

## Chapter 2

### Section 2.1

#### Check Point Exercises

1.  $4(2x+1) = 29 + 3(2x-5)$

$$8x + 4 = 29 + 6x - 15$$

$$8x + 4 = 14 + 6x$$

$$8x - 6x = 14 - 4$$

$$2x = 10$$

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

$$x = 5$$

Check:

$$4(2x+1) = 29 + 3(2x-5)$$

$$4[2(5)+1] = 29 + 3[2(5)-5]$$

$$4[10+1] = 29 + 3[10-5]$$

$$4[11] = 29 + 3[5]$$

$$44 = 29 + 15$$

$$44 = 44 \text{ true}$$

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

2.  $\frac{x-3}{4} = \frac{5}{14} - \frac{x+5}{7}$

$$28 \cdot \frac{x-3}{4} = 28 \left( \frac{5}{14} - \frac{x+5}{7} \right)$$

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

$$7x - 21 = 10 - 4x - 20$$

$$7x - 21 = -4x - 10$$

$$7x + 4x = -10 + 21$$

$$11x = 11$$

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

$$x = 1$$

Check:

$$\frac{x-3}{4} = \frac{5}{14} - \frac{x+5}{7}$$

$$\frac{1-3}{4} = \frac{5}{14} - \frac{1+5}{7}$$

$$\frac{-2}{4} = \frac{5}{14} - \frac{6}{7}$$

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

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

3.  $\frac{5}{2x} = \frac{17}{18} - \frac{1}{3x}, x \neq 0$

$$18x \cdot \frac{5}{2x} = 18x \left( \frac{17}{18} - \frac{1}{3x} \right)$$

$$18 \cdot \frac{5}{2x} = 18x \cdot \frac{17}{18} - 18x \cdot \frac{1}{3x}$$

$$45 = 17x - 6$$

$$45 + 6 = 17x - 6 + 6$$

$$51 = 17x$$

$$\frac{51}{17} = \frac{17x}{17}$$

$$3 = x$$

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

4.  $\frac{x}{x-2} = \frac{2}{x-2} - \frac{2}{3}, x \neq 2$

$$3(x-2) \cdot \frac{x}{x-2} = 3(x-2) \left[ \frac{2}{x-2} - \frac{2}{3} \right]$$

$$3(x-2) \cdot \frac{x}{x-2} = (3x-2) \cdot \frac{2}{x-2} - 3(x-2) \cdot \frac{2}{3}$$

$$3x = 6 - (x-2) \cdot 2$$

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

$$3x = 6 - 2x + 4$$

$$3x = 10 - 2x$$

$$3x + 2x = 10 - 2x + 2x$$

$$5x = 10$$

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

$$x = 2$$

The solution set is the empty set,  $\emptyset$ .

5. Set  $f(x) = g(x)$ .

$$\frac{1}{x+4} + \frac{1}{x-4} = \frac{22}{x^2-16}$$

$$\frac{1}{x+4} + \frac{1}{x-4} = \frac{22}{(x+4)(x-4)}$$

$$\frac{(x+4)(x-4)}{x+4} + \frac{(x+4)(x-4)}{x-4} = \frac{22(x+4)(x-4)}{(x+4)(x-4)}$$

$$(x-4) + (x+4) = 22$$

$$x-4+x+4 = 22$$

$$2x = 22$$

$$x = 11$$

Check:

$$\begin{aligned}\frac{1}{x+4} + \frac{1}{x-4} &= \frac{22}{x^2-16} \\ \frac{1}{11+4} + \frac{1}{11-4} &= \frac{22}{11^2-16} \\ \frac{1}{15} + \frac{1}{7} &= \frac{22}{105} \\ \frac{22}{105} &= \frac{22}{105} \quad \text{true}\end{aligned}$$

6.  $4x - 7 = 4(x - 1) + 3$

$4x - 7 = 4(x - 1) + 3$

$4x - 7 = 4x - 4 + 3$

$4x - 7 = 4x - 1$

$-7 = -1$

The original equation is equivalent to the statement  $-7 = -1$ , which is false for every value of  $x$ . The solution set is the empty set,  $\emptyset$ .

The equation is an inconsistent equation.

