: $-6 + 15 = 9$ *True*

Solution set: $\{-2\}$

(b) $2 - 3(2 + 6x) = 4(x + 1) + 18$

$2 - 6 - 18x = 4x + 4 + 18$ *Distributive property*

$-18x - 4 = 4x + 22$ *Combine terms.*

$-18x - 4 - 4x = 4x + 22 - 4x$ *Subtract 4x.*

$-22x - 4 = 22$ *Combine terms.*

$-22x - 4 + 4 = 22 + 4$ *Add 4.*

$-22x = 26$ *Combine terms.*

$\frac{-22x}{-22} = \frac{26}{-22}$ *Divide by −22.*

$x = -\frac{13}{11}$ *Proposed solution*

Check $x = -\frac{13}{11}$: $\frac{190}{11} = \frac{190}{11}$ *True*

Solution set: $\{-\frac{13}{11}\}$

(c)
$$\begin{aligned} 6-(4+m) &= 8m-2(3m+5) \\ 6-4-m &= 8m-6m-10 \quad \textit{Distributive property} \\ 2-m &= 2m-10 \quad \textit{Combine terms.} \\ 2-m+m+10 &= 2m-10+m+10 \quad \textit{Add m; add 10.} \\ 12 &= 3m \quad \textit{Combine terms.} \\ \frac{12}{3} &= \frac{3m}{3} \quad \textit{Divide by 3.} \\ 4 &= m \quad \textit{Proposed solution} \end{aligned}$$

Check $m = 4$: $-2 = -2$ *True*

Solution set: $\{4\}$

5. **(a)** $\frac{2p}{7} - \frac{p}{2} = -3$

Step 1 The LCD of all the fractions in the equation is 14. Multiply by this LCD.

$$\underline{14}\left(\frac{2p}{7} - \frac{p}{2}\right) = 14(-3)$$

Apply the distributive property.

$$\begin{aligned} \underline{14}\left(\frac{2p}{7}\right) + 14\left(-\frac{p}{\underline{2}}\right) &= 14(-3) \\ 2(2p) - 7p &= -42 \\ 4p - 7p &= -42 \\ -3p &= -42 \\ \frac{-3p}{-3} &= \frac{-42}{-3} \\ p &= 14 \end{aligned}$$

Check $p = 14$: $-3 = -3$ *True*

Solution set: $\{14\}$

(b) $\frac{k+1}{2} + \frac{k+3}{4} = \frac{1}{2}$ ■ Multiply each side by the LCD, 4, and use the distributive property.

$$\begin{aligned} 4\left(\frac{k+1}{2}\right) + 4\left(\frac{k+3}{4}\right) &= 4\left(\frac{1}{2}\right) \\ 2(k+1) + 1(k+3) &= 2 \\ 2k+2+k+3 &= 2 \\ 3k+5 &= 2 \\ 3k &= -3 \quad \textit{Subtract 5.} \\ k &= -1 \quad \textit{Divide by 3.} \end{aligned}$$

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

Solution set: $\{-1\}$

6. **(a)** $0.04x + 0.06(20 - x) = 0.05(50)$ ■ Multiply each side by 100, and use the distributive property.

$$\begin{aligned} 4x + 6(20-x) &= 5(50) \\ 4x + 120 - 6x &= 250 \\ -2x + 120 &= 250 \\ -2x &= 130 \quad \textit{Subtract 120.} \\ x &= -65 \quad \textit{Divide by } -2. \end{aligned}$$

Check $x = -65$: $2.5 = 2.5$ *True*

Solution set: $\{-65\}$

(b) $0.10(x-6) + 0.05x = 0.06(50)$ ■ In this exercise, we will not clear the decimals.

$$\begin{aligned} 0.10x - 0.6 + 0.05x &= 3 \quad \textit{Dist. prop.} \\ 0.15x - 0.6 &= 3 \quad \textit{Combine terms.} \\ 0.15x &= 3.6 \quad \textit{Add 0.6.} \\ x &= 24 \quad \textit{Divide by 0.15.} \end{aligned}$$

Check $x = 24$: $1.8 + 1.2 = 3$ *True*

Solution set: $\{24\}$

7. **(a)**
$$\begin{aligned} 5(x+2) - 2(x+1) &= 3x + 1 \\ 5x + 10 - 2x - 2 &= 3x + 1 \\ 3x + 8 &= 3x + 1 \\ 3x + 8 - 3x &= 3x + 1 - 3x \quad \textit{Subtract 3x.} \\ 8 &= 1 \quad \textit{False} \end{aligned}$$

Since the result, $8 = 1$, is *false*, the equation has no solution and is called a *contradiction.*

Solution set: $\varnothing$

(b)
$$\begin{aligned} 9x - 3(x+4) &= 6(x-2) \\ 9x - 3x - 12 &= 6x - 12 \\ 6x - 12 &= 6x - 12 \end{aligned}$$

This is an *identity.* Any real number will make the equation true.

Solution set: {all real numbers}

(c)
$$\begin{aligned} 5(3x+1) &= x + 5 \\ 15x + 5 &= x + 5 \\ 14x + 5 &= 5 \quad \textit{Subtract x.} \\ 14x &= 0 \quad \textit{Subtract 5.} \\ x &= 0 \quad \textit{Divide by 14.} \end{aligned}$$

This is a *conditional equation.*

Check $x = 0$: $5 = 5$ *True*

Solution set: $\{0\}$

(d) $3(2x-4)=20-2x$

$$\begin{aligned} 6x-12&=20-2x \\ 8x-12&=20 && \textit{Add 2x.} \\ 8x&=32 && \textit{Add 12.} \\ x&=4 && \textit{Divide by 8.} \end{aligned}$$

This is a *conditional equation.*

Check $x=4$: $12=12$ *True*

Solution set: $\{4\}$

1.1 Section Exercises

1. A collection of numbers, variables, operation symbols, and grouping symbols, such as $2(8x-15)$, is an <u>algebraic expression</u>. While an equation *does* include an equality symbol, there *is not* an equality symbol in an algebraic expression.

2. A <u>linear equation</u> in one variable can be written in the form $Ax+B=C$, with $A \underline{\neq} 0$. Another name for a linear equation is a <u>first-degree equation</u>, since the greatest power on the variable is *one*.

3. If we let $x=2$ in the linear equation $2x+5=9$, a *true* statement results. The number 2 is a <u>solution</u> of the equation, and $\{2\}$ is the <u>solution set</u>.

4. A linear equation with one solution in its <u>solution set</u>, such as the equation in **Exercise 3**, is a <u>conditional equation</u>.

5. A linear equation with an infinite number of solutions is an <u>identity</u>. Its solution set is $\{$<u>all real numbers</u>$\}$.

6. A linear equation with no solution is a <u>contradiction</u>. Its solution set is the <u>empty set</u> $\varnothing$.

7. **A.** $3x+x-2=0$ can be written as $4x-2=0$, so it is linear.

C. $9x-4=9$ is in linear form.

8. **B.** $12=x^2$ is not a linear equation because the variable is squared.

D. $\frac{1}{8}x-\frac{1}{x}=0$ is not a linear equation because there is a variable in the denominator of the second term.

9. $-3x+2-4=x$ is an *equation* because it contains an equality symbol.

10. $-3x+2-4-x=4$ is an *equation* because it contains an equality symbol.

11. $4(x+3)-2(x+1)-10$ is an *expression* because it does not contain an equality symbol.

12. $4(x+3)-2(x+1)+10$ is an *expression* because it does not contain an equality symbol.

13. $-10x+12-4x=-3$ is an *equation* because it contains an equality symbol.

14. $-10x+12-4x+3=0$ is an *equation* because it contains an equality symbol.

15. A sign error was made when the distributive property was applied. The left side of the second line should be $8x-4x+6$. This gives us $4x+6=3x+7$ and then $x=1$. Thus, the correct solution is 1.

16. $-(2m-4)=-1(2m-4)$, so the $-$ sign represents -1.

$$\begin{aligned} &-5m-(2m-4)+5 \\ &=-5m-2m+4+5 \\ &=-7m+9 \end{aligned}$$

In the following exercises, we do not show the checks of the solutions. To be sure that your solutions are correct, check them by substituting into the original equations.

17.

$$\begin{aligned} 9x+10&=1 \\ 9x+10-10&=1-10 && \textit{Subtract 10.} \\ 9x&=-9 \\ \frac{9x}{9}&=\frac{-9}{9} && \textit{Divide by 9.} \\ x&=-1 \end{aligned}$$

Solution set: $\{-1\}$

18.

$$\begin{aligned} 7x-4&=31 \\ 7x-4+4&=31+4 && \textit{Add 4.} \\ 7x&=35 \\ \frac{7x}{7}&=\frac{35}{7} && \textit{Divide by 7.} \\ x&=5 \end{aligned}$$

Solution set: $\{5\}$

19.

$$\begin{aligned} 5x+2&=3x-6 \\ 5x+2-3x&=3x-6-3x && \textit{Subtract 3x.} \\ 2x+2&=-6 \\ 2x+2-2&=-6-2 && \textit{Subtract 2.} \\ 2x&=-8 \\ \frac{2x}{2}&=\frac{-8}{2} && \textit{Divide by 2.} \\ x&=-4 \end{aligned}$$

Solution set: $\{-4\}$

20. $9p + 1 = 7p - 9$

$9p + 1 - 7p = 7p - 9 - 7p$ *Subtract 7p.*

$2p + 1 = -9$

$2p + 1 - 1 = -9 - 1$ *Subtract 1.*

$2p = -10$

$\frac{2p}{2} = \frac{-10}{2}$ *Divide by 2.*

$p = -5$

Solution set: $\{-5\}$

21. $7x - 5x + 15 = x + 8$

$2x + 15 = x + 8$ *Combine terms.*

$2x = x - 7$ *Subtract 15.*

$x = -7$ *Subtract x.*

Solution set: $\{-7\}$

22. $2x + 4 - x = 4x - 5$

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

$-3x + 4 = -5$ *Subtract 4x.*

$-3x = -9$ *Subtract 4.*

$x = 3$ *Divide by –3.*

Solution set: $\{3\}$

23. $12w + 15w - 9 + 5 = -3w + 5 - 9$

$27w - 4 = -3w - 4$ *Combine terms.*

$30w - 4 = -4$ *Add 3w.*

$30w = 0$ *Add 4.*

$w = 0$ *Divide by 30.*

Solution set: $\{0\}$

24. $-4t + 5t - 8 + 4 = 6t - 4$

$t - 4 = 6t - 4$ *Combine terms.*

$-5t - 4 = -4$ *Subtract 6t.*

$-5t = 0$ *Add 4.*

$t = 0$ *Divide by –5.*

Solution set: $\{0\}$

25. $3(2t - 4) = 20 - 2t$

$6t - 12 = 20 - 2t$ *Distributive property*

$8t - 12 = 20$ *Add 2t.*

$8t = 32$ *Add 12.*

$t = 4$ *Divide by 8.*

Solution set: $\{4\}$

26. $2(3 - 2x) = x - 4$

$6 - 4x = x - 4$ *Distributive property*

$6 - 5x = -4$ *Subtract x.*

$-5x = -10$ *Subtract 6.*

$x = 2$ *Divide by −5.*

Solution set: $\{2\}$

27. $-5(x + 1) + 3x + 2 = 6x + 4$

$-5x - 5 + 3x + 2 = 6x + 4$ *Distributive property*

$-2x - 3 = 6x + 4$ *Combine terms.*

$-3 = 8x + 4$ *Add 2x.*

$-7 = 8x$ *Subtract 4.*

$-\frac{7}{8} = x$ *Divide by 8.*

Solution set: $\{-\frac{7}{8}\}$

28. $5(x + 3) + 4x - 5 = 4 - 2x$

$5x + 15 + 4x - 5 = 4 - 2x$ *Distributive property*

$9x + 10 = 4 - 2x$ *Combine terms.*

$11x + 10 = 4$ *Add 2x.*

$11x = -6$ *Subtract 10.*

$x = -\frac{6}{11}$ *Divide by 11.*

Solution set: $\{-\frac{6}{11}\}$

29. $2(x + 3) = -4(x + 1)$

$2x + 6 = -4x - 4$ *Remove parentheses.*

$6x + 6 = -4$ *Add 4x.*

$6x = -10$ *Subtract 6.*

$x = \frac{-10}{6} = -\frac{5}{3}$ *Divide by 6.*

Solution set: $\{-\frac{5}{3}\}$

30. $4(t - 9) = 8(t + 3)$

$4t - 36 = 8t + 24$ *Remove parentheses.*

$-4t - 36 = 24$ *Subtract 8t.*

$-4t = 60$ *Add 36.*

$t = -15$ *Divide by –4.*

Solution set: $\{-15\}$

31. $3(2w + 1) - 2(w - 2) = 5$

$6w + 3 - 2w + 4 = 5$ *Remove parentheses.*

$4w + 7 = 5$ *Combine terms.*

$4w = -2$ *Subtract 7.*

$w = \frac{-2}{4}$ *Divide by 4.*

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

Solution set: $\{-\frac{1}{2}\}$

32.
$$\begin{aligned} 4(x+2)-2(x+3)&=5\\ 4x+8-2x-6&=5\\ 2x+2&=5\\ 2x&=3\\ x&=\tfrac{3}{2} \end{aligned}$$
Solution set: $\{\frac{3}{2}\}$

33.
$$\begin{aligned} 2x+3(x-4)&=2(x-3)\\ 2x+3x-12&=2x-6\\ 5x-12&=2x-6\\ 3x&=6\\ x&=\tfrac{6}{3}=2 \end{aligned}$$
Solution set: $\{2\}$

34.
$$\begin{aligned} 6x-3(5x+2)&=4(1-x)\\ 6x-15x-6&=4-4x\\ -9x-6&=4-4x\\ -5x&=10\\ x&=\tfrac{10}{-5}=-2 \end{aligned}$$
Solution set: $\{-2\}$

35.
$$\begin{aligned} 6p-4(3-2p)&=5(p-4)-10\\ 6p-12+8p&=5p-20-10\\ 14p-12&=5p-30\\ 9p&=-18\\ p&=-2 \end{aligned}$$
Solution set: $\{-2\}$

36.
$$\begin{aligned} -2k-3(4-2k)&=2(k-3)+2\\ -2k-12+6k&=2k-6+2\\ 4k-12&=2k-4\\ 2k&=8\\ k&=4 \end{aligned}$$
Solution set: $\{4\}$

37.
$$\begin{aligned} 2[w-(2w+4)+3]&=2(w+1)\\ 2[w-2w-4+3]&=2(w+1)\\ 2[-w-1]&=2(w+1)\\ -w-1&=w+1 && \textit{Divide by 2.}\\ -1&=2w+1 && \textit{Add w.}\\ -2&=2w && \textit{Subtract 1.}\\ -1&=w && \textit{Divide by 2.} \end{aligned}$$
Solution set: $\{-1\}$

38.
$$\begin{aligned} 4[2t-(3-t)+5]&=-(2+7t)\\ 4[2t-3+t+5]&=-(2+7t)\\ 4[3t+2]&=-(2+7t)\\ 12t+8&=-2-7t\\ 19t+8&=-2 && \textit{Add 7t.}\\ 19t&=-10 && \textit{Subtract 8.}\\ t&=-\tfrac{10}{19} && \textit{Divide by 19.} \end{aligned}$$
Solution set: $\{-\frac{10}{19}\}$

39.
$$\begin{aligned} -[2z-(5z+2)]&=2+(2z+7)\\ -[2z-5z-2]&=2+2z+7\\ -[-3z-2]&=2+2z+7\\ 3z+2&=2z+9\\ z&=7 \end{aligned}$$
Solution set: $\{7\}$

40.
$$\begin{aligned} -[6x-(4x+8)]&=9+(6x+3)\\ -[6x-4x-8]&=9+6x+3\\ -[2x-8]&=6x+12\\ -2x+8&=6x+12\\ -8x&=4\\ x&=\tfrac{4}{-8}=-\tfrac{1}{2} \end{aligned}$$
Solution set: $\{-\frac{1}{2}\}$

41.
$$\begin{aligned} -3m+6-5(m-1)&=-5m-(2m-4)+5\\ -3m+6-5m+5&=-5m-2m+4+5\\ -8m+11&=-7m+9\\ -m+11&=9\\ -m&=-2\\ m&=2 \end{aligned}$$
Solution set: $\{2\}$

42.
$$\begin{aligned} 4(k+2)-8k-5&=-3k+9-2(k+6)\\ 4k+8-8k-5&=-3k+9-2k-12\\ -4k+3&=-5k-3\\ k&=-6 \end{aligned}$$
Solution set: $\{-6\}$

43.
$$\begin{aligned} -3(x+2)+4(3x-8)&\\ &=2(4x+7)+2(3x-6)\\ -3x-6+12x-32&=8x+14+6x-12\\ 9x-38&=14x+2\\ -38&=5x+2\\ -40&=5x\\ -8&=x \end{aligned}$$
Solution set: $\{-8\}$

44.
$$\begin{aligned} -7(2x+1)+5(3x+2)&\\ &=6(2x-4)-(12x+3)\\ -14x-7+15x+10&=12x-24-12x-3\\ x+3&=-27\\ x&=-30 \end{aligned}$$
Solution set: $\{-30\}$

45. The denominators of the fractions are 4, 3, 6, and 1. The LCD is $2^2(3)=12$, since it is the smallest number into which each denominator can divide without a remainder.

46. Yes. The coefficients will be greater, but in the end the solution will be the same. As long as you multiply each side of the equation by the *same* nonzero number, the resulting equation is equivalent and the solution does not change.

47. **(a)** We need to make the coefficient of the first term on the left an integer. Since $0.05 = \frac{5}{100}$, we multiply by 10^2 or 100. This will also take care of the second term.

(b) We need to make 0.006, 0.007, and 0.009 integers. These numbers can be written as $\frac{6}{1000}$, $\frac{7}{1000}$, and $\frac{9}{1000}$. Multiplying by 10^3 or 1000 will eliminate the decimal points (the denominators) so that all the coefficients are integers.

48.
$$\begin{aligned} &0.06(10-x)(100)\\ &= 0.06(100)(10-x)\\ &= 6(10-x)\\ &= 60-6x \quad \text{Choice } \mathbf{B} \text{ is correct.}\end{aligned}$$

49. $\frac{m}{2}+\frac{m}{3}=10$ ■ Multiply each side by the LCD, 6, and use the distributive property.

$$\begin{aligned} 6\left(\frac{m}{2}+\frac{m}{3}\right) &= 6(10)\\ 6\left(\frac{m}{2}\right)+6\left(\frac{m}{3}\right) &= 60 && \textit{Distributive property}\\ 3m+2m &= 60\\ 5m &= 60 && \textit{Add.}\\ m &= 12 && \textit{Divide by 5.}\end{aligned}$$

Check $m = 12$: $6+4=10$ *True*

Solution set: $\{12\}$

50. $\frac{x}{5}-\frac{x}{4}=2$ ■ Multiply each side by the LCD, 20, and use the distributive property.

$$\begin{aligned} 20\left(\frac{x}{5}-\frac{x}{4}\right) &= 20(2)\\ 20\left(\frac{x}{5}\right)-20\left(\frac{x}{4}\right) &= 40 && \textit{Distributive property}\\ 4x-5x &= 40\\ -x &= 40 && \textit{Subtract.}\\ x &= -40 && \textit{Multiply by } -1.\end{aligned}$$

Check $x=-40$: $-8+10=2$ *True*

Solution set: $\{-40\}$

51. $\frac{3}{4}x+\frac{5}{2}x=13$ ■ Multiply each side by the LCD, 4, and use the distributive property.

$$\begin{aligned} 4\left(\frac{3}{4}x+\frac{5}{2}x\right) &= 4(13)\\ 4\left(\frac{3}{4}x\right)+4\left(\frac{5}{2}x\right) &= 4(13) && \textit{Distributive property}\\ 3x+10x &= 52\\ 13x &= 52 && \textit{Combine terms.}\\ x &= 4 && \textit{Divide by 13.}\end{aligned}$$

Check $x=4$: $13=13$ *True*

Solution set: $\{4\}$

52. $\frac{8}{3}x-\frac{1}{2}x=-13$ ■ Multiply each side by the LCD, 6, and use the distributive property.

$$\begin{aligned} 6\left(\frac{8}{3}x-\frac{1}{2}x\right) &= 6(-13)\\ 6\left(\frac{8}{3}x\right)-6\left(\frac{1}{2}x\right) &= 6(-13) && \textit{Distributive property}\\ 16x-3x &= -78\\ 13x &= -78\\ x &= -6 && \textit{Divide by 13.}\end{aligned}$$

Check $x=-6$: $-13=-13$ *True*

Solution set: $\{-6\}$

53. $\frac{1}{5}x-2=\frac{2}{3}x-\frac{2}{5}x$ ■ Multiply each side by the LCD, 15, and use the distributive property.

$$\begin{aligned} 15\left(\tfrac{1}{5}x-2\right) &= 15\left(\tfrac{2}{3}x-\tfrac{2}{5}x\right)\\ 15\left(\tfrac{1}{5}x\right)-15(2) &= 15\left(\tfrac{2}{3}x\right)-15\left(\tfrac{2}{5}x\right)\\ 3x-30 &= 10x-6x\\ 3x-30 &= 4x\\ -30 &= x && \textit{Subtract 3x.}\end{aligned}$$

Check $x=-30$: $-8=-8$ *True*

Solution set: $\{-30\}$

54. $\frac{3}{4}x-\frac{1}{3}x=\frac{5}{6}x-5$ ■ Multiply each side by the LCD, 12, and use the distributive property.

$$\begin{aligned} 12\left(\tfrac{3}{4}x-\tfrac{1}{3}x\right) &= 12\left(\tfrac{5}{6}x-5\right)\\ 12\left(\tfrac{3}{4}x\right)-12\left(\tfrac{1}{3}x\right) &= 12\left(\tfrac{5}{6}x\right)-12(5)\\ 9x-4x &= 10x-60\\ 5x &= 10x-60\\ -5x &= -60 && \textit{Subtract 10x.}\\ x &= 12 && \textit{Divide by } -5.\end{aligned}$$

Check $x=12$: $5=5$ *True*

Solution set: $\{12\}$

55. $\frac{x-8}{5}+\frac{8}{5}=-\frac{x}{3}$ ■ Multiply each side by the LCD, 15, and use the distributive property.

$$\begin{aligned} 15\left(\frac{x-8}{5}+\frac{8}{5}\right) &= 15\left(-\frac{x}{3}\right)\\ 15\left(\frac{x-8}{5}\right)+15\left(\frac{8}{5}\right) &= 15\left(-\frac{x}{3}\right)\\ 3(x-8)+3(8) &= -5x\\ 3x-24+24 &= -5x\\ 3x &= -5x\\ 8x &= 0 && \textit{Add 5x.}\\ x &= 0 && \textit{Divide by 8.}\end{aligned}$$

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

Solution set: $\{0\}$

56. $\frac{2r-3}{7}+\frac{3}{7}=-\frac{r}{3}$ ▪ Multiply each side by the LCD, 21, and use the distributive property.