**Exercise Set 2.1**

1.  $7x - 5 = 72$

$7x = 77$

$x = 11$

Check:

$7x - 5 = 72$

$7(11) - 5 = 72$

$77 - 5 = 72$

$72 = 72$

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

2.  $6x - 3 = 63$

$6x = 66$

$x = 11$

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

Check:

$6x - 3 = 63$

$6(11) - 3 = 63$

$66 - 3 = 63$

$63 = 63$

3.  $11x - (6x - 5) = 40$

$11x - 6x + 5 = 40$

$5x + 5 = 40$

$5x = 35$

$x = 7$

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

Check:

$11x - (6x - 5) = 40$

$11(7) - [6(7) - 5] = 40$

$77 - (42 - 5) = 40$

$77 - (37) = 40$

$40 = 40$

4.  $5x - (2x - 10) = 35$

$5x - 2x + 10 = 35$

$3x + 10 = 35$

$3x = 25$

$x = \frac{25}{3}$

The solution set is  $\left\{\frac{25}{3}\right\}$ .

Check:

$5x - (2x - 10) = 35$

$5\left(\frac{25}{3}\right) - \left[2\left(\frac{25}{3}\right) - 10\right] = 35$

$\frac{125}{3} - \left[\frac{50}{3} - 10\right] = 35$

$\frac{125}{3} - \frac{20}{3} = 35$

$\frac{105}{3} = 35$

$35 = 35$

5.  $2x - 7 = 6 + x$   
 $x - 7 = 6$   
 $x = 13$

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

Check:

$$\begin{aligned} 2(13) - 7 &= 6 + 13 \\ 26 - 7 &= 19 \\ 19 &= 19 \end{aligned}$$

6.  $3x + 5 = 2x + 13$   
 $x + 5 = 13$   
 $x = 8$

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

Check:

$$\begin{aligned} 3x + 5 &= 2x + 13 \\ 3(8) + 5 &= 2(8) + 13 \\ 24 + 5 &= 16 + 13 \\ 29 &= 29 \end{aligned}$$

7.  $7x + 4 = x + 16$   
 $6x + 4 = 16$   
 $6x = 12$   
 $x = 2$

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

Check:

$$\begin{aligned} 7(2) + 4 &= 2 + 16 \\ 14 + 4 &= 18 \\ 18 &= 18 \end{aligned}$$

8.  $13x + 14 = 12x - 5$   
 $x + 14 = -5$   
 $x = -19$

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

Check:

$$\begin{aligned} 13x + 14 &= 12x - 5 \\ 13(-19) + 14 &= 12(-19) - 5 \\ -247 + 14 &= -228 - 5 \\ -233 &= -233 \end{aligned}$$

9.  $3(x - 2) + 7 = 2(x + 5)$   
 $3x - 6 + 7 = 2x + 10$   
 $3x + 1 = 2x + 10$

$$\begin{aligned} x + 1 &= 10 \\ x &= 9 \end{aligned}$$

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

Check:

$$\begin{aligned} 3(9 - 2) + 7 &= 2(9 + 5) \\ 3(7) + 7 &= 2(14) \\ 21 + 7 &= 28 \\ 28 &= 28 \end{aligned}$$

10.  $2(x - 1) + 3 = x - 3(x + 1)$   
 $2x - 2 + 3 = x - 3x - 3$   
 $2x + 1 = -2x - 3$   
 $4x + 1 = -3$   
 $4x = -4$   
 $x = -1$

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

Check:

$$\begin{aligned} 2(x - 1) + 3 &= x - 3(x + 1) \\ 2(-1 - 1) + 3 &= -1 - 3(-1 + 1) \\ 2(-2) + 3 &= -1 - 3(0) \\ -4 + 3 &= -1 + 0 \\ -1 &= -1 \end{aligned}$$

11.  $3(x - 4) - 4(x - 3) = x + 3 - (x - 2)$   
 $3x - 12 - 4x + 12 = x + 3 - x + 2$   
 $-x = 5$   
 $x = -5$

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

Check:

$$\begin{aligned} 3(-5 - 4) - 4(-5 - 3) &= -5 + 3 - (-5 - 2) \\ 3(-9) - 4(-8) &= -2 - (-7) \\ -27 + 32 &= -2 + 7 \\ 5 &= 5 \end{aligned}$$

12.  $2 - (7x + 5) = 13 - 3x$   
 $2 - 7x - 5 = 13 - 3x$   
 $-7x - 3 = 13 - 3x$   
 $-4x = 16$   
 $x = -4$

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

Check:

$$\begin{aligned} 2 - (7x + 5) &= 13 - 3x \\ 2 - [7(-4) + 5] &= 13 - 3(-4) \\ 2 - [-28 + 5] &= 13 + 12 \\ 2 - [-23] &= 15 \\ 2 + 23 &= 25 \\ 25 &= 25 \end{aligned}$$

$$\begin{aligned}
 13. \quad 16 &= 3(x-1) - (x-7) \\
 16 &= 3x - 3 - x + 7 \\
 16 &= 2x + 4 \\
 12 &= 2x \\
 6 &= x
 \end{aligned}$$

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

Check:

$$\begin{aligned}
 16 &= 3(6-1) - (6-7) \\
 16 &= 3(5) - (-1) \\
 16 &= 15 + 1 \\
 16 &= 16
 \end{aligned}$$

$$\begin{aligned}
 14. \quad 5x - (2x + 2) &= x + (3x - 5) \\
 5x - 2x - 2 &= x + 3x - 5 \\
 3x - 2 &= 4x - 5 \\
 -x &= -3 \\
 x &= 3
 \end{aligned}$$

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

Check:

$$\begin{aligned}
 5x - (2x + 2) &= x + (3x - 5) \\
 5(3) - [2(3) + 2] &= 3 + [3(3) - 5] \\
 15 - [6 + 2] &= 3 + [9 - 5] \\
 15 - 8 &= 3 + 4 \\
 7 &= 7
 \end{aligned}$$

$$\begin{aligned}
 15. \quad 25 - [2 + 5y - 3(y + 2)] &= -3(2y - 5) - [5(y - 1) - 3y + 3] \\
 25 - [2 + 5y - 3y - 6] &= -6y + 15 - [5y - 5 - 3y + 3] \\
 25 - [2y - 4] &= -6y + 15 - [2y - 2] \\
 25 - 2y + 4 &= -6y + 15 - 2y + 2 \\
 -2y + 29 &= -8y + 17 \\
 6y &= -12 \\
 y &= -2
 \end{aligned}$$

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

Check:

$$\begin{aligned}
 25 - [2 + 5y - 3(y + 2)] &= -3(2y - 5) - [5(y - 1) - 3y + 3] \\
 25 - [2 + 5(-2) - 3(-2 + 2)] &= -3[2(-2) - 5] - [5(-2 - 1) - 3(-2) + 3] \\
 25 - [2 - 10 - 3(0)] &= -3[-4 - 5] - [5(-3) + 6 + 3] \\
 25 - [-8] &= -3(-9) - [-15 + 9] \\
 25 + 8 &= 27 - (-6) \\
 33 &= 27 + 6 \\
 33 &= 33
 \end{aligned}$$

$$\begin{aligned}
 16. \quad 45 - [4 - 2y - 4(y + 7)] &= -4(1 + 3y) - [4 - 3(y + 2) - 2(2y - 5)] \\
 45 - [4 - 2y - 4y - 28] &= -4 - 12y - [4 - 3y - 6 - 4y + 10] \\
 45 - [-6y - 24] &= -4 - 12y - [-7y + 8] \\
 45 + 6y + 24 &= -4 - 12y + 7y - 8 \\
 6y + 69 &= -5y - 12 \\
 11y &= -81 \\
 y &= -\frac{81}{11}
 \end{aligned}$$

The solution set is  $\left\{-\frac{81}{11}\right\}$ .

$$\begin{aligned}
 17. \quad \frac{x}{3} &= \frac{x}{2} - 2 \\
 6\left[\frac{x}{3} &= \frac{x}{2} - 2\right] \\
 2x &= 3x - 12 \\
 12 &= 3x - 2x \\
 x &= 12 \\
 \text{The solution set is } \{12\}.
 \end{aligned}$$

$$\begin{aligned}
 18. \quad \frac{x}{5} &= \frac{x}{6} + 1 \\
 30\left[\frac{x}{5} &= \frac{x}{6} + 1\right] \\
 6x &= 5x + 30 \\
 6x - 5x &= 30 \\
 x &= 30 \\
 \text{The solution set is } \{30\}.
 \end{aligned}$$

$$\begin{aligned}
 19. \quad 20 - \frac{x}{3} &= \frac{x}{2} \\
 6\left[20 - \frac{x}{3} &= \frac{x}{2}\right] \\
 120 - 2x &= 3x \\
 120 &= 3x + 2x \\
 120 &= 5x \\
 x &= \frac{120}{5} \\
 x &= 24 \\
 \text{The solution set is } \{24\}.
 \end{aligned}$$