$$\begin{aligned}21\left(\frac{2r-3}{7}+\frac{3}{7}\right)&=21\left(-\frac{r}{3}\right)\\21\left(\frac{2r-3}{7}\right)+21\left(\frac{3}{7}\right)&=21\left(-\frac{r}{3}\right)\\3(2r-3)+3(3)&=7(-r)\\6r-9+9&=-7r\\6r&=-7r\\13r&=0 \quad \textit{Add 7r.}\\r&=0 \quad \textit{Divide by 13.}\end{aligned}$$

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

Solution set: $\{0\}$

57. $\frac{3x-1}{4}+\frac{x+3}{6}=3$ ▪ Multiply each side by the LCD, 12, and use the distributive property.

$$\begin{aligned}12\left(\frac{3x-1}{4}+\frac{x+3}{6}\right)&=12(3)\\12\left(\frac{3x-1}{4}\right)+12\left(\frac{x+3}{6}\right)&=12(3)\\3(3x-1)+2(x+3)&=36\\9x-3+2x+6&=36\\11x+3&=36\\11x&=33\\x&=3\end{aligned}$$

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

Solution set: $\{3\}$

58. $\frac{3x+2}{7}-\frac{x+4}{5}=2$ ▪ Multiply each side by the LCD, 35, and use the distributive property.

$$\begin{aligned}35\left(\frac{3x+2}{7}-\frac{x+4}{5}\right)&=35(2)\\35\left(\frac{3x+2}{7}\right)-35\left(\frac{x+4}{5}\right)&=35(2)\\5(3x+2)-7(x+4)&=70\\15x+10-7x-28&=70\\8x-18&=70\\8x&=88\\x&=11\end{aligned}$$

Check $x=11$: $5-3=2$ *True*

Solution set: $\{11\}$

59. $\frac{4t+1}{3}=\frac{t+5}{6}+\frac{t-3}{6}$ ▪ Multiply each side by the LCD, 6, and use the distributive property.

$$\begin{aligned}6\left(\frac{4t+1}{3}\right)&=6\left(\frac{t+5}{6}+\frac{t-3}{6}\right)\\6\left(\frac{4t+1}{3}\right)&=6\left(\frac{t+5}{6}\right)+6\left(\frac{t-3}{6}\right)\\2(4t+1)&=(t+5)+(t-3)\\8t+2&=2t+2\\6t&=0\\t&=0\end{aligned}$$

Check $t=0$: $\frac{1}{3}=\frac{5}{6}-\frac{3}{6}$ *True*
Solution set: $\{0\}$

60. $\frac{2x+5}{5}=\frac{3x+1}{2}+\frac{-x+7}{2}$ ▪ Multiply each side by the LCD, 10, and use the distributive property.

$$\begin{aligned}10\left(\frac{2x+5}{5}\right)&=10\left(\frac{3x+1}{2}+\frac{-x+7}{2}\right)\\10\left(\frac{2x+5}{5}\right)&=10\left(\frac{3x+1}{2}\right)+10\left(\frac{-x+7}{2}\right)\\2(2x+5)&=5(3x+1)+5(-x+7)\\4x+10&=15x+5-5x+35\\4x+10&=10x+40\\-6x&=30\\x&=\tfrac{30}{-6}=-5\end{aligned}$$

Check $x=-5$: $-1=-7+6$ *True*
Solution set: $\{-5\}$

61. $0.04x+0.06+0.03x=0.03x+1.46$
Multiply each term by 100.

$$\begin{aligned}4x+6+3x&=3x+146\\4x+6&=146\\4x&=140\\x&=35\end{aligned}$$

Check $x=35$:
$1.40+0.06+1.05=1.05+1.46$ *True*

The solution set is $\{35\}$

62. $0.05x+0.08+0.06x=0.07x+0.68$
Multiply each term by 100.

$$\begin{aligned}5x+8+6x&=7x+68\\11x+8&=7x+68\\4x&=60\\x&=15\end{aligned}$$

Check $x=15$: $0.75+0.08+0.9=1.05+0.68$
True
The solution set is $\{15\}$

63.
$$
\begin{aligned}
0.05x + 0.12(x + 5000) &= 940 \\
&\textit{Multiply each side by 100.} \\
100[0.05x + 0.12(x + 5000)] &= 100(940) \\
100(0.05x) + 100(0.12)(x + 5000) &= 94{,}000 \\
5x + 12(x + 5000) &= 94{,}000 \\
5x + 12x + 60{,}000 &= 94{,}000 \\
17x &= 34{,}000 \\
x &= \tfrac{34{,}000}{17} \\
x &= 2000
\end{aligned}
$$

Check $x = 2000$: $100 + 840 = 940$ *True*

Solution set: $\{2000\}$

64.
$$
\begin{aligned}
0.09k + 0.13(k + 300) &= 61 \\
&\textit{Multiply each side by 100.} \\
100[0.09k + 0.13(k + 300)] &= 100(61) \\
100(0.09k) + 100(0.13)(k + 300) &= 6100 \\
9k + 13(k + 300) &= 6100 \\
9k + 13k + 3900 &= 6100 \\
22k &= 2200 \\
k &= \tfrac{2200}{22} \\
k &= 100
\end{aligned}
$$

Check $k = 100$: $9 + 52 = 61$ *True*

Solution set: $\{100\}$

65.
$$
\begin{aligned}
0.02(50) + 0.08r &= 0.04(50 + r) \\
&\textit{Multiply each side by 100.} \\
100[0.02(50) + 0.08r] &= \\
&100[(0.04)(50 + r)] \\
100(0.02)(50) + 100(0.08r) &= 4(50 + r) \\
2(50) + 8r &= 4(50 + r) \\
100 + 8r &= 200 + 4r \\
4r &= 100 \\
r &= 25
\end{aligned}
$$

Check $r = 25$: $1 + 2 = 3$ *True*

Solution set: $\{25\}$

66.
$$
\begin{aligned}
0.20(14{,}000) + 0.14t &= \\
&0.18(14{,}000 + t) \\
&\textit{Multiply each side by 100.} \\
100[0.20(14{,}000) + 0.14t] &= \\
&100[0.18(14{,}000 + t)] \\
100(0.20)(14{,}000) + 100(0.14t) &= 18(14{,}000 + t) \\
20(14{,}000) + 14t &= 18(14{,}000 + t) \\
280{,}000 + 14t &= 252{,}000 + 18t \\
28{,}000 &= 4t \\
t &= 7000
\end{aligned}
$$

Check $t = 7000$: $2800 + 980 = 3780$ *True*

Solution set: $\{7000\}$

67.
$$
\begin{aligned}
0.05x + 0.10(200 - x) &= 0.45x \\
&\textit{Multiply each side by 100.} \\
5x + 10(200 - x) &= 45x \\
5x + 2000 - 10x &= 45x \\
2000 - 5x &= 45x \\
2000 &= 50x \\
x &= \tfrac{2000}{50} = 40
\end{aligned}
$$

Check $x = 40$: $2 + 16 = 18$ *True*

Solution set: $\{40\}$

68.
$$
\begin{aligned}
0.08x + 0.12(260 - x) &= 0.48x \\
&\textit{Multiply each side by 100.} \\
8x + 12(260 - x) &= 48x \\
8x + 3120 - 12x &= 48x \\
-4x + 3120 &= 48x \\
3120 &= 52x \\
x &= \tfrac{3120}{52} = 60
\end{aligned}
$$

Check $x = 60$: $4.8 + 24 = 28.8$ *True*

Solution set: $\{60\}$

69.
$$
\begin{aligned}
0.006(x + 2) &= 0.007x + 0.009 \\
&\textit{Multiply each side by 1000.} \\
6(x + 2) &= 7x + 9 \\
6x + 12 &= 7x + 9 \\
3 &= x
\end{aligned}
$$

Check $x = 3$: $0.03 = 0.021 + 0.009$ *True*

Solution set: $\{3\}$

70.
$$
\begin{aligned}
0.004x + 0.006(50 - x) &= 0.004(68) \\
&\textit{Multiply each side by 1000.} \\
4x + 6(50 - x) &= 4(68) \\
4x + 300 - 6x &= 272 \\
-2x + 300 &= 272 \\
-2x &= -28 \\
x &= 14
\end{aligned}
$$

Check $x = 14$: $0.056 + 0.216 = 0.272$ *True*

Solution set: $\{14\}$

71.
$$
\begin{aligned}
0.8x - 1.2(x - 4) &= 0.3(x - 5) \\
&\textit{Multiply each side by 10.} \\
8x - 12(x - 4) &= 3(x - 5) \\
8x - 12x + 48 &= 3x - 15 \\
-4x + 48 &= 3x - 15 \\
-7x + 48 &= -15 \\
-7x &= -63 \\
x &= \tfrac{-63}{-7} = 9
\end{aligned}
$$

Check $x = 9$: $7.2 - 6 = 1.2$ *True*

Solution set: $\{9\}$

72. $0.4x - 0.2(x+4) = 1.4(x+2)$

Multiply each side by 10.

$$\begin{aligned} 4x - 2(x+4) &= 14(x+2) \\ 4x - 2x - 8 &= 14x + 28 \\ 2x - 8 &= 14x + 28 \\ -12x - 8 &= 28 \\ -12x &= 36 \\ x &= \tfrac{36}{-12} = -3 \end{aligned}$$

Check $x = -3$: $-1.2 - 0.2 = -1.4$ *True*
Solution set: $\{-3\}$

73. **(a)** $7 = 7$ is true (an identity) and the original equation has solution set {all real numbers}, choice **B**.

(b) $x = 0$ indicates the original equation has solution set $\{0\}$, choice **A**.

(c) $7 = 0$ is false (a contradiction) and the original equation has solution set $\varnothing$, choice **C**.

74. Each equation in choices **A**, **B**, **D**, **E**, and **F** is an identity and has {all real numbers} as its solution set. The equation in choice **C**, $4x = 3x$, has $\{0\}$ as its solution set.

75.
$$\begin{aligned} -x + 4x - 9 &= 3(x-4) - 5 \\ 3x - 9 &= 3x - 12 - 5 \\ 3x - 9 &= 3x - 17 \\ -9 &= -17 \quad \textit{False} \end{aligned}$$

The equation is a *contradiction*.
Solution set: $\varnothing$

76.
$$\begin{aligned} -12x + 2x - 11 &= -2(5x-3) + 4 \\ -10x - 11 &= -10x + 6 + 4 \\ -10x - 11 &= -10x + 10 \\ -11 &= 10 \quad \textit{False} \end{aligned}$$

The equation is a *contradiction*.
Solution set: $\varnothing$

77.
$$\begin{aligned} -11x + 4(x-3) + 6x &= 4x - 12 \\ -11x + 4x - 12 + 6x &= 4x - 12 \\ -x - 12 &= 4x - 12 \\ 0 &= 5x \\ 0 &= x \end{aligned}$$

This is a *conditional equation*.
Solution set: $\{0\}$

78.
$$\begin{aligned} 3x - 5(x+4) + 9 &= -11 + 15x \\ 3x - 5x - 20 + 9 &= -11 + 15x \\ -2x - 11 &= -11 + 15x \\ -17x &= 0 \\ x &= 0 \end{aligned}$$

This is a *conditional equation*.
Solution set: $\{0\}$

79.
$$\begin{aligned} -2(t+3) - t - 4 &= -3(t+4) + 2 \\ -2t - 6 - t - 4 &= -3t - 12 + 2 \\ -3t - 10 &= -3t - 10 \end{aligned}$$

The equation is an *identity*.
Solution set: {all real numbers}

80.
$$\begin{aligned} 4(2d+7) &= 2d + 25 + 3(2d+1) \\ 8d + 28 &= 2d + 25 + 6d + 3 \\ 8d + 28 &= 8d + 28 \end{aligned}$$

The equation is an *identity*.
Solution set: {all real numbers}

81.
$$\begin{aligned} 7[2 - (3+4x)] - 2x &= -9 + 2(1 - 15x) \\ 7[2 - 3 - 4x] - 2x &= -9 + 2 - 30x \\ 7[-1 - 4x] - 2x &= -7 - 30x \\ -7 - 28x - 2x &= -7 - 30x \\ -7 - 30x &= -7 - 30x \end{aligned}$$

The equation is an *identity*.
Solution set: {all real numbers}

82.
$$\begin{aligned} 4[6 - (1+2x)] + 10x &= 2(10 - 3x) + 8x \\ 4[6 - 1 - 2x] + 10x &= 20 - 6x + 8x \\ 4(5 - 2x) + 10x &= 20 + 2x \\ 20 - 8x + 10x &= 20 + 2x \\ 20 + 2x &= 20 + 2x \end{aligned}$$

The equation is an *identity*.
Solution set: {all real numbers}

1.2 Formulas and Percent

1.2 Margin Exercises

1. **(a)** To solve $I = prt$ for p, treat p as the only variable, and isolate it.

$$\begin{aligned} I &= prt \\ I &= p(rt) && \textit{Associative property} \\ \frac{I}{rt} &= \frac{p(rt)}{rt} && \textit{Divide by rt.} \\ \frac{I}{rt} &= p, \quad \text{or} \quad p = \frac{I}{rt} \end{aligned}$$

(b) To solve $I = prt$ for r, treat r as the only variable, and isolate it.

$$\begin{aligned} I &= prt \\ I &= r(pt) && \textit{Associative property} \\ \frac{I}{pt} &= \frac{r(pt)}{pt} && \textit{Divide by pt.} \\ \frac{I}{pt} &= r, \quad \text{or} \quad r = \frac{I}{pt} \end{aligned}$$

2. **(a)** Solve $P = a + b + c$ for a. Our goal is to isolate the variable a. To do this, we *subtract* b and c on each side.

$$P = a + b + c$$
$$P - b - c = a + b + c - b - c \quad \textit{Subtract } b \textit{ and } c.$$
$$P - b - c = a, \text{ or } a = P - b - c$$

(b) Solve $V = \frac{1}{3}Bh$ for B. Our goal is to isolate the variable $\underline{B}$.

$$V = \tfrac{1}{3}Bh$$
$$\underline{3} \cdot V = \underline{3} \cdot \tfrac{1}{3}Bh \quad \textit{Multiply by 3.}$$
$$\underline{3V} = Bh$$
$$\frac{3V}{h} = \frac{Bh}{h} \quad \textit{Divide by } h.$$
$$\frac{3V}{h} = B, \text{ or } B = \frac{3V}{h}$$

Note that we could have multiplied the original equation by $\frac{3}{h}$ to isolate B.

(c) Solve $P = 2a + 2b$ for a. Our goal is to isolate the variable $\underline{a}$.

$$P = 2a + 2b$$
$$P - 2b = 2a + 2b - 2b \quad \textit{Subtract } 2b.$$
$$P - 2b = 2a$$
$$\frac{P - 2b}{2} = \frac{2a}{2} \quad \textit{Divide by 2.}$$
$$\frac{P - 2b}{2} = a, \text{ or } a = \frac{P}{2} - b$$

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

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

(b) Solve $M = \frac{1}{3}(a + b + c)$ for b.

$$M = \tfrac{1}{3}(a + b + c)$$
$$3M = a + b + c \quad \textit{Multiply by 3.}$$
$$3M - a - c = b \quad \textit{Subtract } a \textit{ \& } c.$$

4. Solve each equation for y.

(a)
$$2x + 7y = 5$$
$$2x + 7y - 2x = 5 - 2x \quad \textit{Subtract } 2x.$$
$$7y = -2x + 5$$
$$\frac{7y}{7} = \frac{-2x + 5}{7} \quad \textit{Divide by 7.}$$
$$y = -\frac{2}{7}x + \frac{5}{7}$$

(b)
$$5x - 6y = 12$$
$$5x - 6y - 5x = 12 - 5x \quad \textit{Subtract } 5x.$$
$$-6y = -5x + 12$$
$$\frac{-6y}{-6} = \frac{-5x + 12}{-6} \quad \textit{Divide by } -6.$$
$$y = \frac{5}{6}x - 2$$

5. **(a)** Use $d = rt$. Solve for r.

$$\frac{d}{t} = \frac{rt}{t} \quad \textit{Divide by } t.$$
$$\frac{d}{t} = r, \text{ or } r = \frac{d}{t}$$

Now substitute $d = 21$ and $t = \frac{1}{2}$.

$$r = \frac{d}{t} = \frac{21}{\frac{1}{2}} = 21(\tfrac{2}{1}) = 42$$

The rate is 42 mph.

(b) Use $d = rt$. Solve for t.

$$\frac{d}{r} = \frac{rt}{r} \quad \textit{Divide by } r.$$
$$\frac{d}{r} = t, \text{ or } t = \frac{d}{r}$$

Now substitute $d = 15$ and $r = 45$.

$$t = \frac{d}{r} = \frac{15}{45} = \frac{1}{3}$$

It took $\frac{1}{3}$ hr, or $\underline{20}$ min.

(c) Use $d = rt$. Solve for t.

$$\frac{d}{r} = \frac{rt}{r} \quad \textit{Divide by } r.$$
$$\frac{d}{r} = t, \text{ or } t = \frac{d}{r}$$

Now substitute $d = 600$ and $r = 147.803$.

$$t = \frac{d}{r} = \frac{600}{147.803} \approx 4.059$$

His time was about 4.059 hr.

6. **(a)** The given amount of mixture is 20 oz. The part that is oil is 1 oz. Thus, the percent of oil is

$$\frac{\text{partial amount}}{\text{whole amount}} = \frac{1}{20} = 0.05 = 5\%.$$

(b) Let x represent the amount of commission earned.

$$\frac{x}{22{,}000} = 0.06 \quad \frac{\textit{partial}}{\textit{whole}} = \textit{decimal}$$
$$x = 22{,}000(0.06) \quad \textit{Multiply by 22,000.}$$
$$x = 1320$$

The salesman earns \$1320.

(c) Let x represent the amount of interest earned.

$$\frac{x}{7500} = 0.025 \qquad \frac{\textit{partial}}{\textit{whole}} = \textit{decimal}$$
$$x = 7500(0.025) \quad \textit{Multiply by 7500.}$$
$$x = 187.50$$

The interest earned is \$187.50.

7. Let x represent the amount spent on pet supplies/medicine.

$$\frac{x}{60.6} = 0.237 \qquad \textit{23.7\% = 0.237}$$
$$x = 60.6(0.237) \quad \textit{Multiply by 60.6.}$$
$$x \approx 14.4$$

Therefore, about \$14.4 billion was spent on pet supplies/medicine.

8. **(a)** Let $x =$ the percent increase (as a decimal).

$$\text{percent increase} = \frac{\text{amount of increase}}{\text{original amount}}$$
$$x = \frac{689 - 650}{650}$$
$$x = \frac{39}{650}$$
$$x = 0.06$$

The percent increase was 6%.

(b) Let $x =$ the percent increase (as a decimal).

$$\text{percent increase} = \frac{\text{amount of increase}}{\text{original amount}}$$
$$x = \frac{1352 - 1300}{1300}$$
$$x = \frac{52}{1300}$$
$$x = 0.04$$

The percent increase was 4%.

9. **(a)** Let $x =$ the percent decrease (as a decimal).

$$\text{percent decrease} = \frac{\text{amount of decrease}}{\text{original amount}}$$
$$x = \frac{80 - 56}{80}$$
$$x = \frac{24}{80}$$
$$x = 0.3$$

The jacket was marked down 30%.

(b) Let $x =$ the percent decrease (as a decimal).

$$\text{percent decrease} = \frac{\text{amount of decrease}}{\text{original amount}}$$
$$x = \frac{54.00 - 51.30}{54.00}$$
$$x = \frac{2.70}{54.00}$$
$$x = 0.05$$

The percent decrease was 5%.

10. $S = \frac{4k + 7}{k + 90}$

$$S = \frac{4(14.515) + 7}{(14.515) + 90} \qquad \textit{Substitue k = 14.515.}$$
$$S = 0.62$$

The child has a body surface area of 0.62m^2.

11. The surface area of the child is 0.62m^2. The adult dosage is 100mg.

$$C = \frac{\text{body surface area in m}^2}{1.7} \times D$$
$$C = \frac{0.62}{1.7} \times 100$$
$$C = 36$$

The child dosage is 36mg.

1.2 Section Exercises

1. A <u>formula</u> is an equation in which variables are used to describe a relationship.

2. To solve a formula for a specified variable, treat that <u>variable</u> as if it were the only one and treat all other variables like <u>constants</u> (numbers).

3. **(a)** $0.35 = 35\%$ (move the decimal point to the right two places)

(b) $0.18 = 18\%$

(c) $0.02 = 2\%$

(d) $0.075 = 7.5\%$

(e) $1.5 = 150\%$

4. **(a)** $60\% = 0.60 = 0.6$ (move the decimal point to the left two places)

(b) $37\% = 0.37$

(c) $8\% = 0.08$

(d) $3.5\% = 0.035$

(e) $210\% = 2.1$

5. **(a)** Solve $\mathcal{A} = LW$ for W.

$$\frac{\mathcal{A}}{L} = \frac{LW}{L} \qquad \textit{Divide by L.}$$
$$\frac{\mathcal{A}}{L} = W, \text{ or } W = \frac{\mathcal{A}}{L}$$

(b) Solve $\mathcal{A} = LW$ for L.

$$\frac{\mathcal{A}}{W} = \frac{LW}{W} \qquad \textit{Divide by W.}$$
$$\frac{\mathcal{A}}{W} = L, \text{ or } L = \frac{\mathcal{A}}{W}$$

6. **(a)** Solve $\mathcal{A} = bh$ for b.

$$\frac{\mathcal{A}}{h} = \frac{bh}{h} \quad \textit{Divide by h.}$$

$$\frac{\mathcal{A}}{h} = b, \quad \text{or} \quad b = \frac{\mathcal{A}}{h}$$

(b) Solve $\mathcal{A} = bh$ for h.

$$\frac{\mathcal{A}}{b} = \frac{bh}{b} \quad \textit{Divide by b.}$$

$$\frac{\mathcal{A}}{b} = h, \quad \text{or} \quad h = \frac{\mathcal{A}}{b}$$

7. Solve $P = 2L + 2W$ for L.

$$P - 2W = 2L \quad \textit{Subtract 2W.}$$

$$\frac{P - 2W}{2} = \frac{2L}{2} \quad \textit{Divide by 2.}$$

$$\frac{P - 2W}{2} = L, \quad \text{or} \quad L = \frac{P}{2} - W$$

8. **(a)** Solve $P = a + b + c$ for b.

$$P - a - c = a + b + c - a - c$$

Subtract a and c.

$$P - a - c = b, \quad \text{or} \quad b = P - a - c$$

(b) Solve $P = a + b + c$ for c.

$$P - a - b = a + b + c - a - b$$

Subtract a and b.

$$P - a - b = c, \quad \text{or} \quad c = P - a - b$$

9. **(a)** Solve for $V = LWH$ for W.

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

$$\frac{V}{LH} = W, \quad \text{or} \quad W = \frac{V}{LH}$$

(b) Solve for $V = LWH$ for H.

$$\frac{V}{LW} = \frac{LWH}{LW} \quad \textit{Divide by LW.}$$

$$\frac{V}{LW} = H, \quad \text{or} \quad H = \frac{V}{LW}$$

10. **(a)** Solve $\mathcal{A} = \frac{1}{2}bh$ for h.

$$2\mathcal{A} = bh \quad \textit{Multiply by 2.}$$

$$\frac{2\mathcal{A}}{b} = \frac{bh}{b} \quad \textit{Divide by b.}$$

$$\frac{2\mathcal{A}}{b} = h, \text{ or } h = \frac{2\mathcal{A}}{b}$$

(b) Solve $\mathcal{A} = \frac{1}{2}bh$ for b.

$$2\mathcal{A} = bh \quad \textit{Multiply by 2.}$$

$$\frac{2\mathcal{A}}{h} = \frac{bh}{h} \quad \textit{Divide by h.}$$

$$\frac{2\mathcal{A}}{h} = b, \text{ or } b = \frac{2\mathcal{A}}{h}$$

11. Solve $C = 2\pi r$ for r.

$$\frac{C}{2\pi} = \frac{2\pi r}{2\pi} \quad \textit{Divide by } 2\pi.$$

$$\frac{C}{2\pi} = r, \quad \text{or} \quad r = \frac{C}{2\pi}$$

12. Solve $V = \pi r^2 h$ for h.

$$\frac{V}{\pi r^2} = \frac{\pi r^2 h}{\pi r^2} \quad \textit{Divide by } \pi r^2.$$

$$\frac{V}{\pi r^2} = h, \quad \text{or} \quad h = \frac{V}{\pi r^2}$$

13. **(a)** Solve $\mathcal{A} = \frac{1}{2}h(b + B)$ for h.

$$2\mathcal{A} = h(b + B) \quad \textit{Multiply by 2.}$$

$$\frac{2\mathcal{A}}{b + B} = h \quad \textit{Divide by } b + B.$$

(b) Solve $\mathcal{A} = \frac{1}{2}h(b + B)$ for B.

$$2\mathcal{A} = h(b + B) \quad \textit{Multiply by 2.}$$

$$\frac{2\mathcal{A}}{h} = b + B \quad \textit{Divide by h.}$$

$$\frac{2\mathcal{A}}{h} - b = B \quad \textit{Subtract b.}$$

OR Solve $\mathcal{A} = \frac{1}{2}h(b + B)$ for B.

$$2\mathcal{A} = hb + hB \quad \textit{Multiply by 2.}$$

$$2\mathcal{A} - hb = hB \quad \textit{Subtract hb.}$$

$$\frac{2\mathcal{A} - hb}{h} = B \quad \textit{Divide by h.}$$

14. Solve $V = \frac{1}{3}\pi r^2 h$ for h.

$$3V = \pi r^2 h \quad \textit{Multiply by 3.}$$

$$\frac{3V}{\pi r^2} = \frac{\pi r^2 h}{\pi r^2} \quad \textit{Divide by } \pi r^2.$$

$$\frac{3V}{\pi r^2} = h, \quad \text{or} \quad h = \frac{3V}{\pi r^2}$$

15. Solve $F = \frac{9}{5}C + 32$ for C.

$$F - 32 = \tfrac{9}{5}C \quad \textit{Subtract 32.}$$

$$\tfrac{5}{9}(F - 32) = \tfrac{5}{9}(\tfrac{9}{5}C) \quad \textit{Multiply by } \tfrac{5}{9}.$$

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

16. Solve $C = \frac{5}{9}(F - 32)$ for F.

$$\tfrac{9}{5}C = \tfrac{9}{5} \cdot \tfrac{5}{9}(F - 32) \quad \textit{Multiply by } \tfrac{9}{5}.$$

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

$$\tfrac{9}{5}C + 32 = F \quad \textit{Add 32.}$$

17. **(a)** Solve $Ax + B = C$ for x.

$Ax = C - B$ *Subtract B.*

$\frac{Ax}{A} = \frac{C - B}{A}$ *Divide by A.*

$x = \frac{C - B}{A}$

(b) Solve $Ax + B = C$ for A.

$Ax = C - B$ *Subtract B.*

$\frac{Ax}{x} = \frac{C - B}{x}$ *Divide by x.*

$A = \frac{C - B}{x}$

18. **(a)** Solve $y = mx + b$ for x.

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

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

$\frac{y - b}{m} = x$

(b) Solve $y = mx + b$ for x.

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

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

$\frac{y - b}{x} = m$

19. Solve $A = P(1 + rt)$ for t.

$A = P + Prt$ *Dist. prop.*

$A - P = Prt$ *Subtract P.*

$\frac{A - P}{Pr} = \frac{Prt}{Pr}$ *Divide by Pr.*

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

20.

Solve $M = C(1 + r)$ for r.

$M = C + Cr$ *Dist. prop.*

$M - C = Cr$ *Subtract C.*

$\frac{M - C}{C} = \frac{Cr}{C}$ *Divide by C.*

$\frac{M - C}{C} = r$, or $r = \frac{M - C}{C}$

21. $4x + y = 1$

$4x + y - 4x = 1 - 4x$ *Subtract 4x.*

$y = -4x + 1$

22. $3x + y = 9$

$3x + y - 3x = 9 - 3x$ *Subtract 3x.*

$y = -3x + 9$

23. $x - 2y = -6$

$x - 2y - x = -6 - x$ *Subtract x.*

$-2y = -x - 6$

$\frac{-2y}{-2} = \frac{-x - 6}{-2}$ *Divide by −2.*

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

24. $x - 5y = -20$

$x - 5y - x = -20 - x$ *Subtract x.*

$-5y = -x - 20$

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

$y = \frac{1}{5}x + 4$

25. $4x + 9y = 11$

$4x + 9y - 4x = 11 - 4x$ *Subtract 4x.*

$9y = -4x + 11$

$\frac{9y}{9} = \frac{-4x + 11}{9}$ *Divide by 9.*

$y = -\frac{4}{9}x + \frac{11}{9}$

26. $2x + 5y = 3$

$2x + 5y - 2x = 3 - 2x$ *Subtract 2x.*

$5y = -2x + 3$

$\frac{5y}{5} = \frac{-2x + 3}{5}$ *Divide by 5.*

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

27. $-7x + 8y = 11$

$8y = 11 + 7x$ *Add 7x.*

$\frac{5y}{5} = \frac{11 + 7x}{8}$ *Divide by 8.*

$y = \frac{7}{8}x + \frac{11}{8}$

28. $-3x + 2y = 5$

$2y = 5 + 3x$ *Add 3x.*

$\frac{2y}{2} = \frac{5 + 3x}{2}$ *Divide by 2.*

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

29. $5x - 3y = 12$

$-3y = 12 - 5x$ *Subtract 5x.*

$\frac{-3y}{-3} = \frac{12 - 5x}{-3}$ *Divide by −3.*

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

30. $6x - 5y = 15$

$$\begin{aligned} -5y &= 15 - 6x && \textit{Subtract 6x.} \\ \frac{-5y}{-5} &= \frac{15-6x}{-5}, && \textit{Divide by } -5. \\ y &= \frac{6}{5}x - 3 \end{aligned}$$

31. $\frac{1}{2}x - \frac{1}{3}y = 1$

$$\begin{aligned} 3x - 2y &= 6 && \textit{Multiply by 6.} \\ -2y &= 6 - 3x \\ y &= \frac{6-3x}{-2} \end{aligned}$$

Simplified, this is $y = \frac{3}{2}x - 3$.

32. $\frac{2}{3}x - \frac{2}{5}y = 2$

$$\begin{aligned} \frac{1}{3}x - \frac{1}{5}y &= 1 && \textit{Divide by 2.} \\ 5x - 3y &= 15 && \textit{Multiply by 15.} \\ 3y &= 15 - 5x \\ y &= \frac{15-5x}{-3} \end{aligned}$$

Simplified, this is $y = \frac{5}{3}x - 5$.

33. Solve $d = rt$ for t.

$$t = \frac{d}{r}$$

To find t, substitute $d = 500$ and $r = 161.939$.

$$t = \frac{500}{161.939} \approx 3.088$$

His time was about 3.088 hours.

34. Solve $d = rt$ for t.

$$t = \frac{d}{r}$$

Replace d by 415 and r by 151.774.

$$t = \frac{415}{151.774} \approx 2.734$$

His time was about 2.734 hours.

35. Use the formula $F = \frac{9}{5}C + 32$.

$$\begin{aligned} F &= \tfrac{9}{5}(45) + 32 && \textit{Let } C = 45. \\ &= 81 + 32 \\ &= 113 \end{aligned}$$

The corresponding temperature is 113°F.

36. Use the formula $C = \frac{5}{9}(F - 32)$.

$$\begin{aligned} C &= \tfrac{5}{9}(-58 - 32) && \textit{Let } F = -58. \\ &= \tfrac{5}{9}(-90) \\ &= -50 \end{aligned}$$

The corresponding temperature is about -50°C.

37. Use $V = LWH$.
Let $V = 187$, $L = 11$, and $W = 8.5$.

$$\begin{aligned} 187 &= 11(8.5)H \\ 187 &= 93.5H \\ 2 &= H && \textit{Divide by 93.5.} \end{aligned}$$

The ream is 2 inches thick.

38. Solve $P = 4s$ for s.

$$s = \tfrac{P}{4}$$

To find s, substitute 920 for P.

$$s = \tfrac{920}{4} = 230$$

The length of each side is 230 m.

39. Use the formula $C = 2\pi r$.

$$\begin{aligned} 370\pi &= 2\pi r && \textit{Let } C = 370\pi. \\ \frac{370\pi}{2\pi} &= \frac{2\pi r}{2\pi} && \textit{Divide by } 2\pi. \\ 185 &= r \end{aligned}$$

So the radius of the circle is 185 inches and the diameter is twice that length, that is, 370 inches.

40. $d = 2r = 2(2.5) = 5$
The diameter is 5 inches.

$C = 2\pi r = 2\pi(2.5) = 5\pi$
The circumference is 5π inches.

41. The mixture contains a total of 36 oz of liquid and the part which is alcohol is 9 oz. Thus, the percent of alcohol is

$$\tfrac{9}{36} = \tfrac{1}{4} = \tfrac{25}{100} = 25\%.$$

The percent of water is

$$100\% - 25\% = 75\%.$$

42. Let $x =$ the amount of pure acid in the mixture. Then x can be found by multiplying the total amount of the mixture by the percent of acid given as a decimal (0.35).

$$x = 40(0.35) = 14$$

There are 14 L of pure acid. Since there are 40 L altogether, there are $40 - 14$, or 26 L of pure water in the mixture.

43. Find what percent \$6900 is of \$230,000.

$$\tfrac{6900}{230{,}000} = 0.03 = 3\%$$

The agent received a 3% rate of commission.

44. Solve $I = prt$ for r.

$$\begin{aligned} r &= \frac{I}{pt} \\ r &= \frac{160}{6400(1)} \\ &= 0.025 = 2.5\% \end{aligned}$$

The interest rate on this deposit is 2.5%.

45. $\dfrac{38.4\text{ million}}{114.2\text{ million}} \approx 0.34$

In 2013, about 34% of the U.S. households that owned at least one TV set owned at least 4 TV sets.

46. $\dfrac{94.2\text{ million}}{114.2\text{ million}} \approx 0.82$

In 2013, about 82% of the U.S. households that owned at least one TV set had a DVD player.

47. $0.905(114.2) = 103.351$

In 2013, about 103.4 million U.S. households that owned at least one TV set received basic cable.

48. $0.476(114.2) = 54.3592$

In 2013, about 54.4 million U.S. households that owned at least one TV set received premium cable.

In Exercises 49–52, use the rule of 78:

$$u = f \cdot \frac{k(k+1)}{n(n+1)}$$

49. Substitute 700 for f, 4 for k, and 36 for n.

$$\begin{aligned} u &= 700 \cdot \frac{4(4+1)}{36(36+1)} \\ &= 700 \cdot \frac{4(5)}{36(37)} \approx 10.51 \end{aligned}$$

The unearned interest is \$10.51.

50. Substitute 600 for f, 12 for k, and 36 for n.

$$\begin{aligned} u &= 600 \cdot \frac{12(12+1)}{36(36+1)} \\ &= 600 \cdot \frac{12(13)}{36(37)} \approx 70.27 \end{aligned}$$

The unearned interest is \$70.27.

51. Substitute 380.50 for f, 8 for k, and 24 for n.

$$\begin{aligned} u &= (380.50) \cdot \frac{8(8+1)}{24(24+1)} \\ &= (380.50) \cdot \frac{8(9)}{24(25)} = 45.66 \end{aligned}$$

The unearned interest is \$45.66.

52. Substitute 450 for f, 9 for k, and 24 for n.

$$\begin{aligned} u &= 450 \cdot \frac{9(9+1)}{24(24+1)} \\ &= 450 \cdot \frac{9(10)}{24(25)} = 67.50 \end{aligned}$$

The unearned interest is \$67.50.

53. **(a)** New York Yankees:

$$\text{Pct.} = \frac{W}{W+L} = \frac{87}{87+75} = \frac{87}{162} \approx 0.537$$

(b) Baltimore:

$$\text{Pct.} = \frac{W}{W+L} = \frac{81}{81+81} = \frac{81}{162} = 0.500$$

(c) Tampa Bay:

$$\text{Pct.} = \frac{W}{W+L} = \frac{80}{80+82} = \frac{80}{162} \approx 0.494$$

(d) Boston:

$$\text{Pct.} = \frac{W}{W+L} = \frac{78}{78+84} = \frac{78}{162} \approx 0.481$$

54. **(a)** Washington:

$$\text{Pct.} = \frac{W}{W+L} = \frac{83}{83+79} = \frac{83}{162} \approx 0.512$$

(b) Miami:

$$\text{Pct.} = \frac{W}{W+L} = \frac{71}{71+91} = \frac{71}{162} \approx 0.438$$

(c) Atlanta:

$$\text{Pct.} = \frac{W}{W+L} = \frac{67}{67+95} = \frac{67}{162} \approx 0.414$$

(d) Philadelphia:

$$\text{Pct.} = \frac{W}{W+L} = \frac{63}{63+99} = \frac{63}{162} \approx 0.389$$

55. $0.30(245{,}340) = 73{,}602$

To the nearest dollar, \$73,602 will be spent to provide housing.

56. $0.08(245{,}340) = 19{,}627.20$

To the nearest dollar, \$19,627 will be spent for health care.

57. $\dfrac{\text{partial amount}}{\text{whole amount}} = \dfrac{\$39{,}000}{\$245{,}340} \approx 0.159$

The food cost is about 16%, which agrees with the percent shown in the graph.

58. $\dfrac{\text{partial amount}}{\text{whole amount}} = \dfrac{\$34{,}000}{\$245{,}340} \approx 0.139$

The transportation cost is about 14%, which agrees with the percent shown in the graph.

59. Let $x =$ the percent increase (as a decimal).

$$\text{percent increase} = \frac{\text{amount of increase}}{\text{original amount}}$$
$$x = \frac{11.34 - 10.50}{10.50}$$
$$x = \frac{0.84}{10.50}$$
$$x = 0.08$$

The percent increase was 8%.

60. Let $x =$ the percent decrease (as a decimal).

$$\text{percent decrease} = \frac{\text{amount of decrease}}{\text{original amount}}$$
$$x = \frac{70.00 - 59.50}{70.00}$$
$$x = \frac{10.50}{70.00}$$
$$x = 0.15$$

The percent discount was 15%.

61. Let $x =$ the percent increase (as a decimal).

$$\text{percent increase} = \frac{\text{amount of increase}}{\text{original amount}}$$
$$x = \frac{148 - 140}{140}$$
$$x = \frac{8}{140}$$
$$x \approx 0.057$$

The percent increase was about 5.7%.

62. Let $x =$ the percent increase (as a decimal).

$$\text{percent increase} = \frac{\text{amount of increase}}{\text{original amount}}$$
$$x = \frac{215 - 206}{206}$$
$$x = \frac{9}{206}$$
$$x \approx 0.044$$

The percent increase was about 4.4%.

63. Let $x =$ the percent decrease (as a decimal).

$$\text{percent decrease} = \frac{\text{amount of decrease}}{\text{original amount}}$$
$$x = \frac{484{,}674 - 384{,}420}{484{,}674}$$
$$x = \frac{100{,}254}{484{,}674}$$
$$x \approx 0.207$$

The percent decrease was about 20.7%.

64. Let $x =$ the percent increase (as a decimal).

$$\text{percent increase} = \frac{\text{amount of increase}}{\text{original amount}}$$
$$x = \frac{146{,}128 - 141{,}853}{141{,}853}$$
$$x = \frac{4{,}275}{141{,}853}$$
$$x \approx 0.030$$

The percent increase was about 3.0%.

65.
$$\text{percent decrease} = \frac{\text{amount of decrease}}{\text{original amount}}$$
$$= \frac{34.98 - 19.99}{34.98}$$
$$= \frac{14.99}{34.98} \approx 0.429$$

The percent discount was about 42.9%.

66.
$$\text{percent decrease} = \frac{\text{amount of decrease}}{\text{original amount}}$$
$$= \frac{39.99 - 19.99}{39.99}$$
$$= \frac{20.00}{39.99} \approx 0.500$$

The percent discount was about 50.0%.

67. **(a)**
$$S = \frac{4k + 7}{k + 90}$$
$$S = \frac{4(20) + 7}{(20) + 90}$$
$$S \approx 0.79$$

A 20 kg child has a body surface area of approximately 0.79 m^2.

(b)
$$S = \frac{4k + 7}{k + 90}$$
$$S = \frac{4(26) + 7}{(26) + 90}$$
$$S \approx 0.96$$

A 26 kg child has a body surface area of approximately 0.96 m^2.

68. **(a)**
$$S = \frac{4k + 7}{k + 90}$$
$$S = \frac{4(13.608) + 7}{(13.608) + 90}$$
$$S \approx 0.59$$

A 30 lb child (13.608 kg) has a body surface area of approximately 0.59 m^2.

(b) $S = \dfrac{4k+7}{k+90}$

$S = \dfrac{4(11.793)+7}{(11.793)+90}$

$S \approx 0.53$

A 26 lb child (11.793 kg) has a body surface area of approximately 0.53 m^2.

69. **(a)** Recall from exercise 67, part a, that a 20 kg child has a body surface area of approximately $0.79\,\text{m}^2$.

$C = \dfrac{\text{body surface area in m}^2}{1.7} \times D$

$C = \dfrac{0.79}{1.7} \times 250$

$C \approx 116$

A 20 kg child requires a dose of approximately 116 mg.

(b) Recall from exercise 67, part b, that a 26 kg child has a body surface area of approximately $0.96\,\text{m}^2$.

$C = \dfrac{\text{body surface area in m}^2}{1.7} \times D$

$C = \dfrac{0.96}{1.7} \times 250$

$C \approx 141$

A 26 kg child requires a dose of approximately 141 mg.

70. **(a)** Recall from exercise 68, part a, that a 30 lb child has a body surface area of approximately $0.59\,\text{m}^2$.

$C = \dfrac{\text{body surface area in m}^2}{1.7} \times D$

$C = \dfrac{0.59}{1.7} \times 500$

$C \approx 174$

A 30 lb child requires a dose of approximately 174 mg.

(b) Recall from exercise 68, part b, that a 26 kg child has a body surface area of approximately $0.53\,\text{m}^2$.

$C = \dfrac{\text{body surface area in m}^2}{1.7} \times D$

$C = \dfrac{0.53}{1.7} \times 500$

$C \approx 156$

A 26 lb child requires a dose of approximately 156 mg.

Relating Concepts (Exercises 71–76)

71. **(a)** $\dfrac{7x+8}{3} = 12$

$3\left(\dfrac{7x+8}{3}\right) = 3(12)$ *Multiply by 3.*

$7x + 8 = 36$

(b) $\dfrac{ax+k}{c} = t \; (c \neq 0)$

$c\left(\dfrac{ax+k}{c}\right) = tc$ *Multiply by c.*

$ax + k = tc$

72. **(a)** $7x + 8 = 36$

$7x + 8 - 8 = 36 - 8$ *Subtract 8.*

(b) $ax + k = tc$

$ax + k - k = tc - k$ *Subtract k.*

73. **(a)** $7x = 28$ **(b)** $ax = tc - k$

74. **(a)** $\dfrac{7x}{7} = \dfrac{28}{7}$ *Divide by 7.*

$x = 4$

(b) $\dfrac{ax}{a} = \dfrac{tc-k}{a}$ *Divide by a.*

$x = \dfrac{tc-k}{a}$

75. The restriction $a \neq 0$ must be applied. If $a = 0$, the denominator becomes 0 and division by 0 is undefined.

76. To solve an equation for a particular variable, such as solving the second equation for x, go through the same steps as you would in solving for x in the first equation. Treat all other variables as constants.

77. $28 = \dfrac{7}{2}(a+13)$

$\dfrac{2}{7} \cdot 28 = \dfrac{2}{7} \cdot \dfrac{7}{2}(a+13)$

$8 = a + 13$

$8 - 13 = a + 13 - 13$

$-5 = a$

Solution set: $\{-5\}$

78. $S = \dfrac{n}{2}(a+\ell)$

$\dfrac{2}{n} \cdot S = \dfrac{2}{n} \cdot \dfrac{n}{2}(a+\ell)$

$\dfrac{2S}{n} = a + \ell$

$\dfrac{2S}{n} - \ell = a$ OR $a = \dfrac{2S - n\ell}{n}$

Division by zero is undefined, so $n \neq 0$.

1.3 Applications of Linear Equations

1.3 Margin Exercises

1. **(a)** "9 added to a number" translates as

$$9 + x, \quad \text{or} \quad x + 9.$$

(b) "The difference between 7 and a number" translates as

$$7 - x.$$

Note: $x - 7$ is the difference between a number and 7.

(c) "Four times a number" translates as

$$4 \cdot x \quad \text{or} \quad 4x.$$

(d) "The quotient of 7 and a nonzero number" translates as

$$\frac{7}{x} \quad (x \neq 0).$$

2. **(a)**

The sum of a number and 6	is	28.
↓	↓	↓
$\underline{x+6}$	$=$	$\underline{28}$

An equation is $x + 6 = 28$.

(b)

If twice a number	is decreased	by 3,	the result is	17.
↓	↓	↓	↓	↓
$2x$	$-$	3	$=$	17

An equation is $2x - 3 = 17$.

(c)

The product of a number and 7	is	twice the number	plus	12.
↓	↓	↓	↓	↓
$7x$	$=$	$2x$	$+$	12

An equation is $7x = 2x + 12$.

(d)

The quotient of a number and 6,	added to	twice the number,	is	7.
↓	↓	↓	↓	↓
$\frac{x}{6}$	$+$	$2x$	$=$	7

An equation is $\frac{x}{6} + 2x = 7$.