$$\begin{aligned}
 20. \quad \frac{x}{5} - \frac{1}{2} &= \frac{x}{6} \\
 30\left[\frac{x}{5} - \frac{1}{2} &= \frac{x}{6}\right] \\
 6x - 15 &= 5x \\
 6x - 5x &= 15 \\
 x &= 15 \\
 \text{The solution set is } \{15\}.
 \end{aligned}$$

$$\begin{aligned}
 21. \quad \frac{3x}{5} &= \frac{2x}{3} + 1 \\
 15\left[\frac{3x}{5} &= \frac{2x}{3} + 1\right] \\
 9x &= 10x + 15 \\
 9x - 10x &= 15 \\
 -x &= 15 \\
 x &= -15 \\
 \text{The solution set is } \{-15\}.
 \end{aligned}$$

$$\begin{aligned}
 22. \quad \frac{x}{2} &= \frac{3x}{4} + 5 \\
 4\left[\frac{x}{2} &= \frac{3x}{4} + 5\right] \\
 2x &= 3x + 20 \\
 2x - 3x &= 20 \\
 -x &= 20 \\
 x &= -20 \\
 \text{The solution set is } \{-20\}.
 \end{aligned}$$

$$\begin{aligned}
 23. \quad \frac{3x}{5} - x &= \frac{x}{10} - \frac{5}{2} \\
 10\left[\frac{3x}{5} - x &= \frac{x}{10} - \frac{5}{2}\right] \\
 6x - 10x &= x - 25 \\
 -4x - x &= -25 \\
 -5x &= -25 \\
 x &= 5 \\
 \text{The solution set is } \{5\}.
 \end{aligned}$$

$$\begin{aligned}
 24. \quad 2x - \frac{2x}{7} &= \frac{x}{2} + \frac{17}{2} \\
 14\left[2x - \frac{2x}{7} &= \frac{x}{2} + \frac{17}{2}\right] \\
 28x - 4x &= 7x + 119 \\
 24x - 7x &= 119 \\
 17x &= 119 \\
 x &= 7 \\
 \text{The solution set is } \{7\}.
 \end{aligned}$$

$$25. \quad \frac{x+3}{6} = \frac{3}{8} + \frac{x-5}{4}$$

$$24 \left[ \frac{x+3}{6} = \frac{3}{8} + \frac{x-5}{4} \right]$$

$$4x+12=9+6x-30$$

$$4x-6x=-21-12$$

$$-2x=-33$$

$$x = \frac{33}{2}$$

The solution set is  $\left\{\frac{33}{2}\right\}$ .

$$26. \quad \frac{x+1}{4} = \frac{1}{6} + \frac{2-x}{3}$$

$$12 \left[ \frac{x+1}{4} = \frac{1}{6} + \frac{2-x}{3} \right]$$

$$3x+3=2+8-4x$$

$$3x+4x=10-3$$

$$7x=7$$

$$x=1$$

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

$$27. \quad \frac{x}{4} = 2 + \frac{x-3}{3}$$

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

$$3x=24+4x-12$$

$$3x-4x=12$$

$$-x=12$$

$$x=-12$$

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

$$28. \quad 5 + \frac{x-2}{3} = \frac{x+3}{8}$$

$$24 \left[ 5 + \frac{x-2}{3} = \frac{x+3}{8} \right]$$

$$120+8x-16=3x+9$$

$$8x-3x=9-104$$

$$5x=-95$$

$$x=-19$$

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

$$29. \quad \frac{x+1}{3} = 5 - \frac{x+2}{7}$$

$$21 \left[ \frac{x+1}{3} = 5 - \frac{x+2}{7} \right]$$

$$7x+7=105-3x-6$$

$$7x+3x=99-7$$

$$10x=92$$

$$x = \frac{92}{10}$$

$$x = \frac{46}{5}$$

The solution set is  $\left\{\frac{46}{5}\right\}$ .

$$30. \quad \frac{3x}{5} - \frac{x-3}{2} = \frac{x+2}{3}$$

$$30 \left[ \frac{3x}{5} - \frac{x-3}{2} = \frac{x+2}{3} \right]$$

$$18x-15x+45=10x+20$$

$$3x-10x=20-45$$

$$-7x=-25$$

$$x = \frac{25}{7}$$

The solution set is  $\left\{\frac{25}{7}\right\}$ .