3. **(a)** $5x - 3(x + 2) = 7$ is an *equation* because it has an equality symbol.

$$\begin{aligned} 5x - 3(x+2) &= 7 \\ 5x - 3x - 6 &= 7 && \textit{Distributive property} \\ 2x - 6 &= 7 && \textit{Combine like terms.} \\ 2x &= 13 && \textit{Add 6.} \\ x &= \tfrac{13}{2} && \textit{Divide by 2.} \end{aligned}$$

The solution set is $\{\frac{13}{2}\}$.

(b) $5x - 3(x + 2)$ is an *expression* because there is no equality symbol.

$$\begin{aligned} &5x - 3(x+2) \\ &= 5x - 3x - 6 && \textit{Distributive property} \\ &= 2x - 6 && \textit{Combine like terms.} \end{aligned}$$

4. **(a)** ***Step 1*** We must find the dimensions of the <u>rectangle</u>.

Step 2 The length and perimeter are given in terms of the <u>width</u> W. The length L is 5 cm more than the width, so

$$L = \underline{W + 5}.$$

The perimeter P is 5 times the width, so

$$P = \underline{5W}.$$

Step 3 Use the formula for perimeter of a rectangle.

$$\begin{aligned} P &= 2L + 2W \\ \underline{5W} &= \underline{2(W+5)} + 2W && P = 5W;\ L = W + 5 \end{aligned}$$

Step 4 Solve the equation.

$$\begin{aligned} 5W &= 2W + 10 + 2W && \textit{Distributive property} \\ 5W &= 4W + 10 && \textit{Combine terms.} \\ W &= 10 && \textit{Subtract 4W.} \end{aligned}$$

Step 5 The width is 10 and the length is

$$L = W + 5 = 10 + 5 = 15.$$

The dimensions of the rectangle are 10 cm by 15 cm.

Step 6 15 is 5 more than 10 and $P = 2(10) + 2(15) = 50$ is five times 10, as required.

(b) ***Step 1*** We must find the dimensions of the rectangle.

Step 2 The length is given in terms of the width W. The length L is 2 ft more than twice the width, so $L = 2W + 2$.

The perimeter P is 34, so $P = 34$.

Step 3 Use the formula for perimeter of a rectangle.

$$\begin{aligned} P &= 2L + 2W \\ 34 &= 2(2W + 2) + 2W && P = 34;\ L = 2W + 2 \end{aligned}$$

Step 4 Solve the equation.

$$\begin{aligned} 34 &= 4W + 4 + 2W && \textit{Distributive property} \\ 34 &= 6W + 4 && \textit{Combine terms.} \\ 30 &= 6W && \textit{Subtract 4.} \\ 5 &= W && \textit{Divide by 6.} \end{aligned}$$

(continued)

Step 5 The width is 5 and the length is

$$L = 2W + 2 = 10 + 2 = 12.$$

The dimensions of the rectangle are 5 ft by 12 ft.

Step 6 12 is 2 more than twice 5 and $P = 2(12) + 2(5) = 34$.

5. ***Step 1*** We must find the number of RBIs for each player.

Step 2 Let r = the number of RBIs for Arenado.
Then $r - 7$ = the number of RBIs for Donaldson.

Step 3 The sum of their RBIs is 253, so an equation is

$$r + (r - 7) = 253.$$

Step 4 Solve the equation.

$$2r - 7 = 253$$
$$2r = 260 \quad \textit{Add 7.}$$
$$r = 130 \quad \textit{Divide by 2.}$$

Step 5 Arenado had 130 RBIs and Donaldson had $130 - 7 = 123$ RBIs.

Step 6 123 is 7 less than 130, and the sum of 123 and 130 is 253.

6. **(a)** ***Step 1*** We must find the store's cost.

Step 2 Let x = the store's cost. The markup was 25% of the store's cost, which can be expressed in terms of x as $0.25x$.

Step 3 The sum of the store's cost and the markup was \$2375, so an equation is

$$x + 0.25x = 2375.$$

Step 4 Solve the equation.

$$1x + 0.25x = 2375 \quad \textit{Identity property}$$
$$1.25x = 2375 \quad \textit{Combine like terms.}$$
$$x = 1900 \quad \textit{Divide by 1.25.}$$

Step 5 The store's cost was \$1900.

Step 6 The markup was 25% of \$1900, or \$475. The cost plus the markup was \$1900 + \$475, or \$2375, as required.

(b) Let x be the amount she earned before deductions. Then 10% of x, or $0.10x$, is the amount of her deductions. An equation is

$$x - 0.10x = 162.$$
$$1x - 0.10x = 162 \quad \textit{Identity property}$$
$$0.90x = 162 \quad \textit{Combine terms}$$
$$x = 180 \quad \textit{Divide by 0.90.}$$

She earned \$180 before deductions were made.

7. **(a)** Let x = the amount invested at 2.5%.
Then $72{,}000 - x$ = the amount invested at 3%.

Use $I = prt$ with $t = 1$.
Make a table to organize the information.

Principal (in dollars)	Rate (as a decimal)	Interest (in dollars)
x	0.025	$0.025x$
$72{,}000 - x$	0.03	$0.03(72{,}000 - x)$
72,000	← Totals →	1910

Use the values in the last column to write an equation.

$$0.025x + 0.03(72{,}000 - x) = 1910$$
$$0.025x + 2160 - 0.03x = 1910$$
$$-0.005x = -250$$
$$x = 50{,}000$$

The woman invested \$50,000 at 2.5% and \$72,000 − \$50,000 = \$22,000 at 3%.

Check 2.5% of \$50,000 is \$1250 and 3% of \$22,000 is \$660. The sum is \$1910, as required.

(b) Let x = the amount invested at 2.5%.
Then $34{,}000 - x$ = the amount invested at 2%.

Use $I = prt$ with $t = 1$.
Make a table to organize the information.

Principal (in dollars)	Rate (as a decimal)	Interest (in dollars)
x	0.025	$0.025x$
$34{,}000 - x$	0.02	$0.02(34{,}000 - x)$
34,000	← Totals →	772.50

Use the values in the last column to write an equation.

$$0.025x + 0.02(34{,}000 - x) = 772.50$$
$$0.025x + 680 - 0.02x = 772.50$$
$$0.005x = 92.50$$
$$x = 18{,}500$$

The man invested \$18,500 at 2.5% and \$34,000 − \$18,500 = \$15,500 at 2%.

Check 2.5% of \$18,500 is \$462.50 and 2% of \$15,500 is \$3100. The sum is \$772.50, as required.

8. **(a)** Let x = the number of liters of the 10% solution. Then $x + 60$ = the number of liters of the 15% solution.

Make a table to organize the information.

(continued)

Number of Liters	Percent (as a decimal)	Liters of Pure Solution
x	$10\% = 0.10$	$0.10x$
60	$25\% = 0.25$	$0.25(60)$
$x + 60$	$15\% = 0.15$	$0.15(x + 60)$

Use the values in the last column to write an equation.

$$
\begin{aligned}
0.10x + 0.25(60) &= 0.15(x + 60) \\
0.10x + 15 &= 0.15x + 9 && \textit{Distributive property} \\
15 &= 0.05x + 9 && \textit{Subtract 0.10x.} \\
6 &= 0.05x && \textit{Subtract 9.} \\
120 &= x && \textit{Divide by 0.05.}
\end{aligned}
$$

120 L of 10% solution should be used.

Check 10% of 120 L is 12 L and 25% of 60 L is 15 L. The sum is $12 + 15 = 27$ L, which is the same as 15% of 180 L, as required.

(b) Let $x =$ the amount of \$8 per lb candy. Then $x + 100 =$ the amount of \$7 per lb candy.

Make a table to organize the information.

Number of Pounds	Price per Pound	Value
x	\$8	$8x$
100	\$4	400
$x + 100$	\$7	$7(x + 100)$

Use the values in the last column to write an equation.

$$
\begin{aligned}
8x + 400 &= 7(x + 100) \\
8x + 400 &= 7x + 700 && \textit{Distributive property} \\
x + 400 &= 700 && \textit{Subtract 7x.} \\
x &= 300 && \textit{Subtract 400.}
\end{aligned}
$$

300 lb of candy worth \$8 per lb should be used.

Check 300 lb of candy worth \$8 per lb is worth \$2400. 100 lb of candy worth \$4 per lb is worth \$400. The sum is $2400 + 400 = \$2800$, which is the same as 400 lb of candy worth \$7 per lb, as required.

9. **(a)** Let $x =$ the number of liters of pure acid.

Number of Liters	Percent (as a decimal)	Liters of Pure Acid
x	$100\% = 1$	x
6	$30\% = 0.30$	$0.30(6)$
$x + 6$	$50\% = 0.50$	$0.50(x + 6)$

Use the values in the last column to write an equation.

$$
\begin{aligned}
x + 0.30(6) &= 0.50(x + 6) \\
1x + 1.8 &= 0.5x + 3 \\
0.5x + 1.8 &= 3 && \textit{Subtract 0.5x.} \\
0.5x &= 1.2 && \textit{Subtract 1.8.} \\
x &= 2.4 && \textit{Divide by 0.5.}
\end{aligned}
$$

2.4 L of pure acid are needed.

Check 100% of 2.4 L is 2.4 L and 30% of 6 L is 1.8 L. The sum is $2.4 + 1.8 = 4.2$ L, which is the same as 50% of $2.4 + 6 = 8.4$ L, as required.

(b) Let $x =$ the number of liters of water.

Number of Liters	Percent (as a decimal)	Liters of Pure Antifreeze
x	$0\% = 0$	0
20	$50\% = 0.50$	$0.50(20)$
$x + 20$	$40\% = 0.40$	$0.40(x + 20)$

Use the values in the last column to write an equation.

$$
\begin{aligned}
0 + 0.50(20) &= 0.40(x + 20) \\
10 &= 0.4x + 8 \\
2 &= 0.4x && \textit{Subtract 8.} \\
5 &= x && \textit{Divide by 0.4.}
\end{aligned}
$$

5 L of water are needed.

Check 50% of 20 L is 10 L as is 40% of $20 + 5 = 25$ L, as required.

1.3 Section Exercises

1. **(a)** 12 more than a number $\underline{x + 12}$

(b) 12 is more than a number. $\underline{12 > x}$

2. **(a)** 3 less than a number $\underline{x - 3}$

(b) 3 is less than a number. $\underline{3 < x}$

3. **(a)** 4 less than a number $\underline{x - 4}$

(b) 4 is less than a number. $\underline{4 < x}$

4. **(a)** 6 greater than a number $\underline{x + 6}$

(b) 6 is greater than a number. $\underline{6 > x}$

5. Because the unknown number comes first in the verbal phrase, it must come first in the mathematical expression. The correct expression is $x - 7$.

6. Because the unknown number comes first in the verbal phrase, it must be placed in the numerator of the mathematical expression. The correct expression is $\frac{n}{12}$.

7. Twice a number, decreased by 13 $\underline{2x - 13}$

8. The product of 8 and a number, increased by 14 $\underline{8x + 14}$

9. 15 more than one-half of a number $\underline{\frac{1}{2}x + 15}$

10. 12 less than one-third of a number $\underline{\frac{1}{3}x - 12}$

11. The product of 10 and 6 less than a number $\underline{10(x - 6)}$

12. The product of 8 less than a number and 7 more than the number $\underline{(x - 8)(x + 7)}$

13. The quotient of five times a number and 9 $\underline{\frac{5x}{9}}$

14. The quotient of 12 and seven times a nonzero number $\underline{\frac{12}{7x} \quad (x \neq 0)}$

15. "The sum of a number and 6 is -31" is translated as

$$\begin{aligned} x + 6 &= -31. \\ x &= -37 \quad \textit{Subtract 6.} \end{aligned}$$

The number is -37.

16. "The sum of a number and -4 is 12" is translated as

$$\begin{aligned} x + (-4) &= 12. \\ x &= 16 \quad \textit{Add 4.} \end{aligned}$$

The number is 16.

17. "If the product of a number and -4 is subtracted from the number, the result is 9 more than the number" is translated as

$$\begin{aligned} x - (-4x) &= x + 9. \\ x + 4x &= x + 9 \\ 4x &= 9 \\ x &= \frac{9}{4} \end{aligned}$$

The number is $\frac{9}{4}$.

18. "If the quotient of a number and 6 is added to twice the number, the result is 8 less than the number" is translated as

$$\begin{aligned} 2x + \frac{x}{6} &= x - 8. \\ 12x + x &= 6x - 48 \quad \textit{Multiply by 6.} \\ 13x &= 6x - 48 \\ 7x &= -48 \\ x &= -\frac{48}{7} \end{aligned}$$

The number is $-\frac{48}{7}$.

19. "When $\frac{2}{3}$ of a number is subtracted from 12, the result is 10" is translated as

$$\begin{aligned} 12 - \frac{2}{3}x &= 10. \\ 36 - 2x &= 30 \quad \textit{Multiply by 3.} \\ -2x &= -6 \quad \textit{Subtract 36.} \\ x &= 3 \quad \textit{Divide by } -2. \end{aligned}$$

The number is 3.

20. "When 75% of a number is added to 6, the result is 3 more than the number" is translated as

$$\begin{aligned} 6 + 0.75x &= x + 3. \\ 600 + 75x &= 100x + 300 \quad \textit{Multiply by 100.} \\ 600 - 25x &= 300 \quad \textit{Subtract 100x.} \\ -25x &= -300 \quad \textit{Subtract 600.} \\ x &= 12 \quad \textit{Divide by } -25. \end{aligned}$$

The number is 12.

21. $5(x + 3) - 8(2x - 6)$ is an *expression* because there is no equals symbol.

$$\begin{aligned} &5(x + 3) - 8(2x - 6) \\ &= 5x + 15 - 16x + 48 \quad \textit{Distributive property} \\ &= -11x + 63 \quad \textit{Combine like terms.} \end{aligned}$$

22. $-7(y + 4) + 13(y - 6)$ has no equals symbol, so it is an *expression.*

$$\begin{aligned} &-7(y + 4) + 13(y - 6) \\ &= -7y - 28 + 13y - 78 \quad \textit{Distributive prop.} \\ &= 6y - 106 \quad \textit{Combine like terms.} \end{aligned}$$

23. $5(x + 3) - 8(2x - 6) = 12$ has an equals symbol, so this represents an *equation.*

$$\begin{aligned} 5(x + 3) - 8(2x - 6) &= 12 \\ 5x + 15 - 16x + 48 &= 12 \quad \textit{Dist. prop.} \\ -11x + 63 &= 12 \quad \textit{Combine terms.} \\ -11x &= -51 \quad \textit{Subtract 63.} \\ x &= \frac{51}{11} \quad \textit{Divide by } -11. \end{aligned}$$

The solution set is $\{\frac{51}{11}\}$.

24. $-7(y + 4) + 13(y - 6) = 18$ has an equals symbol, so it is an *equation.*

$$\begin{aligned} -7(y + 4) + 13(y - 6) &= 18 \\ -7y - 28 + 13y - 78 &= 18 \quad \textit{Dist. prop.} \\ 6y - 106 &= 18 \quad \textit{Combine terms.} \\ 6y &= 124 \quad \textit{Add 106.} \\ y = \frac{124}{6} &= \frac{62}{3} \quad \textit{Divide by 6.} \end{aligned}$$

The solution set is $\{\frac{62}{3}\}$.

25. $\frac{2}{3}x - \frac{1}{6}x + \frac{3}{2} = 8$ has an equals symbol, so this respresents an *equation*.

$$\begin{aligned} \tfrac{2}{3}x - \tfrac{1}{6}x + \tfrac{3}{2} &= 8 \\ 6\left(\tfrac{2}{3}x - \tfrac{1}{6}x + \tfrac{3}{2}\right) &= 6(8) && \textit{Multiply by the LCD, 6.} \\ 4x - x + 9 &= 48 && \textit{Distribute} \\ 3x + 9 &= 48 && \textit{Combine like terms.} \\ 3x &= 39 && \textit{Subtract 9.} \\ x &= 13 && \textit{Divide by 3.} \end{aligned}$$

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

26. $\frac{1}{3}x + \frac{1}{5}x - \frac{1}{2} - 8$ is an *expression* because there is no equals symbol.

$$\begin{aligned} &\tfrac{1}{3}x + \tfrac{1}{5}x - \tfrac{1}{2} - 8 \\ &= \tfrac{5}{15}x + \tfrac{3}{15}x - \tfrac{1}{2} - \tfrac{16}{2} && \textit{Common denom.} \\ &= \tfrac{8}{15}x - \tfrac{17}{2} && \textit{Combine like terms.} \end{aligned}$$

27. ***Step 1*** We are asked to find the number of patents each corporation secured.

Step 2 Let $x =$ the number of patents IBM secured. Then $x - 2545 =$ the number of patents that Samsung secured.

Step 3 A total of 12,417 patents were secured, so

$$\underline{x} + \underline{x - 2545} = 12{,}417.$$

Step 4
$$\begin{aligned} 2x - 2545 &= 12{,}417 \\ 2x &= 14{,}962 \\ x &= \underline{7481} \end{aligned}$$

Step 5 IBM secured 7481 patents and Samsung secured $7481 - 2545 =$ 4936 patents.

Step 6 The number of Samsung patents was 2545 fewer than the number of IBM patents, and the total number of patents was $7481 +$ 4936 $=$ 12,417.

28. ***Step 1*** We are asked to find the number of travelers to each country.

Step 2 Let $x =$ the number of travelers to Canada (in millions). Then $x + 14.4 =$ the number of travelers to Mexico (in millions).

Step 3 A total of 37.4 million U.S. residents traveled to Mexico and Canada, so

$$\underline{x} + (\underline{x + 14.4}) = 37.4$$

Step 4
$$\begin{aligned} 2x + 14.4 &= 37.4 \\ 2x &= 23 \\ x &= \underline{11.5} \end{aligned}$$

Step 5 There were 11.5 million travelers to Canada and $11.5 + 14.4 =$ 25.9 million travelers to Mexico.

Step 6 The number of travelers to Mexico was 14.4 million more than the number of travelers to Canada, and the total number of these travelers was $11.5 +$ 25.9 $=$ 37.4 million.

29. ***Step 2*** Let $W =$ the width of the base. Then $2W - 65$ is the length of the base.

Step 3 The perimeter of the base is 860 feet. Using $P = 2L + 2W$ gives us

$$2(2W - 65) + 2W = 860.$$

Step 4
$$\begin{aligned} 4W - 130 + 2W &= 860 \\ 6W - 130 &= 860 \\ 6W &= 990 \\ W &= \tfrac{990}{6} = 165 \end{aligned}$$

Step 5 The width of the base is 165 feet and the length of the base is $2(165) - 65 = 265$ feet.

Step 6 $2L + 2W = 2(265) + 2(165)$ $= 530 + 330 = 860$, which is the perimeter of the base, and the length, 265 ft, is 65 ft less than twice the base, 330 ft.

30. ***Step 2*** Let $L =$ the length of the top floor. Then $\frac{1}{2}L + 20$ is the width of the top floor.

Step 3 The perimeter of the top floor is 520 feet. Using $P = 2L + 2W$ gives us

$$2L + 2(\tfrac{1}{2}L + 20) = 520.$$

Step 4
$$\begin{aligned} 2L + L + 40 &= 520 \\ 3L + 40 &= 520 \\ 3L &= 480 \\ L &= 160 \end{aligned}$$

Step 5 The length of the top floor is 160 feet and the width of the top floor is $\frac{1}{2}(160) + 20 = 100$ feet.

Step 6 $2L + 2W = 2(160) + 2(100)$ $= 320 + 200 = 520$, which is the perimeter of the top floor. Also, the width, 100 ft, is 20 ft more than one-half the length, 80 ft.

31. ***Step 2*** Let $x =$ the length of the middle side. Then the shortest side is $x - 75$ and the longest side is $x + 375$.

Step 3 The perimeter of the Bermuda Triangle is 3075 miles. Using $P = a + b + c$ gives us

$$x + (x - 75) + (x + 375) = 3075.$$

(continued)

Step 4 $3x + 300 = 3075$

$3x = 2775$ *Subtract 300.*

$x = 925$ *Divide by 3.*

Step 5 The length of the middle side is 925 miles. The length of the shortest side is $x - 75 =$
$925 - 75 = 850$ miles. The length of the longest side is $x + 375 = 925 + 375 = 1300$ miles.

Step 6 $925 + 850 + 1300 = 3075$ miles (the correct perimeter), the shortest side measures 75 miles less than the middle side, and the longest side measures 375 miles more than the middle side, so the answer checks.

32. ***Step 2*** Let $x =$ the length of one of the sides of equal length.

Step 3 The perimeter of the triangle is 931.5 feet. Using $P = a + b + c$ gives us

$$x + x + 438 = 931.5$$

Step 4 $2x + 438 = 931.5$

$2x = 493.5$ *Subtract 438.*

$x = 246.75$ *Divide by 2.*

Step 5 The two walls are each 246.75 feet long.

Step 6 The answer checks since $246.75 + 246.75 + 438 = 931.75$, which is the correct perimeter.

33. ***Step 2*** Let $x =$ the height of the Eiffel Tower. Then $x - 804 =$ the height of the Leaning Tower of Pisa.

Step 3 Together these heights are 1164 ft, so

$$x + (x - 804) = 1164.$$

Step 4 $2x - 804 = 1164$

$2x = 1968$

$x = 984$

Step 5 The height of the Eiffel Tower is 984 feet and the height of the Leaning Tower of Pisa is $984 - 804 =$ 180 feet.

Step 6 180 feet is 804 feet shorter than 984 feet and the sum of 180 feet and 984 feet is 1164 feet.

34. ***Step 2*** Let $x =$ the number of performances of *Cats*. Then $x - 805 =$ the number of performances of *Les Misérables.*

Step 3 There were 14,165 total performances, so

$$x + (x - 805) = 14{,}165.$$

Step 4 $2x - 805 = 14{,}165$

$2x = 14{,}970$

$x = 7485$

Step 5 There were 7485 performances of *Cats* and $7485 - 805 = 6680$ performances of *Les Misérables.*

Step 6 The total number of performances is 14,165 and 6680 is 805 fewer than 7485, as required.

35. ***Step 2*** Let $x =$ the Dodgers' payroll (in millions). Then $x - 59.9 =$ the Yankees' payroll (in millions).

Step 3 The two payrolls totaled \$492.7 million, so

$$x + (x - 59.9) = 492.7$$

Step 4 $2x - 59.9 = 492.7$

$2x = 552.6$

$x = 276.3$

Step 5 In 2015, the Dodgers' payroll was \$276.3 million and the Yankees' payroll was $276.3 - 59.9 =$ \$216.4 million.

Step 6 \$216.4 million is \$59.9 million less than \$276.3 million and the sum of \$216.4 million and \$276.3 million is \$492.7 million.

36. ***Step 2*** Let $x =$ the number of hits Williams had. Then $x + 276 =$ the number of hits Hornsby had.

Step 3 Their base hits totaled 5584, so

$$x + (x + 276) = 5584.$$

Step 4 $2x + 276 = 5584$

$2x = 5308$

$x = 2654$

Step 5 Williams had 2654 base hits, and Hornsby had $2654 + 276 = 2930$ base hits.

Step 6 2930 is 276 more than 2654 and the total is $2654 + 2930 = 5584$.

37. Let $x =$ the percent increase (as a decimal).

$$\text{percent increase} = \frac{\text{amount of increase}}{\text{original amount}}$$

$$x = \frac{1{,}924{,}436 - 1{,}617{,}173}{1{,}617{,}173}$$

$$x = \frac{307{,}263}{1{,}617{,}173}$$

$$x \approx 0.190$$

The percent increase was about 19.0%.

38. Let $x =$ the percent increase (as a decimal).

$$\text{percent increase} = \frac{\text{amount of increase}}{\text{original amount}}$$
$$x = \frac{347 - 321}{321}$$
$$x = \frac{26}{321}$$
$$x \approx 0.081$$

The percent increase is expected to be about 8.1%.

39. Let $x =$ the tuition rate for Missouri residents. Then $1.38x$ represents the 138% increase for non-Missouri residents.

Tuition for Missouri residents plus the 138% increase equals the tuition rate for non-Missouri residents. Thus,

$$x + 1.38x = 25{,}198$$
$$2.38x = 25{,}198$$
$$x = \frac{25{,}198}{2.38}$$
$$x \approx 10{,}587$$

The tuition rate for Missouri residents was approximately \$10,587.

40. Let $x =$ the approximate cost in 2013–2014. Since x is 173.3% more than the 1993–1994 cost solve the equation below to find the cost in 2013–2014.

$$x = 9399 + 1.733(9399)$$
$$= 9399 + 16{,}288.467$$
$$\approx 25{,}687.47$$

To the nearest dollar, the cost was \$25,687.

41. Let $x =$ the 2014 cost. Then solve the equation below to find the cost in 2014.

$$x + 0.014x = 50.11$$
$$1.014x = 50.11$$
$$x = \frac{50.11}{1.014}$$
$$\approx 49.42$$

The 2014 cost was about \$49.42.

42. Let $x =$ the CPI in February 2015. Then $0.01x$ represents the 1.0% increase from February 2015 to February 2016.

The February 2015 CPI plus the 1.0% increase equals the February 2016 CPI. Thus,

$$x + 0.01x = 237.1$$
$$1.01x = 237.1$$
$$x = \frac{237.1}{1.01}$$
$$x \approx 234.8$$

The CPI was approximately 234.8 in February 2015.

43. Let $x =$ the amount of the receipts excluding tax. Since the sales tax is 9% of x, the total amount is

$$x + 0.09x = 2725$$
$$1x + 0.09x = 2725$$
$$1.09x = 2725$$
$$x = \frac{2725}{1.09} = 2500$$

Thus, the tax was $0.09(2500) =$ \$225.

44. Let $x =$ the amount of commission. Since x is 6% of the selling price,

$$x = 0.06(159{,}000) = 9540.$$

So after the agent was paid, he had $159{,}000 - 9540 =$ \$149,460.

45. Let $x =$ the amount invested at 3%. Then $12{,}000 - x =$ the amount invested at 4%.

Complete the table. Use $I = prt$ with $t = 1$.

Principal (in dollars)	Rate (as a decimal)	Interest (in dollars)
x	0.03	$0.03x$
$12{,}000 - x$	0.04	$0.04(12{,}000 - x)$
12,000	← Totals →	440

Use the values in the last column to write an equation.

Interest at 3%	+	interest at 4%	=	total interest.
$0.03x$	+	$0.04(12{,}000 - x)$	=	440

$$3x + 4(12{,}000 - x) = 44{,}000 \quad \textit{Multiply by 100.}$$
$$3x + 48{,}000 - 4x = 44{,}000$$
$$-x = -4000$$
$$x = 4000$$

He should invest \$4000 at 3% and $12{,}000 - 4000 =$ \$8000 at 4%.

Check \$4000 @ 3% = \$120 and \$8000 @ 4% = \$320; \$120 + \$320 = \$440.

46. Let $x =$ the amount invested at 2%. Then $60{,}000 - x =$ the amount invested at 3%.

Complete the table. Use $I = prt$ with $t = 1$.

Principal (in dollars)	Rate (as a decimal)	Interest (in dollars)
x	0.02	$0.02x$
$60{,}000 - x$	0.03	$0.03(60{,}000 - x)$
60,000	← Totals →	1600

Use the values in the last column to write an equation.

Interest at 2%	+	interest at 3%	=	total interest.
$0.02x$	+	$0.03(60{,}000 - x)$	=	1600

$$2x + 3(60{,}000 - x) = 160{,}000 \quad \textit{Multiply by 100.}$$
$$2x + 180{,}000 - 3x = 160{,}000$$
$$-x = -20{,}000$$
$$x = 20{,}000$$

He invested \$20,000 at 2% and $60{,}000 - x = 60{,}000 - 20{,}000 = \$40{,}000$ at 3%.

Check \$20,000 @ 2% = \$400 and \$40,000 @ 3% = \$1200; \$400 + \$1200 = \$1600.

47. Let $x =$ the amount invested at 4.5%. Then $2x - 1000 =$ the amount invested at 3%.

Use $I = prt$ with $t = 1$. Make a table.

Principal (in dollars)	Rate (as a decimal)	Interest (in dollars)
x	0.045	$0.045x$
$2x - 1000$	0.03	$0.03(2x - 1000)$
	Total →	1020

Use the values in the last column to write an equation.

Interest at 4.5%	+	interest at 3%	=	total interest.
$0.045x$	+	$0.03(2x - 1000)$	=	1020

$$45x + 30(2x - 1000) = 1{,}020{,}000 \quad \textit{Multiply by 1000.}$$
$$45x + 60x - 30{,}000 = 1{,}020{,}000$$
$$105x = 1{,}050{,}000$$
$$x = \frac{1{,}050{,}000}{105} = 10{,}000$$

She invested \$10,000 at 4.5% and $2x - 1000 = 2(10{,}000) - 1000 = \$19{,}000$ at 3%.

Check \$19,000 is \$1000 less than two times \$10,000. \$10,000 @ 4.5% = \$450 and \$19,000 @ 3% = \$570; \$450 + \$570 = \$1020.

48. Let $x =$ the amount invested at 3.5%. Then $3x + 5000 =$ the amount invested at 4%.

Use $I = prt$ with $t = 1$. Make a table.

Principal (in dollars)	Rate (as a decimal)	Interest (in dollars)
x	0.035	$0.035x$
$3x + 5000$	0.04	$0.04(3x + 5000)$
	Total →	1440

Use the values in the last column to write an equation.

Interest at 3.5%	+	interest at 4%	=	1440.
$0.035x$	+	$0.04(3x + 5000)$	=	1440

$$35x + 40(3x + 5000) = 1{,}440{,}000 \quad \textit{Multiply by 1000.}$$
$$35x + 120x + 200{,}000 = 1{,}440{,}000$$
$$155x = 1{,}240{,}000$$
$$x = \frac{1{,}240{,}000}{155} = 8000$$

He invested \$8000 at 3.5% and $3x + 5000 = 3(8000) + 5000 = \$29{,}000$ at 4%.

Check \$29,000 is \$5000 more than three times \$8000. \$8000 @ 3.5% = \$280 and \$29,000 @ 4% = \$1160; \$280 + \$1160 = \$1440.

49. Let $x =$ the amount of additional money to be invested at 2%.
Use $I = prt$ with $t = 1$. Make a table.
Use the fact that the total return on the two investments is 4%.

Principal (in dollars)	Rate (as a decimal)	Interest (in dollars)
27,000	0.05	$0.05(27{,}000)$
x	0.02	$0.02x$
$27{,}000 + x$	0.04	$0.04(27{,}000 + x)$

Use the values in the last column to write an equation.

Interest at 5%	+	interest at 2%	=	interest at 4%.
$0.05(27{,}000)$	+	$0.02x$	=	$0.04(27{,}000 + x)$

$$5(27{,}000) + 2x = 4(27{,}000 + x) \quad \textit{Multiply by 100.}$$
$$135{,}000 + 2x = 108{,}000 + 4x$$
$$27{,}000 = 2x$$
$$13{,}500 = x$$

(continued)

They should invest \$13,500 at 2%.

Check \$27,000 @ 5% = \$1350 and
\$13,500 @ 2% = \$270;
\$1350 + \$270 = \$1620, which is the same as (\$27,000 + \$13,500) @ 4%.

50. Let $x =$ the amount of additional money to be invested at 3%.
Use $I = prt$ with $t = 1$. Make a table.
Use the fact that the total return on the two investments is 4%.

Principal (in dollars)	Rate (as a decimal)	Interest (in dollars)
17,000	0.045	0.045(17,000)
x	0.03	$0.03x$
$17{,}000 + x$	0.04	$0.04(17{,}000 + x)$

Use the values in the last column to write an equation.

$$\begin{array}{ccccc} \text{Interest at 4.5\%} & + & \text{interest at 3\%} & = & \text{interest at 4\%.} \\ 0.045(17{,}000) & + & 0.03x & = & 0.04(17{,}000 + x) \end{array}$$

$$45(17{,}000) + 30x = 40(17{,}000 + x) \quad \textit{Multiply by 1000.}$$
$$765{,}000 + 30x = 680{,}000 + 40x$$
$$85{,}000 = 10x$$
$$8500 = x$$

She should invest \$8500 at 3%.

Check \$17,000 @ 4.5% = \$765 and
\$8500 @ 3% = \$255;
\$765 + \$255 = \$1020, which is the same as (\$17,000 + \$8500) @ 4%.

51. Let $x =$ the number of liters of 10% acid solution needed. Make a table.

Liters of Solution	Percent (as a decimal)	Liters of Pure Acid
10	0.04	$0.04(10) = 0.4$
x	0.10	$0.10x$
$x + 10$	0.06	$0.06(x + 10)$

Use the values in the last column to write an equation.

$$\begin{array}{ccccc} \text{Acid in 4\% solution} & + & \text{acid in 10\% solution} & = & \text{acid in 6\% solution.} \\ 0.4 & + & 0.10x & = & 0.06(x + 10) \end{array}$$

$$0.4 + 0.10x = 0.06x + 0.6 \quad \textit{Distributive property}$$
$$0.04x = 0.2 \quad \textit{Subtract 0.06x and 0.4.}$$
$$x = 5 \quad \textit{Divide by 0.04.}$$

Five liters of the 10% solution are needed.

Check 4% of 10 is 0.4 and 10% of 5 is 0.5; $0.4 + 0.5 = 0.9$, which is the same as 6% of $(10 + 5)$.

52. Let $x =$ the number of liters of 14% alcohol solution needed. Make a chart.

Liters of Solution	Percent (as a decimal)	Liters of Pure Alcohol
x	0.14	$0.14x$
20	0.50	$0.50(20) = 10$
$x + 20$	0.30	$0.30(x + 20)$

Use the values in the last column to write an equation.

$$\begin{array}{ccccc} \text{Alcohol in 14\% solution} & + & \text{alcohol in 50\% solution} & = & \text{alcohol in 30\% solution.} \\ 0.14x & + & 10 & = & 0.30(x + 20) \end{array}$$

$$14x + 1000 = 30(x + 20) \quad \textit{Multiply by 100.}$$
$$14x + 1000 = 30x + 600$$
$$-16x = -400 \quad \textit{Subtract 30x and 1000.}$$
$$x = 25 \quad \textit{Divide by } -16.$$

25 L of 14% solution must be added.

Check 14% of 25 is 3.5 and 50% of 20 is 10; $3.5 + 10 = 13.5$, which is the same as 30% of $(25 + 20)$.

53. Let $x =$ the number of liters of the 20% alcohol solution. Make a table.

Liters of Solution	Percent (as a decimal)	Liters of Pure Alcohol
12	0.12	$0.12(12) = 1.44$
x	0.20	$0.20x$
$x + 12$	0.14	$0.14(x + 12)$

Use the values in the last column to write an equation.

$$\begin{array}{ccccc} \text{Alcohol in 12\% solution} & + & \text{alcohol in 20\% solution} & = & \text{alcohol in 14\% solution.} \\ 1.44 & + & 0.20x & = & 0.14(x + 12) \end{array}$$

(continued)

$$\begin{aligned} 144 + 20x &= 14(x + 12) && \textit{Multiply by 100.} \\ 144 + 20x &= 14x + 168 && \textit{Distributive property} \\ 6x &= 24 && \textit{Subtract 14x and 144.} \\ x &= 4 && \textit{Divide by 6.} \end{aligned}$$

Four L of 20% alcohol solution are needed.

Check 12% of 12 is 1.44 and 20% of 4 is 0.8; $1.44 + 0.8 = 2.24$, which is the same as 14% of $(12 + 4)$.

54. Let x = the number of liters of 10% alcohol solution. Make a chart.

Liters of Solution	Percent (as a decimal)	Liters of Pure Alcohol
x	0.10	$0.10x$
40	0.50	$0.50(40) = 20$
$x + 40$	0.40	$0.40(x + 40)$

Use the values in the last column to write an equation.

Alcohol in 10% solution	+	alcohol in 50% solution	=	alcohol in 40% solution.
$0.10x$	+	20	=	$0.40(x + 40)$

$$\begin{aligned} 10x + 2000 &= 40(x + 40) && \textit{Multiply by 100.} \\ 10x + 2000 &= 40x + 1600 && \\ -30x &= -400 && \textit{Subtract 40x and 2000.} \\ x &= \tfrac{40}{3} \text{ or } 13\tfrac{1}{3} && \textit{Divide by } -30. \end{aligned}$$

$13\frac{1}{3}$ L of 10% solution should be added.

Check 50% of 40 is 20 and 10% of $\frac{40}{3}$ is $\frac{4}{3}$; $20 + \frac{4}{3} = 21\frac{1}{3}$, which is the same as 40% of $(\frac{40}{3} + 40)$.

55. Let x = the amount of pure dye used (pure dye is 100% dye). Make a table.

Gallons of Solution	Percent (as a decimal)	Gallons of Pure Dye
x	1	$1x = x$
4	0.25	$0.25(4) = 1$
$x + 4$	0.40	$0.40(x + 4)$

Use the values in the last column to write an equation.

$$\begin{aligned} x + 1 &= 0.4(x + 4) && \\ x + 1 &= 0.4x + 1.6 && \textit{Distributive property} \\ 0.6x &= 0.6 && \textit{Subtract 0.4x and 1.} \\ x &= 1 && \textit{Divide by 0.6.} \end{aligned}$$

One gallon of pure (100%) dye is needed.

Check 100% of 1 is 1 and 25% of 4 is 1; $1 + 1 = 2$, which is the same as 40% of $(1 + 4)$.

56. Let x = the number of gallons of water. Make a chart.

Gallons of Solution	Percent (as a decimal)	Gallons of Pure Insecticide
x	0	$0(x) = 0$
6	0.04	$0.04(6) = 0.24$
$x + 6$	0.03	$0.03(x + 6)$

Use the values in the last column to write an equation.

Insecticide in water	+	insecticide in 4% solution	=	insecticide in 3% solution.
0	+	0.24	=	$0.03(x + 6)$

$$\begin{aligned} 0 + 24 &= 3(x + 6) && \textit{Multiply by 100.} \\ 24 &= 3x + 18 && \textit{Distributive property} \\ 6 &= 3x && \textit{Subtract 18.} \\ 2 &= x && \textit{Divide by 3.} \end{aligned}$$

Two gallons of water should be added.

Check 4% of 6 is 0.24, which is the same as 3% of $(2 + 6)$.

57. Let x = the amount of \$6 per lb nuts. Make a table.

Pounds of Nuts	Cost per Pound	Total Cost
50	\$2	$2(50) = 100$
x	\$6	$6x$
$x + 50$	\$5	$5(x + 50)$

The total value of the \$2 per lb nuts and the \$6 per lb nuts must equal the value of the \$5 per lb nuts.

$$\begin{aligned} 100 + 6x &= 5(x + 50) \\ 100 + 6x &= 5x + 250 \\ x &= 150 \end{aligned}$$

She should use 150 lb of \$6 nuts.

Check 50 pounds of the \$2 per lb nuts are worth \$100 and 150 pounds of the \$6 per lb nuts are worth \$900; $\$100 + \$900 = \$1000$, which is the same as $(50 + 150)$ pounds worth \$5 per lb.

58. Let $x =$ the number of ounces of 2¢ per oz tea. Make a table.

Ounces of Tea	Cost per Ounce	Total Cost
x	2¢ or 0.02	$0.02x$
100	5¢ or 0.05	$0.05(100) = 5$
$x + 100$	3¢ or 0.03	$0.03(x + 100)$

Use the values in the last column to write an equation.

$$\begin{array}{ccccc} \text{Cost of} & + & \text{cost of} & = & \text{cost of} \\ 2¢ \text{ tea} & & 5¢ \text{ tea} & & 3¢ \text{ tea.} \\ 0.02x & + & 5 & = & 0.03(x+100) \end{array}$$

$$\begin{aligned} 2x + 500 &= 3(x + 100) && \textit{Multiply by 100.} \\ 2x + 500 &= 3x + 300 && \textit{Distributive property} \\ 200 &= x && \textit{Subtract 2x and 300.} \end{aligned}$$

200 oz of 2¢ per oz tea should be used.

Check 200 oz of 2¢ per oz tea is worth \$4 and 100 oz of 5¢ per oz tea is worth \$5; $\$4 + \$5 = \$9$, which is the same value as $(200 + 100)$ oz of 3¢ per oz tea.

59. We cannot expect the final mixture to be worth more than the more expensive of the two ingredients. Answers will vary.

60. Let $x =$ the number of liters of 30% acid solution. Make a chart.

Liters of Solution	Percent (as a decimal)	Liters of Pure Acid
x	0.30	$0.30x$
15	0.50	$0.50(15) = 7.5$
$x + 15$	0.60	$0.60(x + 15)$

Use the values in the last column to write an equation.

$$\begin{array}{ccccc} \text{Acid} & & \text{acid} & & \text{acid} \\ \text{in 30\%} & + & \text{in 50\%} & = & \text{in 60\%} \\ \text{solution} & & \text{solution} & & \text{solution.} \\ 0.30x & + & 7.5 & = & 0.60(x+15) \end{array}$$

$$\begin{aligned} 3x + 75 &= 6(x + 15) && \textit{Multiply by 10.} \\ 3x + 75 &= 6x + 90 && \textit{Distributive property} \\ -3x &= 15 && \textit{Subtract 6x and 75.} \\ x &= -5 && \textit{Divide by } -3. \end{aligned}$$

The solution, -5, is impossible because the number of liters of 30% acid solution cannot be negative. Therefore, this problem has no solution.

Relating Concepts (Exercises 61–65)

61. **(a)** Let $x =$ the amount invested at 3%. Then $800 - x =$ the amount invested at 6%.

(b) Let $y =$ the amount of 3% acid used. Then $800 - y =$ the amount of 6% acid used.

62. Organize the information in a table.

(a)

Principal (in dollars)	Percent (as a decimal)	Interest (in dollars)
x	0.03	$0.03x$
$800 - x$	0.06	$0.06(800 - x)$
800	0.0525	$0.0525(800)$

The amount of interest earned at 3% and 6% is found in the last column of the table, $0.03x$ and $0.06(800 - x)$.

(b)

Liters of Solution	Percent (as a decimal)	Liters of Pure Acid
y	0.03	$0.03y$
$800 - y$	0.06	$0.06(800 - y)$
800	0.0525	$0.0525(800)$

The amount of pure acid in the 3% and 6% mixtures is found in the last column of the table, $0.03y$ and $0.06(800 - y)$.

63. Refer to the tables for Exercise 62. In each case, use the values in the last column to write an equation.

(a) $0.03x + 0.06(800 - x) = 0.0525(800)$

(b) $0.03y + 0.06(800 - y) = 0.0525(800)$

64. In both cases, multiply by 10,000 to clear the decimals.

(a)
$$\begin{aligned} 0.03x + 0.06(800 - x) &= 0.0525(800) \\ 300x + 600(800 - x) &= 525(800) \\ 300x + 480{,}000 - 600x &= 420{,}000 \\ -300x &= -60{,}000 \\ x &= 200 \end{aligned}$$

Jack invested \$200 at 3% and $800 - x = 800 - 200 = \$600$ at 6%.

(b)
$$\begin{aligned} 0.03y + 0.06(800 - y) &= 0.0525(800) \\ 300y + 600(800 - y) &= 525(800) \\ 300y + 480{,}000 - 600y &= 420{,}000 \\ -300y &= -60{,}000 \\ y &= 200 \end{aligned}$$

Jill used 200 L of 3% acid solution and $800 - y = 800 - 200 = 600$ L of 6% acid solution.

65. The processes used to solve Problems A and B were virtually the same. Aside from the variables chosen, the problem information was organized in similar tables and the equations solved were the same. The amounts of money in Problem A correspond to the amounts of solution in Problem B.

1.4 Further Applications of Linear Equations

1.4 Margin Exercises

1. Let $x =$ the number of dimes.
Then $26 - x =$ the number of half-dollars.

	Number of Coins	Denom-ination	Value (in dollars)
Dimes	x	\$0.10	$0.10x$
Halves	$26 - x$	\$0.50	$0.50(26 - x)$
	26	← Totals →	8.60

Multiply the number of coins by the denominations, and add the results to get 8.60.

$$0.10x + 0.50(26 - x) = 8.60$$
$$1x + 5(26 - x) = 86 \quad \textit{Multiply by 10.}$$
$$1x + 130 - 5x = 86$$
$$-4x = -44$$
$$x = 11$$

The cashier has 11 dimes and $26 - 11 = 15$ half-dollars.

Check The number of coins is $11 + 15 = 26$ and the value of the coins is $\$0.10(11) + \$0.50(15) = \$8.60$, as required.

2. **(a)** ***Step 1*** We must find *time*.

Step 2 Let $x =$ the time traveled by each train.

Make a table. Use the formula $d = rt$, that is, find each distance by multiplying rate by time.

	Rate	Time	Distance
Train 1	80	x	$80x$
Train 2	75	x	$75x$
Total			387.5

Step 3 The total distance traveled is the sum of the distances traveled by each train, since they are traveling in opposite directions. This total is 387.5 km, so

$$80x + 75x = 387.5.$$

Step 4 $155x = 387.5$
$$x = \frac{387.5}{155} = 2.5$$

Step 5 The trains will be 387.5 km apart in 2.5 hr.

Step 6 **Check** The first train traveled $80(2.5) = 200$ km. The second train traveled $75(2.5) = 187.5$ km, for a total of $200 + 187.5 = 387.5$, as required.

(b) Let $x =$ the amount of time needed for the cars to be 420 mi apart.

Make a table. Use the formula $d = rt$, that is, find each distance by multiplying rate by time.

	Rate	Time	Distance
Northbound Car	60	x	$60x$
Southbound Car	45	x	$45x$
Total			420

The total distance traveled is the sum of the distances traveled by each car, since they are traveling in opposite directions. This total is 420 mi.

$$60x + 45x = 420$$
$$105x = 420$$
$$x = \frac{420}{105} = 4$$

The cars will be 420 mi apart in 4 hr.