$$31. \quad \text{a.} \quad \frac{4}{x} = \frac{5}{2x} + 3 \quad (x \neq 0)$$

$$\text{b.} \quad \frac{4}{x} = \frac{5}{2x} + 3$$

$$8=5+6x$$

$$3=6x$$

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

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

32. a.  $\frac{5}{x} = \frac{10}{3x} + 4 \quad (x \neq 0)$

b.  $\frac{5}{x} = \frac{10}{3x} + 4$   
 $15 = 10 + 12x$   
 $5 = 12x$   
 $x = \frac{5}{12}$

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

33. a.  $\frac{2}{x} + 3 = \frac{5}{2x} + \frac{13}{4} \quad (x \neq 0)$

b.  $\frac{2}{x} + 3 = \frac{5}{2x} + \frac{13}{4}$   
 $8 + 12x = 10 + 13x$   
 $-x = 2$   
 $x = -2$

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

34. a.  $\frac{7}{2x} - \frac{5}{3x} = \frac{22}{3} \quad (x \neq 0)$

b.  $\frac{7}{2x} - \frac{5}{3x} = \frac{22}{3}$   
 $21 - 10 = 44x$   
 $11 = 44x$   
 $x = \frac{1}{4}$

The solution set is  $\left\{\frac{1}{4}\right\}$ .

35. a.  $\frac{2}{3x} + \frac{1}{4} = \frac{11}{6x} - \frac{1}{3} \quad (x \neq 0)$

b.  $\frac{2}{3x} + \frac{1}{4} = \frac{11}{6x} - \frac{1}{3}$   
 $8 + 3x = 22 - 4x$   
 $7x = 14$   
 $x = 2$

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

36. a.  $\frac{5}{2x} - \frac{8}{9} = \frac{1}{18} - \frac{1}{3x} \quad (x \neq 0)$

b.  $\frac{5}{2x} - \frac{8}{9} = \frac{1}{18} - \frac{1}{3x}$   
 $45 - 16x = x - 6$   
 $-17x = -51$   
 $x = 3$   
The solution set is  $\{3\}$ .

37. a.  $\frac{x-2}{2x} + 1 = \frac{x+1}{x} \quad (x \neq 0)$

b.  $\frac{x-2}{2x} + 1 = \frac{x+1}{x}$   
 $x - 2 + 2x = 2x + 2$   
 $x - 2 = 2$   
 $x = 4$   
The solution set is  $\{4\}$ .

38. a.  $\frac{4}{x} = \frac{9}{5} - \frac{7x-4}{5x} \quad (x \neq 0)$

b.  $\frac{4}{x} = \frac{9}{5} - \frac{7x-4}{5x}$   
 $20 = 9x - 7x + 4$   
 $16 = 2x$   
 $8 = x$   
The solution set is  $\{8\}$ .

39. a.  $\frac{1}{x-1} + 5 = \frac{11}{x-1} \quad (x \neq 1)$

b.  $\frac{1}{x-1} + 5 = \frac{11}{x-1}$   
 $1 + 5(x-1) = 11$   
 $1 + 5x - 5 = 11$   
 $5x - 4 = 11$   
 $5x = 15$   
 $x = 3$   
The solution set is  $\{3\}$ .

40. a.  $\frac{3}{x+4} - 7 = \frac{-4}{x+4} (x \neq -4)$

b.  $\frac{3}{x+4} - 7 = \frac{-4}{x+4}$   
 $3 - 7(x+4) = -4$   
 $3 - 7x - 28 = -4$   
 $-7x = 21$   
 $x = -3$   
 The solution set is  $\{-3\}$ .

41. a.  $\frac{8x}{x+1} = 4 - \frac{8}{x+1} (x \neq -1)$

b.  $\frac{8x}{x+1} = 4 - \frac{8}{x+1}$   
 $8x = 4(x+1) - 8$   
 $8x = 4x + 4 - 8$   
 $4x = -4$   
 $x = -1 \Rightarrow$  no solution  
 The solution set is the empty set,  $\emptyset$ .

42. a.  $\frac{2}{x-2} = \frac{x}{x-2} - 2 (x \neq 2)$

b.  $\frac{2}{x-2} = \frac{x}{x-2} - 2$   
 $2 = x - 2(x-2)$   
 $2 = x - 2x + 4$   
 $x = 2 \Rightarrow$  no solution  
 The solution set is the empty set,  $\emptyset$ .