Check The northbound car travels $60(4) = 240$ miles and the southbound car travels $45(4) = 180$ miles for a total of 420 miles, as required.

3. **(a)** Let $x =$ the driving rate.
Then $x - 30 =$ the bicycling rate.

Make a table. Use the formula $d = rt$, that is, find each distance by multiplying rate by time.

	Rate	Time	Distance
Car	x	$\frac{1}{2}$	$\frac{1}{2}x$
Bike	$x - 30$	$1\frac{1}{2} = \frac{3}{2}$	$\frac{3}{2}(x - 30)$

The distances are equal.

$$\tfrac{1}{2}x = \tfrac{3}{2}(x - 30)$$
$$1x = 3(x - 30) \quad \textit{Multiply by 2.}$$
$$x = 3x - 90$$
$$90 = 2x \quad \textit{Subtract x; add 90.}$$
$$45 = x \quad \textit{Divide by 2.}$$

The distance he travels to work is

$$\tfrac{1}{2}x = \tfrac{1}{2}(45) = 22.5 \text{ miles.}$$

Check The distance he travels to work by bike is $\frac{3}{2}(x - 30) = \frac{3}{2}(45 - 30) = \frac{3}{2}(15) = 22.5$ miles, which is the same as we found above (by car).

(b) Let $x =$ the time it takes Clay to catch up to Elayn. Then $x + \frac{1}{2} =$ Elayn's time.

Make a table. Use the formula $d = rt$, that is, find each distance by multiplying rate by time.

	Rate	Time	Distance
Elayn	3	$x + \frac{1}{2}$	$3(x + \frac{1}{2})$
Clay	5	x	$5x$

(continued)

The distance traveled by Elayn is equal to the distance traveled by Clay.

$$\begin{aligned} 3(x + \tfrac{1}{2}) &= 5x \\ 3x + \tfrac{3}{2} &= 5x \\ 6x + 3 &= 10x \quad \textit{Multiply by 2.} \\ 3 &= 4x \\ \tfrac{3}{4} &= x \end{aligned}$$

It takes Clay $\frac{3}{4}$ hr or 45 min to catch up to Elayn.

Check Elayn travels $3(\frac{3}{4} + \frac{1}{2}) = \frac{15}{4}$ miles and Clay also travels $5(\frac{3}{4}) = \frac{15}{4}$ miles, as required.

4. The sum of the three measures must equal 180°.

$$\begin{aligned} x + (x + 61) + (2x + 7) &= 180 \\ 4x + 68 &= 180 \\ 4x &= 112 \\ x &= 28 \end{aligned}$$

The angles measure 28°, $28 + 61 = 89°$, and $2(28) + 7 = 63°$.

Check Since $28° + 89° + 63° = 180°$, the answers are correct.

5. Let $x =$ the first consecutive integer. Then $x + 1$ will be the second consecutive integer, and $x + 2$ willl be the third consecutive integer.

The sum of the first and second is 43 less than three times the third.

$$\begin{aligned} x + (x + 1) &= 3(x + 2) - 43 \\ 2x + 1 &= 3x + 6 - 43 \\ 2x + 1 &= 3x - 37 \\ 38 &= x \end{aligned}$$

Since $x = 38$, $x + 1 = 39$, and $x + 2 = 40$. The three consecutive integers are $38, 39,$ and 40.

1.4 Section Exercises

1. 38 nickels and 26 dimes are worth

$$\begin{aligned} 38(0.05) + 26(0.10) &= 1.90 + 2.60 \\ &= \$4.50. \end{aligned}$$

2. Use $d = rt$, or $t = \frac{d}{r}$. Substitute 7700 for d and 550 for r.

$$t = \frac{d}{r} = \frac{7700}{550} = 14$$

Its travel time is 14 hours.

3. Use $d = rt$, or $r = \frac{d}{t}$. Substitute 300 for d and 5 for t.

$$r = \frac{d}{t} = \frac{300}{5} = 60$$

His rate was 60 mph.

4. Use $P = 4s$ or $s = \frac{P}{4}$. Substitute 40 for P.

$$s = \frac{P}{4} = \frac{40}{4} = 10$$

The length of each side of the square is 10 in. This is also the length of each side of the equilateral triangle. To find the perimeter of the equilateral triangle, use $P = 3s$. Substitute 10 for s.

$$P = 3s = 3(10) = 30$$

The perimeter would be 30 inches.

5. Let $x =$ the number of pennies. Then x is also the number of dimes, and $44 - 2x$ is the number of quarters.

Number of Coins	Denomination (in dollars)	Value (in dollars)
x	0.01	$0.01x$
x	0.10	$0.10x$
$44 - 2x$	0.25	$0.25(44 - 2x)$
44	← Totals →	4.37

The sum of the values must equal the total value.

$$\begin{aligned} 0.01x + 0.10x + 0.25(44 - 2x) &= 4.37 \\ x + 10x + 25(44 - 2x) &= 437 \\ &\textit{Multiply by 100.} \\ x + 10x + 1100 - 50x &= 437 \\ -39x + 1100 &= 437 \\ -39x &= -663 \\ x &= 17 \end{aligned}$$

There are 17 pennies, 17 dimes, and $44 - 2(17) = 10$ quarters.

Check The number of coins is $17 + 17 + 10 = 44$ and the value of the coins is $\$0.01(17) + \$0.10(17) + \$0.25(10) = \$4.37$, as required.

6. Let $x =$ the number of nickels and the number of quarters. Then $2x$ is the number of half-dollars.

Number of Coins	Denomination (in dollars)	Value (in dollars)
x	0.05	$0.05x$
x	0.25	$0.25x$
$2x$	0.50	$0.50(2x)$
	Total →	2.60

The sum of the values must equal the total value.

(continued)

$$\begin{aligned} 0.05x + 0.25x + 0.50(2x) &= 2.60 \\ 5x + 25x + 50(2x) &= 260 \\ &\textit{Multiply by 100.} \\ 5x + 25x + 100x &= 260 \\ 130x &= 260 \\ x &= 2 \end{aligned}$$

She found 2 nickels, 2 quarters, and $2(2) = 4$ half-dollars.

Check The number of nickels, 2, is the same as the number of quarters. The number of half-dollars, 4, is twice the number of quarters. The value of the coins is $\$0.05(2) + \$0.25(2) + \$0.50(4) = \$2.60$, as required.

7. Let $x =$ the number of loonies.
Then $37 - x$ is the number of toonies.

Number of Coins	Denomination (in dollars)	Value (in dollars)
x	1	$1x$
$37 - x$	2	$2(37 - x)$
37	← Totals →	51

The sum of the values must equal the total value.

$$\begin{aligned} 1x + 2(37 - x) &= 51 \\ x + 74 - 2x &= 51 \\ -x + 74 &= 51 \\ 23 &= x \end{aligned}$$

She has 23 loonies and $37 - 23 = 14$ toonies.

Check The total number of coins is 37 and the value of the coins is $\$1(23) + \$2(14) = \$51$, as required.

8. Let $x =$ the number of \$1 bills.
Then $119 - x$ is the number of \$5 bills.

Number of Bills	Denomination (in dollars)	Value (in dollars)
x	1	$1x$
$119 - x$	5	$5(119 - x)$
119	← Totals →	347

The sum of the values must equal the total value.

$$\begin{aligned} 1x + 5(119 - x) &= 347 \\ x + 595 - 5x &= 347 \\ -4x &= -248 \\ x &= 62 \end{aligned}$$

He has 62 \$1 bills and $119 - 62 = 57$ \$5 bills.

Check The value of the bills is $\$1(62) + \$5(57) = \$62 + \$285 = \$347$, as required.

9. Let $x =$ the number of \$10 coins.
Then $53 - x$ is the number of \$20 coins.

Number of Coins	Denomination (in dollars)	Value (in dollars)
x	10	$10x$
$53 - x$	20	$20(53 - x)$
53	← Totals →	780

The sum of the values must equal the total value.

$$\begin{aligned} 10x + 20(53 - x) &= 780 \\ 10x + 1060 - 20x &= 780 \\ -10x &= -280 \\ x &= 28 \end{aligned}$$

He has 28 \$10 coins and $53 - 28 = 25$ \$20 coins.

Check The number of coins is $28 + 25 = 53$ and the value of the coins is $\$10(28) + \$20(25) = \$780$, as required.

10. Let $x =$ the number of two-cent pieces.
Then $3x$ is the number of three-cent pieces.

Number of Coins	Denomination (in dollars)	Value (in dollars)
x	0.02	$0.02x$
$3x$	0.03	$0.03(3x)$
	Total →	2.42

The sum of the values must equal the total value.

$$\begin{aligned} 0.02x + 0.03(3x) &= 2.42 \\ 2x + 3(3x) &= 242 \quad \textit{Multiply by 100.} \\ 2x + 9x &= 242 \\ 11x &= 242 \\ x &= 22 \end{aligned}$$

She has 22 two-cent pieces and $3(22) = 66$ three-cent pieces.

Check The number of three-cent pieces, 66, is three times the number of two-cent pieces, 22. The value of the coins is $\$0.02(22) + \$0.03(66) = \$2.42$, as required.

11. Let $x =$ the number of adult tickets sold. Then $1460 - x =$ the number of children and senior tickets sold.

Cost of Ticket	Number Sold	Amount Collected
\$18	x	$18x$
\$12	$1460 - x$	$12(1460 - x)$
Totals	1460	\$22,752

Use the values in the last column to write an equation.

$$\begin{aligned} 18x + 12(1460 - x) &= 22{,}752 \\ 18x + 17{,}520 - 12x &= 22{,}752 \\ 6x &= 5232 \\ x &= 872 \end{aligned}$$

There were 872 adult tickets sold and $1460 - 872 = 588$ children and senior tickets sold.

Check The amount collected was $\$18(872) + \$12(588)$ $= \$15{,}696 + \$7056 = \$22{,}752$, as required.

12. Let $x =$ the number of student tickets sold. Then $480 - x =$ the number of nonstudent tickets sold.

Cost of Ticket	Number Sold	Amount Collected
\$5	x	$5x$
\$8	$480 - x$	$8(480 - x)$
Totals	480	\$2895

Use the values in the last column to write an equation.

$$\begin{aligned} 5x + 8(480 - x) &= 2895 \\ 5x + 3840 - 8x &= 2895 \\ -3x &= -945 \\ x &= 315 \end{aligned}$$

There were 315 student tickets sold and $480 - 315 = 165$ nonstudent tickets sold.

Check The amount collected was $\$5(315) + \$8(165) = \$1575 + \$1320 = \$2895$, as required.

13. $d = rt$, so

$$r = \frac{d}{t} = \frac{100}{12.35} \approx 8.10$$

Her rate was about 8.10 m/sec.

14. $d = rt$, so

$$r = \frac{d}{t} = \frac{400}{52.70} \approx 7.59$$

Her rate was about 7.59 m/sec.

15. $d = rt$, so

$$r = \frac{d}{t} = \frac{200}{19.32} \approx 10.35$$

His rate was about 10.35 m/sec.

16. $d = rt$, so

$$r = \frac{d}{t} = \frac{400}{43.94} \approx 9.10$$

His rate was about 9.10 m/sec.

17. Let $t =$ the time until they are 110 mi apart. Make a table. Use the formula $d = rt$, that is, find each distance by multiplying rate by time.

	Rate	Time	Distance
First Steamer	22	t	$22t$
Second Steamer	22	t	$22t$
Total →			110

The total distance traveled is the sum of the distances traveled by each steamer, since they are traveling in opposite directions. This total is 110 mi.

$$\begin{aligned} 22t + 22t &= 110 \\ 44t &= 110 \\ t &= \tfrac{110}{44} = \tfrac{5}{2}, \text{ or } 2\tfrac{1}{2} \end{aligned}$$

It will take them $2\frac{1}{2}$ hr.

Check Each steamer traveled $22(2.5) = 55$ miles for a total of $2(55) = 110$ miles, as required.

18. Let $t =$ the time it takes for the trains to be 315 km apart. Make a table. Use the formula $d = rt$, that is, find each distance by multiplying rate by time.

	Rate	Time	Distance
First train	85	t	$85t$
Second train	95	t	$95t$
Total →			315

The total distance traveled is the sum of the distances traveled by each train, since they are traveling in opposite directions. This total is 315 km.

$$\begin{aligned} 85t + 95t &= 315 \\ 180t &= 315 \\ t &= \tfrac{315}{180} = \tfrac{7}{4}, \text{ or } 1\tfrac{3}{4} \end{aligned}$$

It will take the trains $1\frac{3}{4}$ hr before they are 315 km apart.

Check The first train traveled $85(1.75) = 148.75$ km and the second train traveled $95(1.75) = 166.25$ km. The sum is 315 km, as required.

19. Let $t =$ Mulder's time.
Then $t - \frac{1}{2} =$ Scully's time.

	Rate	Time	Distance
Mulder	65	t	$65t$
Scully	68	$t - \frac{1}{2}$	$68(t - \frac{1}{2})$

The distances are equal.

$$\begin{aligned} 65t &= 68(t - \tfrac{1}{2}) \\ 65t &= 68t - 34 \\ -3t &= -34 \\ t &= \tfrac{34}{3}, \text{ or } 11\tfrac{1}{3} \end{aligned}$$

Mulder's time will be $11\frac{1}{3}$ hr. Since he left at 8:30 A.M., $11\frac{1}{3}$ hr or 11 hr 20 min later is 7:50 P.M.

Check Mulder's distance was $65(\frac{34}{3}) = 736\frac{2}{3}$ miles. Scully's distance was $68(\frac{34}{3} - \frac{1}{2}) = 68(\frac{65}{6}) = 736\frac{2}{3}$, as required.

20. Let $x =$ Clark's travel time.
Since Lois leaves 15 minutes after Clark, and $\frac{15}{60} = \frac{1}{4}$ hr, $t + \frac{1}{4} =$ time for Lois.
Complete a table using the formula $rt = d$.

	Rate	Time	Distance
Lois	48	$t + \frac{1}{4}$	$48(t + \frac{1}{4})$
Clark	56	t	$56t$

Since Lois and Clark are arriving at the same place, their distances are equal.

$$\begin{aligned} 48(t + \tfrac{1}{4}) &= 56t \\ 48t + 12 &= 56t \\ 12 &= 8t \\ 1.5 &= t \end{aligned}$$

Clark's time will be 1.5 hours after he leaves, or 8:15 A.M. + 1.5 hr = 9:45 A.M.

Check Clark's distance was $56(1.5) = 84$ mi.
Lois' distance was $48(1.5 + \frac{1}{4}) = 84$.
The solution checks.

21. Let $x =$ her average rate on Sunday.
Then $x + 5 =$ her average rate on Saturday.

	Rate	Time	Distance
Saturday	$x + 5$	3.6	$3.6(x + 5)$
Sunday	x	4	$4x$

The distances are equal.

$$\begin{aligned} 3.6(x + 5) &= 4x \\ 3.6x + 18 &= 4x \\ 18 &= 0.4x \qquad \textit{Subtract 3.6x.} \\ x &= \tfrac{18}{0.4} = 45 \end{aligned}$$

Her average rate on Sunday was 45 mph.

Check On Sunday, 4 hours @ 45 mph = 180 miles. On Saturday, 3.6 hours @ 50 mph = 180 miles. The distances are equal.

22. Let $x =$ her biking rate.
Then $x - 7 =$ her walking rate.

	Rate	Time	Distance
Walking	$x - 7$	$\frac{40}{60} = \frac{2}{3}$ hr	$\frac{2}{3}(x - 7)$
Biking	x	$\frac{12}{60} = \frac{1}{5}$ hr	$\frac{1}{5}x$

The distances are equal.

$$\begin{aligned} \tfrac{2}{3}(x - 7) &= \tfrac{1}{5}x \\ 10(x - 7) &= 3x \qquad \textit{Multiply by 15.} \\ 10x - 70 &= 3x \\ 7x &= 70 \\ x &= 10 \end{aligned}$$

The distance from her house to the train station is $\frac{1}{5}x = \frac{1}{5}(10) = 2$ miles.

Check The distance walking is (3 mph)($\frac{2}{3}$ hr) = 2 miles. The distance biking is (10 mph)($\frac{1}{5}$ hr) = 2 miles. The distances are equal.

23. Let $x =$ Anne's time.
Then $x + \frac{1}{2} =$ Johnny's time.

	Rate	Time	Distance
Anne	60	x	$60x$
Johnny	50	$x + \frac{1}{2}$	$50(x + \frac{1}{2})$

The total distance is 80.

$$\begin{aligned} 60x + 50(x + \tfrac{1}{2}) &= 80 \\ 60x + 50x + 25 &= 80 \\ 110x &= 55 \\ x &= \tfrac{55}{110} = \tfrac{1}{2} \end{aligned}$$

They will meet $\frac{1}{2}$ hr after Anne leaves.

Check Anne travels $60(\frac{1}{2}) = 30$ miles. Johnny travels $50(\frac{1}{2} + \frac{1}{2}) = 50$ miles. The sum of the distances is 80 miles, as required.

24. Let x = Heather's rate (speed) during the first part of the trip. Then $x - 25$ = her rate during rush hour traffic. Make a table using the formula $rt = d$.

	Rate	Time	Distance
First Part	x	2	$2x$
Rush Hour	$x - 25$	$\frac{1}{2}$	$\frac{1}{2}(x - 25)$

The total distance was 125 miles.

$$\begin{aligned} 2x + \tfrac{1}{2}(x - 25) &= 125 \\ 4x + x - 25 &= 250 \quad \textit{Multiply by 2.} \\ 5x &= 275 \\ x &= 55 \end{aligned}$$

The rate during the first part of the trip was 55 mph.

Check The distance traveled during the first part of the trip was $55(2) = 110$ miles. The distance traveled during the second part of the trip was $(55 - 25)(0.5) = 15$ miles. The sum of the distances is 125 miles, as required.

25. The sum of the measures of the three angles of a triangle is 180°.

$$\begin{aligned} (x - 30) + (2x - 120) + (\tfrac{1}{2}x + 15) &= 180 \\ \tfrac{7}{2}x - 135 &= 180 \\ 7x - 270 &= 360 \\ &\textit{Multiply by 2.} \\ 7x &= 630 \\ x &= 90 \end{aligned}$$

With $x = 90$, the three angle measures become

$$\begin{aligned} (90 - 30)^\circ &= 60^\circ, \\ (2 \cdot 90 - 120)^\circ &= 60^\circ, \\ \text{and} \quad (\tfrac{1}{2} \cdot 90 + 15)^\circ &= 60^\circ. \end{aligned}$$

Check $60^\circ + 60^\circ + 60^\circ = 180^\circ$, as required.

26. The sum of the measures of the three angles of a triangle is 180°.

$$\begin{aligned} (x + 15) + (10x - 20) + (x + 5) &= 180 \\ 12x &= 180 \\ x &= 15 \end{aligned}$$

With $x = 15$, the three angle measures become

$$\begin{aligned} (15 + 15)^\circ &= 30^\circ, \\ (10 \cdot 15 - 20)^\circ &= 130^\circ, \\ \text{and} \quad (15 + 5)^\circ &= 20^\circ. \end{aligned}$$

Check $30^\circ + 130^\circ + 20^\circ = 180^\circ$, as required.

27. The sum of the measures of the three angles of a triangle is 180°.

$$\begin{aligned} (3x + 7) + (9x - 4) + (4x + 1) &= 180 \\ 16x + 4 &= 180 \\ 16x &= 176 \\ x &= 11 \end{aligned}$$

With $x = 11$, the three angle measures become

$$\begin{aligned} (3 \cdot 11 + 7)^\circ &= 40^\circ, \\ (9 \cdot 11 - 4)^\circ &= 95^\circ, \\ \text{and} \quad (4 \cdot 11 + 1)^\circ &= 45^\circ. \end{aligned}$$

Check $40^\circ + 95^\circ + 45^\circ = 180^\circ$, as required.

28. The sum of the measures of the three angles of a triangle is 180°.

$$\begin{aligned} (2x + 7) + (x + 61) + x &= 180 \\ 4x + 68 &= 180 \\ 4x &= 112 \\ x &= 28 \end{aligned}$$

With $x = 28$, the three angle measures become

$$(2 \cdot 28 + 7)^\circ = 63^\circ, \quad (28 + 61)^\circ = 89^\circ, \quad \text{and} \quad 28^\circ.$$

Check $63^\circ + 89^\circ + 28^\circ = 180^\circ$, as required.

29. The sum of the measures of the three angles of a triangle is 180°.

$$\begin{aligned} x + (x + 11) + (3x - 36) &= 180 \\ 5x - 25 &= 180 \\ 5x &= 205 \\ x &= 41 \end{aligned}$$

The angles measure 41°, $41 + 11 = 52^\circ$, and $3(41) - 36 = 87^\circ$.

Check Since $41^\circ + 52^\circ + 87^\circ = 180^\circ$, the answers are correct.

30. The sum of the measures of the three angles of a triangle is 180°.

$$\begin{aligned} (x + 10) + (x + 4) + (12x - 30) &= 180 \\ 14x - 16 &= 180 \\ 14x &= 196 \\ x &= 14 \end{aligned}$$

The angles measure $14 + 10 = 24^\circ$, $14 + 4 = 18^\circ$, and $12(14) - 30 = 138^\circ$.

Check Since $24^\circ + 18^\circ + 138^\circ = 180^\circ$, the answers are correct.

31. Vertical angles have equal measure.

$$\begin{aligned} 8x + 2 &= 7x + 17 \\ x &= 15 \end{aligned}$$
$$8 \cdot 15 + 2 = 122 \quad \text{and} \quad 7 \cdot 15 + 17 = 122.$$

The angles are both 122°.

32. Vertical angles have equal measure.

$$\begin{aligned} 9 - 5x &= 25 - 3x \\ 9 &= 25 + 2x \\ -16 &= 2x \\ -8 &= x \end{aligned}$$
$$9 - 5(-8) = 49 \quad \text{and} \quad 25 - 3(-8) = 49.$$

The angles are both 49°.

33. The sum of the two angles is 90°.

$$\begin{aligned} (5x - 1) + 2x &= 90 \\ 7x - 1 &= 90 \\ 7x &= 91 \\ x &= 13 \end{aligned}$$

The measures of the two angles are $[5(13) - 1]° = 64°$ and $[2(13)] = 26°$.

34. The sum of the two angles is 90°.

$$\begin{aligned} (3x - 9) + 6x &= 90 \\ 9x - 9 &= 90 \\ 9x &= 99 \\ x &= 11 \end{aligned}$$

The measures of the two angles are $[3(11) - 9]° = 24°$ and $[2(11)] = 66°$.

35. Supplementary angles have an angle measure sum of 180°.

$$\begin{aligned} (3x + 5) + (5x + 15) &= 180 \\ 8x + 20 &= 180 \\ 8x &= 160 \\ x &= 20 \end{aligned}$$

With $x = 20$, the two angle measures become $(3 \cdot 20 + 5)° = 65°$ and $(5 \cdot 20 + 15)° = 115°$.

36. Supplementary angles have an angle measure sum of 180°.

$$\begin{aligned} (3x + 1) + (7x + 49) &= 180 \\ 10x + 50 &= 180 \\ 10x &= 130 \\ x &= 13 \end{aligned}$$

With $x = 13$, the two angle measures become $(3 \cdot 13 + 1)° = 40°$ and $(7 \cdot 13 + 49)° = 140°$.

37. Let $x =$ the first consecutive integer. Then $x + 1$ will be the second consecutive integer, and $x + 2$ will be the third consecutive integer.

The sum of the first and twice the second is 22 more than twice the third.

$$\begin{aligned} x + 2(x + 1) &= 2(x + 2) + 22 \\ x + 2x + 2 &= 2x + 4 + 22 \\ 3x + 2 &= 2x + 26 \\ x &= 24 \end{aligned}$$

Since $x = 24$, $x + 1 = 25$, and $x + 2 = 26$. The three consecutive integers are 24, 25, and 26.

38. Let $x =$ the first consecutive integer. Then $x + 1$ will be the second consecutive integer, and $x + 2$ will be the third consecutive integer.
The sum of the first and twice the third is 39 more than twice the second.

$$\begin{aligned} x + 2(x + 2) &= 2(x + 1) + 39 \\ x + 2x + 4 &= 2x + 2 + 39 \\ 3x + 4 &= 2x + 41 \\ x &= 37 \end{aligned}$$

Since $x = 37$, $x + 1 = 38$, and $x + 2 = 39$. The three consecutive integers are 37, 38, and 39.

39. Let $x =$ the first integer. Then $x + 1$, $x + 2$, and $x + 3$ are the next three consecutive integers.
The sum of the first three integers is 62 more than the fourth.

$$\begin{aligned} x + (x + 1) + (x + 2) &= (x + 3) + 62 \\ 3x + 3 &= x + 65 \\ 2x &= 62 \\ x &= 31 \end{aligned}$$

The four consecutive integers are 31, 32, 33, and 34.

40. Let $x =$ the first integer. Then $x + 1$, $x + 2$, and $x + 3$ are the next three consecutive integers.
The sum of the last three integers is 86 more than the fourth.

$$\begin{aligned} (x + 1) + (x + 2) + (x + 3) &= x + 86 \\ 3x + 6 &= x + 86 \\ 2x &= 80 \\ x &= 40 \end{aligned}$$

The four consecutive integers are 40, 41, 42, and 43.

41. Let $x =$ the first even integer. Then $x + 2$ and $x + 4$ are the next two consecutive even integers.
The sum of the least integers and the middle integer is 26 more than the greatest integer.

(continued)

$$
\begin{aligned}
x+(x+2) &= (x+4)+26 \\
2x+2 &= x+30 \\
x+2 &= 30 \\
x &= 28
\end{aligned}
$$

The three even integers are 28, 30, and 32.

42. Let $x =$ the first even integer. Then $x+2$ and $x+4$ are the next two consecutive even integers. The sum of the least integers and the greatest integer is 12 more than the middle integer.

$$
\begin{aligned}
x+(x+4) &= (x+2)+12 \\
2x+4 &= x+14 \\
x+4 &= 14 \\
x &= 10
\end{aligned}
$$

The three even integers are 10, 12, and 14.

43. Let $x =$ the first odd integer. Then $x+2$ and $x+4$ are the next two consecutive odd integers. The sum of the least integers and the middle integer is 19 more than the greatest integer.

$$
\begin{aligned}
x+(x+2) &= (x+4)+19 \\
2x+2 &= x+23 \\
x+2 &= 23 \\
x &= 21
\end{aligned}
$$

The three even integers are 21, 23, and 25.

44. Let $x =$ the first odd integer. Then $x+2$ and $x+4$ are the next two consecutive odd integers. The sum of the least integers and the greatest integer is 13 more than the middle integer.

$$
\begin{aligned}
x+(x+4) &= (x+2)+13 \\
2x+4 &= x+15 \\
x+4 &= 15 \\
x &= 11
\end{aligned}
$$

The three even integers are 11, 13, and 15.

45. Let $x =$ the current age. Then $x+1$ will be the age next year. The sum of these ages will be 95 years.

$$
\begin{aligned}
x+(x+1) &= 95 \\
2x+1 &= 95 \\
2x &= 94 \\
x &= 47
\end{aligned}
$$

If my current age is 47, in 10 years I will be

$47+10 = 57$ years old.

46. Let $x =$ the page number on one page. Then $x+1$ is the page number on the next page. The sum of the page numbers is 365.

$$
\begin{aligned}
x+(x+1) &= 365 \\
2x+1 &= 365 \\
2x &= 364 \\
x &= 182
\end{aligned}
$$

The page numbers are 182 and 183.

Relating Concepts (Exercises 47–50)

47. The sum of the measures of the angles of a triangle is 180°.

$$
\begin{aligned}
x+2x+60 &= 180 \\
3x+60 &= 180 \\
3x &= 120 \\
x &= 40
\end{aligned}
$$

The measures of the unknown angles are $40°$ and $2x = 80°$.

48. The sum of the measures of the marked angles, $60° + y°$, must equal $180°$. Thus, the measure of the unknown angle is $120°$.

49. The sum of the measures of the unknown angles in Exercise 37 is $40° + 80° = 120°$. This is equal to the measure of the angle in Exercise 38.

50. The sum of the measures of angles (1) and (2) is equal to the measure of angle (3).

Summary Exercises *Applying Problem-Solving Techniques*

1. Let $x =$ the width of the rectangle. Then $x+3$ is the length of the rectangle.

If the length were decreased by 2 inches and the width were increased by 1 inch, the perimeter would be 24 inches. Use the formula $P = 2L + 2W$, and substitute 24 for P, $(x+3)-2$ or $x+1$ for L, and $x+1$ for W.

$$
\begin{aligned}
P &= 2L+2W \\
24 &= 2(x+1)+2(x+1) \\
24 &= 2x+2+2x+2 \\
24 &= 4x+4 \\
20 &= 4x \\
5 &= x
\end{aligned}
$$

The width of the rectangle is 5 inches, and the length is $5+3 = 8$ inches.

Check The length is 3 in. more than the width and the perimeter of the proposed rectangle is $2(8-2)+2(5+1) = 24$ in., as required.

2. Let $x =$ the length of the shortest side. Then $2x$ is the length of the middle side and $3x - 2$ is the length of the longest side.

The perimeter is 34 inches. Using $P = a + b + c$ gives us

$$\begin{aligned} x + 2x + (3x - 2) &= 34. \\ 6x - 2 &= 34 \\ 6x &= 36 \\ x &= 6 \end{aligned}$$

The lengths of the three sides are 6 inches, $2(6) = 12$ inches, and $3(6) - 2 = 16$ inches.

Check The sum of the lengths of the three sides is $6 + 12 + 16 = 34$ inches, as required.

3. Let $x =$ the regular price of the item. The sale price after a 46% (or 0.46) discount was \$49.96, so an equation is

$$\begin{aligned} x - 0.46x &= 49.96. \\ 0.54x &= 49.96 \\ x &\approx 92.52 \end{aligned}$$

To the nearest cent, the regular price was \$92.52.

4. Let $x =$ the regular price of the audio system. The sale price after a discount of 40% (or 0.40) was \$255, so an equation is

$$\begin{aligned} x - 0.40x &= 255. \\ 0.60x &= 255 \\ x &= 425 \end{aligned}$$

The regular price of the audio system was \$425.

5. Let $x =$ the amount invested at 2%.
Then $2x$ is the amount invested at 3%.
Use $I = prt$ with $t = 1$ yr. Make a table.

Principal (in dollars)	**Rate (as a decimal)**	**Interest (in dollars)**
x	0.02	$0.02x$
$2x$	0.03	$0.03(2x) = 0.06x$
	Total →	44

Use the values in the last column to write an equation.

$$\begin{array}{ccccc} \text{Interest at 2\%} & + & \text{interest at 3\%} & = & \text{total interest.} \\ 0.02x & + & 0.06x & = & 44 \end{array}$$

$$\begin{aligned} 2x + 6x &= 4400 \quad \textit{Multiply by 100.} \\ 8x &= 4400 \\ x &= 550 \end{aligned}$$

\$550 is invested at 2% and
$2(\$550) = \$1100$ is invested at 3%.

Check \$550 @ 2% = \$11 and
\$1100 @ 3% = \$33; \$11 + \$33 = \$44

6. Let $x =$ the amount invested at 3%.
Then $x + 3000$ is the amount invested at 4%.
Use $I = prt$ with $t = 1$ yr. Make a table.

Principal (in dollars)	**Rate (as a decimal)**	**Interest (in dollars)**
x	0.03	$0.03x$
$x + 3000$	0.04	$0.04(x + 3000)$
	Total →	960

Use the values in the last column to write an equation.

$$\begin{array}{ccccc} \text{Interest at 3\%} & + & \text{interest at 4\%} & = & \text{total interest.} \\ 0.03x & + & 0.04(x + 3000) & = & 960 \end{array}$$

$$\begin{aligned} 3x + 4(x + 3000) &= 96{,}000 \quad \textit{Multiply by 100.} \\ 3x + 4x + 12{,}000 &= 96{,}000 \\ 7x &= 84{,}000 \\ x &= 12{,}000 \end{aligned}$$

\$12,000 is invested at 3% and
\$12,000 + \$3000 = \$15,000 is invested at 4%.

Check \$12,000 @ 3% = \$360 and
\$15,000 @ 4% = \$600; \$360 + \$600 = \$960

7. Let $x =$ the number of points he scored in 2012–2013. Then $x + 743 =$ the number of points he scored in 2014–2015. The total number of points he scored was 4443.

$$\begin{aligned} x + (x + 743) &= 4443 \\ 2x + 743 &= 4443 \\ 2x &= 3700 \\ x &= 1850 \end{aligned}$$

He scored in 1850 points in 2012–2013 and $1850 + 743 = 2593$ points 2014–2015.

8. Let $x =$ the amount, in millions of dollars grossed for *Jurassic World.* Then $x + 281 =$ the amount grossed for *Stars Wars: The Force Awakens*. The two films totaled \$1585 million.

$$\begin{aligned} x + (x + 281) &= 1585 \\ 2x + 281 &= 1585 \\ 2x &= 1304 \\ x &= 652 \end{aligned}$$

Jurassic World grossed \$652 million and *Star Wars: The Force Awakens* grossed
$652 + 281 = \$933$ million.

9. Let $x =$ the side length of the square cut out of each corner. Then the width is $12 - 2x$ and the length is $16 - 2x$. We want the length to be 5 cm less than twice the width.

$$\begin{aligned} \text{length} &= 2(\text{width}) - 5 \\ 16 - 2x &= 2(12 - 2x) - 5 \\ 16 - 2x &= 24 - 4x - 5 \\ 16 - 2x &= 19 - 4x \\ 2x &= 3 \\ x &= \tfrac{3}{2}, \text{ or } 1\tfrac{1}{2} \end{aligned}$$

The square should be $1\frac{1}{2}$ cm on each side.

Check The width is $12 - 2(\frac{3}{2}) = 9$ and the length is $16 - 2(\frac{3}{2}) = 13$. Two times the width is $2(9) = 18$, which is 5 more than the length, 13.

10. Let $t =$ the time it will take until John and Pat meet. Use $d = rt$ and make a table.

	Rate	**Time**	**Distance**
John	60	t	$60t$
Pat	28	t	$28t$

The total distance is 440 miles.

$$\begin{aligned} 60t + 28t &= 440 \\ 88t &= 440 \\ t &= 5 \end{aligned}$$

It will take 5 hours for John and Pat to meet.

Check John traveled $60(5) = 300$ miles and Pat traveled $28(5) = 140$ miles; $300 + 140 = 440$, as required.

11. Let $x =$ the number of liters of the 5% drug solution.

Liters of Solution	**Percent (as a decimal)**	**Liters of Pure Drug**
20	0.10	$20(0.10) = 2$
x	0.05	$0.05x$
$20 + x$	0.08	$0.08(20 + x)$

Drug in 10% solution	+	drug in 5% solution	=	drug in 8% solution.
2	+	$0.05x$	=	$0.08(20 + x)$

$$\begin{aligned} 200 + 5x &= 8(20 + x) \qquad \textit{Multiply by 100.} \\ 200 + 5x &= 160 + 8x \\ 40 &= 3x \\ x &= \tfrac{40}{3}, \text{ or } 13\tfrac{1}{3} \end{aligned}$$

The pharmacist should add $13\frac{1}{3}$ L.

Check 10% of 20 is 2 and 5% of $\frac{40}{3}$ is $\frac{2}{3}$; $2 + \frac{2}{3} = \frac{8}{3}$, which is the same as 8% of $(20 + \frac{40}{3})$.

12. Let $x =$ the number of kilograms of the metal that is 20% tin.

Kilograms of Metal	**Percent (as a decimal)**	**Kilograms of Pure Tin**
80	0.70	$80(0.70) = 56$
x	0.20	$0.20x$
$80 + x$	0.50	$0.50(80 + x)$

Tin in 70% alloy	+	tin in 20% alloy	=	tin in 50% alloy.
56	+	$0.20x$	=	$0.50(80 + x)$

$$\begin{aligned} 560 + 2x &= 5(80 + x) \qquad \textit{Multiply by 10.} \\ 560 + 2x &= 400 + 5x \\ 160 &= 3x \\ x &= \tfrac{160}{3}, \text{ or } 53\tfrac{1}{3} \end{aligned}$$

$53\frac{1}{3}$ kilograms should be added.

Check 70% of 80 is 56 and 20% of $\frac{160}{3}$ is $\frac{32}{3}$; $56 + \frac{32}{3} = 66\frac{2}{3}$, which is the same as 50% of $(80 + \frac{160}{3})$.

13. Let $x =$ the number of \$5 bills. Then $126 - x$ is the number of \$10 bills.

Number of Bills	**Denomination (in dollars)**	**Value (in dollars)**
x	5	$5x$
$126 - x$	10	$10(126 - x)$
126	← Totals →	840

The sum of the values must equal the total value.

$$\begin{aligned} 5x + 10(126 - x) &= 840 \\ 5x + 1260 - 10x &= 840 \\ -5x &= -420 \\ x &= 84 \end{aligned}$$

There are 84 \$5 bills and $126 - 84 = 42$ \$10 bills.

Check The value of the bills is $\$5(84) + \$10(42) = \$840$, as required.

14. Use the formula for the volume of a box.

$$\begin{aligned} V &= LWH \\ 75 &= 5(1.5)H \\ 75 &= 7.5H \\ 10 &= H \qquad \textit{Divide by 7.5.} \end{aligned}$$

The height is 10 ft.

15. Let $x =$ the number of Introductory Statistics students in the fall of 2000. Since $700\% = 700(0.01) = 7$, $7x =$ the number of additional students in 2016.

The number in 2000	plus	the increase	is	96.
↓	↓	↓	↓	↓
x	$+$	$7x$	$=$	96

$$\begin{aligned} 1x + 7x &= 96 && \textit{Identity property} \\ 8x &= 96 && \textit{Combine like terms.} \\ x &= 12 && \textit{Divide by 8.} \end{aligned}$$

There were 12 students in the fall of 2000.

Check that the increase, $96 - 12 = 84$, is 700% of 12. $700\% \cdot 12 = 700(0.01)(12) = 84$, as required.

16. Let $x =$ the least integer. Then $x + 1$ is the middle integer and $x + 2$ is the greatest integer.

"The sum of the least and greatest of three consecutive integers is 45 more than the middle integer" translates to

$$\begin{aligned} x + (x + 2) &= 45 + (x + 1). \\ 2x + 2 &= x + 46 \\ x &= 44 \end{aligned}$$

The three consecutive integers are 44, 45, and 46.

Check The sum of the least and greatest integers is $44 + 46 = 90$, which is the same as 45 more than the middle integer.

17. The sum of the measures of the three angles of a triangle is 180°.

$$\begin{aligned} x + (6x - 50) + (x - 10) &= 180 \\ 8x - 60 &= 180 \\ 8x &= 240 \\ x &= 30 \end{aligned}$$

With $x = 30$, the three angle measures become

$(6 \cdot 30 - 50)° = 130°$,
$(30 - 10)° = 20°$, and 30°.

18. In the figure, the two angles are supplementary, so their sum is 180°.

$$\begin{aligned} (10x + 7) + (7x + 3) &= 180 \\ 17x + 10 &= 180 \\ 17x &= 170 \\ x &= 10 \end{aligned}$$

The two angle measures are $10(10) + 7 = 107°$ and $7(10) + 3 = 73°$.

Chapter 1 Review Exercises

1.
$$\begin{aligned} -(8 + 3x) + 5 &= 2x + 6 \\ -8 - 3x + 5 &= 2x + 6 \\ -3x - 3 &= 2x + 6 \\ -5x &= 9 \\ x &= -\tfrac{9}{5} \end{aligned}$$

Solution set: $\{-\frac{9}{5}\}$

2.
$$\begin{aligned} -3x + 2(4x + 5) &= 10 \\ -3x + 8x + 10 &= 10 \\ 5x + 10 &= 10 \\ 5x &= 0 \\ x &= 0 && \textit{Divide by 5.} \end{aligned}$$

Solution set: $\{0\}$

3. $\dfrac{m-2}{4} + \dfrac{m+2}{2} = 8$ ▪ Multiply each side by the LCD, 4, and use the distributive property.

$$\begin{aligned} 4\left(\frac{m-2}{4} + \frac{m+2}{2}\right) &= 4(8) \\ (m - 2) + 2(m + 2) &= 32 \\ m - 2 + 2m + 4 &= 32 \\ 3m + 2 &= 32 \\ 3m &= 30 \\ m &= 10 \end{aligned}$$

Solution set: $\{10\}$

4. $\dfrac{2q+1}{3} - \dfrac{q-1}{4} = 0$ ▪ Multiply each side by the LCD, 12, and use the distributive property.

$$\begin{aligned} 4(2q + 1) - 3(q - 1) &= 0 \\ 8q + 4 - 3q + 3 &= 0 \\ 5q + 7 &= 0 \\ 5q &= -7 \\ q &= -\tfrac{7}{5} \end{aligned}$$

Solution set: $\{-\frac{7}{5}\}$

5.
$$\begin{aligned} 5(2x - 3) &= 6(x - 1) + 4x \\ 10x - 15 &= 6x - 6 + 4x \\ 10x - 15 &= 10x - 6 \\ -15 &= -6 && \textit{False} \end{aligned}$$

This is a false statement, so the equation is a *contradiction*.

Solution set: $\varnothing$

6. $\frac{1}{2}x - \frac{3}{8}x = \frac{1}{4}x + 2$ ▪ Multiply each side by the LCD, 8, and use the distributive property.

$$\begin{aligned} 4x - 3x &= 2x + 16 \\ x &= 2x + 16 \\ -x &= 16 \\ x &= -16 \end{aligned}$$

Solution set: $\{-16\}$

7.
$$\begin{aligned} -(r+5) - (2+7r) + 8r &= 3r - 8 \\ -r - 5 - 2 - 7r + 8r &= 3r - 8 \\ -7 &= 3r - 8 \\ 1 &= 3r \\ \tfrac{1}{3} &= r \end{aligned}$$

Solution set: $\{\frac{1}{3}\}$

8. $0.05x + 0.03(1200 - x) = 42$

$5x + 3(1200 - x) = 4200$
Multiply by 100 to clear all decimals.

$$\begin{aligned} 5x + 3600 - 3x &= 4200 \\ 2x + 3600 &= 4200 \\ 2x &= 600 \\ x &= 300 \end{aligned}$$

Solution set: $\{300\}$

9. Solve each equation.

A. $x - 7 = 7$
$x = 14$ *Add 7.*

Solution set: $\{14\}$

B. $9x = 10x$
$0 = x$ *Subtract 9x.*

Solution set: $\{0\}$

C. $x + 4 = -4$
$x = -8$ *Subtract 4.*

Solution set: $\{-8\}$

D. $8x - 8 = 8$
$8x = 16$ *Add 8.*
$x = 2$ *Divide by 8.*

Solution set: $\{2\}$

Equation **B** has $\{0\}$ as its solution set.

10. Solve each equation.

A. $6x - 6x = 4$
$0 = 4$ *False.*

Not an identity.

B. $2x + 4 = 0$
$2x = -4$
$x = -2$ *one solution.*

Not an identity.

C.
$$\begin{aligned} \frac{1}{2}(2x - 3) &= x - \frac{3}{2} \\ \frac{1}{2}(2x) - \frac{1}{2}(3) &= x - \frac{3}{2} \\ x - \frac{3}{2} &= x - \frac{3}{2} \quad \textit{True.} \end{aligned}$$

This is an identity.

D.
$$\begin{aligned} 8(x - 3) &= 2(4x + 12) \\ 8x - 8(3) &= 2(4x) + 2(12) \\ 8x - 24 &= 8x + 24 \\ -24 &= 24 \quad \textit{False.} \end{aligned}$$

Not an identity.

11.
$$\begin{aligned} 7r - 3(2r - 5) + 5 + 3r &= 4r + 20 \\ 7r - 6r + 15 + 5 + 3r &= 4r + 20 \\ 4r + 20 &= 4r + 20 \\ 20 &= 20 \quad \textit{True} \end{aligned}$$

This equation is an *identity*.

Solution set: {all real numbers}

12.
$$\begin{aligned} 8p - 4p - (p - 7) + 9p + 13 &= 12p \\ 8p - 4p - p + 7 + 9p + 13 &= 12p \\ 12p + 20 &= 12p \\ 20 &= 0 \quad \textit{False} \end{aligned}$$

This equation is a *contradiction*.

Solution set: $\varnothing$

13.
$$\begin{aligned} -2r + 6(r - 1) + 3r - (4 - r) &= -(r + 5) - 5 \\ -2r + 6r - 6 + 3r - 4 + r &= -r - 5 - 5 \\ 8r - 10 &= -r - 10 \\ 9r &= 0 \\ r &= 0 \end{aligned}$$

This equation is a *conditional equation*.

Solution set: $\{0\}$

14. $\frac{2}{3}x + \frac{5}{8}x = \frac{31}{24}x$ ▪ Multiply each side by the LCD, 24, and use the distributive property.

$$\begin{aligned} 8(2x) + 3(5x) &= 31x \\ 16x + 15x &= 31x \\ 31x &= 31x \quad \textit{True} \end{aligned}$$

This equation is an *identity*.

Solution set: {all real numbers}

15. Solve $P = a + b + c + B$ for c.

$P - a - b - B = a + b + c + B - a - b - B$ *Subtract a, b, and B.*

$P - a - b - B = c$

16. Solve $V = LWH$ for L.

$\frac{V}{WH} = \frac{LWH}{WH}$ *Divide by WH.*

$\frac{V}{WH} = L$, or $L = \frac{V}{WH}$

17. Solve $\mathcal{A} = \frac{1}{2}h(b + B)$ for b.

$2\mathcal{A} = h(b + B)$ *Multiply by 2.*

$\frac{2\mathcal{A}}{h} = b + B$ *Divide by h.*

$\frac{2\mathcal{A}}{h} - B = b$ *Subtract B.*

OR

Solve $\mathcal{A} = \frac{1}{2}h(b + B)$ for b.

$2\mathcal{A} = hb + hB$ *Multiply by 2.*

$2\mathcal{A} - hB = hb$ *Subtract hB.*

$\frac{2\mathcal{A} - hB}{h} = b$ *Divide by h.*

18. Solve $4x + 7y = 9$ for y.

$4x + 7y - 4x = 9 - 4x$ *Subtract 4x.*

$7y = -4x + 9$

$\frac{7y}{7} = \frac{-4x + 9}{7}$ *Divide by 7.*

$y = -\frac{4}{7}x + \frac{9}{7}$

19. Solve $d = rt$ for t.

$t = \frac{d}{r}$

$t = \frac{10{,}500}{500} = 21$ *Let d = 10,500, r = 500.*

The travel time is 21 hr.

20. Let $x =$ the percent increase (as a decimal).

$$\text{percent increase} = \frac{\text{amount of increase}}{\text{original amount}}$$

$$x = \frac{23.1 - 20.2}{20.2}$$

$$x = \frac{2.9}{20.2}$$

$$x \approx 0.144$$

The percent increase is expected to be about 14.4%.

21. Use the formula $I = prt$, and solve for r.

$\frac{I}{pt} = \frac{prt}{pt}$

$\frac{I}{pt} = r$

Substitute 30,000 for p, 4200 for I, and 4 for t.

$$r = \frac{4200}{30{,}000(4)} = \frac{4200}{120{,}000} = 0.035$$

The rate is 3.5%.

22. Use the formula $C = \frac{5}{9}(F - 32)$ and substitute 77 for F.

$$C = \tfrac{5}{9}(77 - 32)$$
$$= \tfrac{5}{9}(45) = 25$$

The Celsius temperature is 25°.

23. Use the formula $V = LWH$ and substitute 180 for V, 9 for L, and 4 for W.

$$180 = 9(4)H$$
$$180 = 36H$$
$$5 = H$$

The height is 5 feet.

24. $C = 2\pi r$

$200\pi = 2\pi r$ *Substitute 200π for C.*

$\frac{200\pi}{2\pi} = \frac{2\pi r}{2\pi}$ *Divide by 2π.*

$100 = r$

The radius is 100 mm.

25. The amount of money spent on Social Security in 2015 was about

0.241($3690 billion) ≈ $889 billion.

26. The amount of money spent on Education and social services in 2015 was about

0.033($3690 billion) ≈ $122 billion

27. The amount of money spent on National defense in 2015 was about

0.160($3690 billion) ≈ $590 billion

28. The amount of money spent on Medicare/health programs in 2015 was about

0.279($3690 billion) ≈ $1030 billion

29. "One-fifth of a number, subtracted from 14" is translated as

$$14 - \tfrac{1}{5}x.$$

30. "$\frac{5}{8}$ of the difference between a number and 4" is translated as

$$\tfrac{5}{8}(x - 4).$$

31. "The product of 6 and a number, divided by 3 more than the number" is translated as

$$\frac{6x}{x+3}.$$

32. "The product of a number and the number increased by 8" is translated as

$$x(x+8).$$

33. Let $x =$ the width of the rectangle. Then $2x - 3 =$ the length of the rectangle.

Use the formula $P = 2L + 2W$ with $P = 42$.

$$\begin{aligned} 42 &= 2(2x-3)+2x \\ 42 &= 4x-6+2x \\ 48 &= 6x \\ 8 &= x \end{aligned}$$

The width is 8 meters and the length is $2(8) - 3 = 13$ meters.

34. Let $x =$ the length of each equal side. Then $2x - 15 =$ the length of the third side.

Use the formula $P = a + b + c$ with $P = 53$.

$$\begin{aligned} 53 &= x+x+(2x-15) \\ 53 &= 4x-15 \\ 68 &= 4x \\ 17 &= x \end{aligned}$$

The lengths of the three sides are 17 inches, 17 inches, and $2(17) - 15 = 19$ inches.

35. Let $x =$ the number of kilograms of peanut clusters. Then $3x$ is the number of kilograms of chocolate creams. The clerk has a total of 48 kg.

$$\begin{aligned} x+3x &= 48 \\ 4x &= 48 \\ x &= 12 \end{aligned}$$

The clerk has 12 kilograms of peanut clusters.

36. Let $x =$ the number of liters of the 20% solution. Make a table.

Liters of Solution	Percent (as a decimal)	Liters of Pure Chemical
x	0.20	$0.20x$
15	0.50	$0.50(15) = 7.5$
$x + 15$	0.30	$0.30(x + 15)$

Use the values in the last column to write an equation.

$$\begin{aligned} 0.20x + 7.5 &= 0.30(x+15) \\ 0.20x + 7.5 &= 0.30x + 4.5 \\ 3 &= 0.10x \\ 30 &= x \end{aligned}$$

30 L of the 20% solution should be used.

37. Let $x =$ the number of liters of water.

Liters of Solution	Percent (as a decimal)	Liters of Pure Acid
30	0.40	$0.40(30) = 12$
x	0	$0(x) = 0$
$30 + x$	0.30	$0.30(30 + x)$

Use the values in the last column to write an equation.

$$\begin{aligned} 12 + 0 &= 0.30(30+x) \\ 12 &= 9 + 0.3x \\ 3 &= 0.3x \\ 10 &= x \end{aligned}$$

10 L of water should be added.

38. Let $x =$ the amount invested at 4%. Then $x - 4000 =$ the amount invested at 3%.

Principal (in dollars)	Rate (as a decimal)	Interest (in dollars)
x	0.04	$0.04x$
$x - 4000$	0.03	$0.03(x - 4000)$
	Total →	\$580

Use the values in the last column to write an equation.

$$\begin{aligned} 0.04x + 0.03(x-4000) &= 580 \\ 4x + 3(x-4000) &= 58{,}000 \\ &\textit{Multiply by 100.} \\ 4x + 3x - 12{,}000 &= 58{,}000 \\ 7x &= 70{,}000 \\ x &= 10{,}000 \end{aligned}$$

Anna should invest \$10,000 at 4% and \$10,000 − \$4000 = \$6000 at 3%.

39. Let $x =$ the number of quarters. Then $2x - 1$ is the number of dimes.

Number of Coins	Denomination (in dollars)	Value (in dollars)
x	0.25	$0.25x$
$2x - 1$	0.10	$0.10(2x - 1)$
	Total →	3.50

(continued)

The sum of the values equals the total value.

$$\begin{aligned} 0.25x + 0.10(2x - 1) &= 3.50 \\ &\textit{Multiply by 100.} \\ 25x + 10(2x - 1) &= 350 \\ 25x + 20x - 10 &= 350 \\ 45x &= 360 \\ x &= 8 \end{aligned}$$

There are 8 quarters and $2(8) - 1 = 15$ dimes.

Check $8(0.25) + 15(0.10) = 3.50$

40. Let $x =$ the number of nickels.
Then $19 - x$ is the number of dimes.

Number of Coins	Denomination (in dollars)	Value (in dollars)
x	0.05	$0.05x$
$19 - x$	0.10	$0.10(19 - x)$
	Total →	1.55

The sum of the values equals the total value.

$$\begin{aligned} 0.05x + 0.10(19 - x) &= 1.55 \\ &\textit{Multiply by 100.} \\ 5x + 10(19 - x) &= 155 \\ 5x + 190 - 10x &= 155 \\ -5x &= -35 \\ x &= 7 \end{aligned}$$

He had 7 nickels and $19 - 7 = 12$ dimes.

Check $7(0.05) + 12(0.10) = 1.55$

41. Let $x =$ the time it takes for the trains to be 297 mi apart. Make a table. Use the formula $d = rt$.

	Rate	Time	Distance
Passenger Train	60	x	$60x$
Freight Train	75	x	$75x$
Total →			297

The total distance traveled is the sum of the distances traveled by each train.

$$\begin{aligned} 60x + 75x &= 297 \\ 135x &= 297 \\ x &= 2.2 \end{aligned}$$

It will take the trains 2.2 hours before they are 297 miles apart.

Check $2.2(60) + 2.2(75) = 297$

42. Let $x =$ the rate of the faster car and $x - 15 =$ the rate of the slower car. Make a table. Use the formula $d = rt$.

	Rate	Time	Distance
Faster Car	x	2	$2x$
Slower Car	$x - 15$	2	$2(x - 15)$
Total →			230

The total distance traveled is the sum of the distances traveled by each car.

$$\begin{aligned} 2x + 2(x - 15) &= 230 \\ 2x + 2x - 30 &= 230 \\ 4x &= 260 \\ x &= 65 \end{aligned}$$

The faster car travels at 65 km per hr, while the slower car travels at $65 - 15 = 50$ km per hr.

Check $2(65) + 2(50) = 230$

43. Let $x =$ amount of time spent averaging 45 miles per hour. Then $4 - x =$ amount of time at 50 mph.

	Rate	Time	Distance
First Part	45	x	$45x$
Second Part	50	$4 - x$	$50(4 - x)$
Total →			195

Use the values in the last column to write an equation.

$$\begin{aligned} 45x + 50(4 - x) &= 195 \\ 45x + 200 - 50x &= 195 \\ -5x &= -5 \\ x &= 1 \end{aligned}$$

The automobile averaged 45 mph for 1 hour.

Check 45 mph for 1 hour $=$ 45 miles and 50 mph for 3 hours $=$ 150 miles; $45 + 150 = 195$.

44. Let $x =$ the average rate for the first hour. Then $x - 7 =$ the average rate for the second hour. Using $d = rt$, the distance traveled for the first hour is $x(1)$ miles, for the second hour is $(x - 7)(1)$ miles, and for the whole trip, 85 miles.

$$\begin{aligned} x + (x - 7) &= 85 \\ 2x - 7 &= 85 \\ 2x &= 92 \\ x &= 46 \end{aligned}$$

The average rate for the first hour was 46 mph.

Check 46 mph for 1 hour $=$ 46 miles and $46 - 7 = 39$ mph for 1 hour $=$ 39 miles; $46 + 39 = 85$.

45. The sum of the three measures must equal $180°$.

$$\begin{aligned} x+(x+11)+(3x-36)&=180 \\ 5x-25&=180 \\ 5x&=205 \\ x&=41 \end{aligned}$$

The angles measure $41°$, $41+11=52°$, and $3(41)-36=87°$.

Check Since $41°+52°+87°=180°$, the answers are correct.

46. The marked angles are supplements which have a sum of $180°$.

$$\begin{aligned} (15x+15)+(3x+3)&=180 \\ 18x+18&=180 \\ 18x&=162 \\ x&=9 \end{aligned}$$

The angle measures are $15(9)+15=150°$ and $3(9)+3=30°$.

47. $x=$ the first of the three consecutive integers
$x+1=$ the second integer
$x+2=$ the third integer
Write the sum of the first and third numbers, $x+(x+2)$, and set it equal to 49 less than 3 times the second.

$$\begin{aligned} x+(x+2)&=3(x+1)-49 \\ 2x+2&=3x+3-49 \\ 2x+2&=3x-46 \\ 2&=x-46 \\ 48&=x \end{aligned}$$

The three consecutive numbers are 48, 49, and 50.

Check The sum of the first and third consecutive integers is $48+50=98$. 49 less than 3 times the second, yields $3(49)-49=98$, as desired.

48. Let $x=$ the first consecutive integer. Then $x+1=$ the second consecutive integer and $x+2=$ the third consecutive integer.
The sum of the first and third integers is 47 more than the second integer, so an equation is

$$\begin{aligned} x+(x+2)&=47+(x+1) \\ 2x+2&=48+x \\ x&=46 \end{aligned}$$

Then $x+1=47$, and $x+2=48$.The integers are 46, 47, and 48.

Chapter 1 Mixed Review Exercises

1.
$$\begin{aligned} (7-2k)+3(5-3k)&=k+8 \\ 7-2k+15-9k&=k+8 \\ -11k+22&=k+8 \\ -12k+22&=8 \\ -12k&=-14 \\ k&=\tfrac{-14}{-12}=\tfrac{7}{6} \end{aligned}$$

Solution set: $\{\frac{7}{6}\}$

2. $\dfrac{4x+2}{4}+\dfrac{3x-1}{8}=\dfrac{x+6}{16}$ ■ Multiply each side by the LCD, 16, and use the distributive property.

$$\begin{aligned} 4(4x+2)+2(3x-1)&=x+6 \\ 16x+8+6x-2&=x+6 \\ 22x+6&=x+6 \\ 21x&=0 \\ x&=0 \end{aligned}$$

Solution set: $\{0\}$

3.
$$\begin{aligned} -5(6p+4)-2p&=-32p+14 \\ -30p-20-2p&=-32p+14 \\ -32p-20&=-32p+14 \\ -20&=14 \qquad \textit{False} \end{aligned}$$

The equation is a *contradiction.*

Solution set: $\varnothing$

4.
$$\begin{aligned} 0.08x+0.04(x+200)&=188 \\ 8x+4(x+200)&=18{,}800 \\ &\textit{Multiply each side by 100.} \\ 8x+4x+800&=18{,}800 \\ 12x+800&=18{,}800 \\ 12x&=18{,}000 \\ x&=1500 \end{aligned}$$

Solution set: $\{1500\}$

5.
$$\begin{aligned} 5(2r-3)+7(2-r)&=3(r+2)-7 \\ 10r-15+14-7r&=3r+6-7 \\ 3r-1&=3r-1 \\ 3r&=3r \\ 0&=0 \qquad \textit{True} \end{aligned}$$

Solution set: {all real numbers}

6.
$$\begin{aligned} Ax+By&=C \text{ for } x \\ Ax&=C-By \qquad \textit{Subtract By.} \\ x&=\frac{C-By}{A} \qquad \textit{Divide by A.} \end{aligned}$$

7. Use the formula $d = rt$ or $r = \frac{d}{t}$.
Here, d is about 400 mi and t is about 8 hr.
Since $\frac{400}{8} = 50$, the best estimate is choice **A**.

8. Use the formula $d = rt$.

(a) Here, $r = 53$ mph and $t = 10$ hr.

$$d = 53(10) = 530$$

The distance is 530 miles.

(b) Here, $r = 164$ mph and $t = 2$ hr.

$$d = 164(2) = 328$$

The distance is 328 miles.

9. Let $x =$ the length of each side of the original square; $x + 4 =$ the length of each side of the enlarged square.

The original perimeter is $4x$. The perimeter of the enlarged square is $4(x + 4)$. The perimeter of the enlarged square is 8 in. less than twice the perimeter of the original square.

$$\begin{aligned} 4(x+4) &= 2(4x) - 8 \\ 4x + 16 &= 8x - 8 \\ 16 &= 4x - 8 \\ 24 &= 4x \\ 6 &= x \end{aligned}$$

The length of a side of the original square is 6 in.

10. The sum of the two angles is 90°.

$$\begin{aligned} (5x+5) + (3x+5) &= 90 \\ 8x + 10 &= 90 \\ 8x &= 80 \\ x &= 10 \end{aligned}$$

$$\begin{aligned} 5x + 5 &= 5(10) + 5 = 50 + 5 = 55 \\ 3x + 5 &= 3(10) + 5 = 30 + 5 = 35 \end{aligned}$$

The angles measure 55° and 35°.

11. Let $x =$ the time traveled by eastbound car.
Then $x - 1 =$ the time traveled by westbound car.

	Rate	**Time**	**Distance**
Eastbound Car	40	x	$40x$
Westbound Car	60	$x - 1$	$60(x - 1)$

Their total distance is 240 mi.

$$\begin{aligned} 40x + 60(x-1) &= 240 \\ 40x + 60x - 60 &= 240 \\ 100x - 60 &= 240 \\ 100x &= 300 \\ x &= 3 \end{aligned}$$

The eastbound car traveled for 3 hr and the westbound car traveled for $3 - 1 =$ 2 hr.

12. Let $x =$ the amount invested at 3%.
Then $x + 600 =$ the amount invested at 5%.

Principal (in dollars)	**Rate (as a decimal)**	**Interest (in dollars)**
x	0.03	$0.03x$
$x + 600$	0.05	$0.05(x + 600)$

The total interest is \$126.

$$\begin{aligned} 0.03x + 0.05(x+600) &= 126 \\ 0.03x + 0.05x + 30 &= 126 \\ 0.08x + 30 &= 126 \\ 0.08x &= 96 \\ x &= 1200 \end{aligned}$$

\$1200 was invested at 3% and
$1200 + 600 =$ \$1800 was invested at 5%.

Check 5% of \$1800 is \$90 and 3% of \$1200 is \$36. The sum is \$126, as required.

Chapter 1 Test

1.
$$\begin{aligned} 3(2x-2) - 4(x+6) &= 4x + 8 \\ 6x - 6 - 4x - 24 &= 4x + 8 \\ 2x - 30 &= 4x + 8 \\ -2x - 30 &= 8 \\ -2x &= 38 \\ x &= -19 \end{aligned}$$

Check $x = -19$: $-120 + 52 = -68$ *True*

Solution set: $\{-19\}$

2.
$$\begin{aligned} -3(2+6x) &= 4(x+1) + 36 \\ -6 - 18x &= 4x + 4 + 36 \\ -6 - 18x &= 4x + 40 \\ -22x - 6 &= 40 \\ -22x &= 46 \\ x &= -\frac{23}{11} \end{aligned}$$

Check $x = -\frac{23}{11}$: $-31\frac{7}{11} = -4\frac{4}{11} + 36$ *True*

Solution set: $\{-\frac{23}{11}\}$

3.
$$\begin{aligned} 0.08x + 0.06(x+9) &= 1.24 \\ 8x + 6(x+9) &= 124 \end{aligned}$$

Multiply each side by 100.

$$\begin{aligned} 8x + 6x + 54 &= 124 \\ 14x + 54 &= 124 \\ 14x &= 70 \\ x &= 5 \end{aligned}$$

Check $x = 5$: $0.40 + 0.84 = 1.24$ *True*

Solution set: $\{5\}$

4. $\frac{x+6}{10}+\frac{x-4}{15}=1$ ■ Multiply each side by the LCD, 30, and use the distributive property.

$$\begin{aligned}3(x+6)+2(x-4)&=30\\3x+18+2x-8&=30\\5x+10&=30\\5x&=20\\x&=4\end{aligned}$$

Check $x=4$: $1+0=1$ *True*

Solution set: $\{4\}$

5.
$$\begin{aligned}3x-(2-x)+4x+2&=8x+3\\3x-2+x+4x+2&=8x+3\\8x&=8x+3\\0&=3 \quad \textit{False}\end{aligned}$$

The false statement indicates that the equation is a *contradiction*.

Solution set: $\varnothing$

6. $\frac{x}{3}+7=\frac{5x}{6}-2-\frac{x}{2}+9$ ■ Multiply each side by the LCD, 6, and use the distributive property.

$$\begin{aligned}2x+42&=5x-12-3x+54\\2x+42&=2x+42\\0&=0 \quad \textit{True}\end{aligned}$$

The true statement indicates that the equation is an *identity.*

Solution set: $\{$all real numbers$\}$

7.
$$\begin{aligned}-4(2x-6)&=5x+24-7x\\-8x+24&=-2x+24\\24&=6x+24\\0&=6x\\0&=x\end{aligned}$$

This is a *conditional equation.*

Check $x=0$: $24=0+24-0$ *True*

Solution set: $\{0\}$

8. Solve $S=-16t^2+vt$ for v.

$$\begin{aligned}S+16t^2&=vt &&\textit{Add } 16t^2.\\\frac{S+16t^2}{t}&=v, &&\textit{Divide by } t.\\\text{or }\ v&=\frac{S+16t^2}{t}\end{aligned}$$

9. Solve $-3x+2y=6$ for y.

$$\begin{aligned}2y&=3x+6 &&\textit{Add } 3x.\\\frac{2y}{2}&=\frac{3x+6}{2} &&\textit{Divide by } 2.\\y&=\frac{3}{2}x+3\end{aligned}$$

10. Solve $V=\frac{1}{3}bh$ for h.

$$\begin{aligned}V&=\frac{1}{3}bh\\3V&=bh &&\textit{Multiply by } 3.\\\frac{3V}{b}&=h &&\textit{Divide by } b.\end{aligned}$$

11. Use $d=rt$. Solve for t.

$$t=\frac{d}{r}$$

Now substitute $d=348$ and $r=65$.

$$t=\frac{d}{r}=\frac{348}{65}\approx 5.4$$

Her time was about 5.4 hr.

12. Let $x=$ the percent increase (as a decimal).

$$\begin{aligned}\text{percent increase}&=\frac{\text{amount of increase}}{\text{original amount}}\\x&=\frac{12.75-11.25}{11.25}\\x&=\frac{1.50}{11.25}\\x&\approx 0.133\end{aligned}$$

The percent increase was about 13.3%.

13. Let $x=$ the number of liters of 20% alcohol.

Liters of Solution	Percent (as a decimal)	Liters of Pure Alcohol
x	0.20	$0.20x$
40	0.50	$0.50(40)=20$
$x+40$	0.30	$0.30(x+40)$

Use the values in the last column to write an equation.

$$\begin{aligned}0.20x+20&=0.30(x+40)\\0.20x+20&=0.30x+12\\8&=0.10x\\80&=x\end{aligned}$$

80L of 20% alcohol should be added.

14. Let $x=$ the amount invested at 1.5%. Then $28,000-x=$ the amount invested at 2.5%.

Principal	Rate (as a decimal)	Interest
x	0.015	$0.015x$
$28{,}000-x$	0.025	$0.025(28{,}000-x)$
$28,000	←Total→	$620

From the last column:

$$\begin{aligned} 0.015x + 0.025(28{,}000 - x) &= 620 \\ 15x + 25(28{,}000 - x) &= 620{,}000 \\ 15x + 700{,}000 - 25x &= 620{,}000 \\ -10x &= -80{,}000 \\ x &= 8000 \end{aligned}$$

He invested \$8000 at 1.5% and \$28,000 − \$8000 = \$20,000 at 2.5%.

15. Let $x =$ the rate of the faster car.
Then $x - 15 =$ the rate of the slower car.

Make a table. Use the formula $d = rt$.

	Rate	**Time**	**Distance**
Slower Car	$x - 15$	6	$6(x - 15)$
Faster Car	x	6	$6x$
Total →			630

The total distance traveled is the sum of the distances traveled by each car.

$$\begin{aligned} 6(x - 15) + 6x &= 630 \\ 6x - 90 + 6x &= 630 \\ 12x &= 720 \\ x &= 60 \end{aligned}$$

The faster car traveled at 60 mph, while the slower car traveled at $60 - 15 = 45$ mph.

16. The sum of the three angle measures is 180°.

$$\begin{aligned} (2x + 20) + x + x &= 180 \\ 4x + 20 &= 180 \\ 4x &= 160 \\ x &= 40 \end{aligned}$$

The three angle measures are 40°, 40°, and $(2 \cdot 40 + 20)° = 100°$.