43. a.  $\frac{3}{2x-2} + \frac{1}{2} = \frac{2}{x-1} (x \neq 1)$

b.  $\frac{3}{2x-2} + \frac{1}{2} = \frac{2}{x-1}$   
 $\frac{3}{2(x-1)} + \frac{1}{2} = \frac{2}{x-1}$   
 $3 + 1(x-1) = 4$   
 $3 + x - 1 = 4$   
 $x = 2$   
 The solution set is  $\{2\}$ .

44. a.  $\frac{3}{x+3} = \frac{5}{2x+6} + \frac{1}{x-2} (x \neq -3, x \neq 2)$

b.  $\frac{3}{x+3} = \frac{5}{2(x+3)} + \frac{1}{x-2}$   
 $6(x-2) = 5(x-2) + 2(x+3)$   
 $6x - 12 = 5x - 10 + 2x + 6$   
 $-x = 8$   
 $x = -8$   
 The solution set is  $\{-8\}$ .

45. a.  $\frac{3}{x+2} + \frac{2}{x-2} = \frac{8}{(x+2)(x-2)}; (x \neq -2, 2)$

b.  $\frac{3}{x+2} + \frac{2}{x-2} = \frac{8}{(x+2)(x-2)}$   
 $(x \neq 2, x \neq -2)$   
 $3(x-2) + 2(x+2) = 8$   
 $3x - 6 + 2x + 4 = 8$   
 $5x = 10$   
 $x = 2 \Rightarrow$  no solution  
 The solution set is the empty set,  $\emptyset$ .

46. a.  $\frac{5}{x+2} + \frac{3}{x-2} = \frac{12}{(x+2)(x-2)}$   
 $(x \neq 2, x \neq -2)$

b.  $\frac{5}{x+2} + \frac{3}{x-2} = \frac{12}{(x+2)(x-2)}$   
 $5(x-2) + 3(x+2) = 12$   
 $5x - 10 + 3x + 6 = 12$   
 $8x = 16$   
 $x = 2 \Rightarrow$  no solution  
 The solution set is the empty set,  $\emptyset$ .

47. a.  $\frac{2}{x+1} - \frac{1}{x-1} = \frac{2x}{x^2-1} (x \neq 1, x \neq -1)$

b.  $\frac{2}{x+1} - \frac{1}{x-1} = \frac{2x}{x^2-1}$   
 $\frac{2}{x+1} - \frac{1}{x-1} = \frac{2x}{(x+1)(x-1)}$   
 $2(x-1) - 1(x+1) = 2x$   
 $2x - 2 - x - 1 = 2x$   
 $-x = 3$   
 $x = -3$   
 The solution set is  $\{-3\}$ .

48. a.  $\frac{4}{x+5} + \frac{2}{x-5} = \frac{32}{x^2-25}; x \neq 5, -5$

b.  $\frac{4}{x+5} + \frac{2}{x-5} = \frac{32}{(x+5)(x-5)}$   
 $(x \neq 5, x \neq -5)$

$$4(x-5) + 2(x+5) = 32$$

$$4x - 20 + 2x + 10 = 32$$

$$6x = 42$$

$$x = 7$$

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

49. a.  $\frac{1}{x-4} - \frac{5}{x+2} = \frac{6}{(x-4)(x+2)}; (x \neq -2, 4)$

b.  $\frac{1}{x-4} - \frac{5}{x+2} = \frac{6}{x^2-2x-8}$   
 $\frac{1}{x-4} - \frac{5}{x+2} = \frac{6}{(x-4)(x+2)}$   
 $(x \neq 4, x \neq -2)$

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

$$x + 2 - 5x + 20 = 6$$

$$-4x = -16$$

$$x = 4 \Rightarrow \text{no solution}$$

The solution set is the empty set,  $\emptyset$ .

50. a.  $\frac{6}{x+3} - \frac{5}{x-2} = \frac{-20}{x^2+x-6}; x \neq -3, 2$

b.  $\frac{6}{x+3} - \frac{5}{x-2} = \frac{-20}{(x-2)(x+3)}$   
 $(x \neq -3, x \neq 2)$

$$6(x-2) - 5(x+3) = -20$$

$$6x - 12 - 5x - 15 = -20$$

$$x = 7$$

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

51. Set  $y_1 = y_2$ .

$$5(2x-8) - 2 = 5(x-3) + 3$$

$$10x - 40 - 2 = 5x - 15 + 3$$

$$10x - 42 = 5x - 12$$

$$10x - 5x = -12 + 42$$

$$5x = 30$$

$$x = 6$$

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

52. Set  $y_1 = y_2$ .

$$7(3x-2) + 5 = 6(2x-1) + 24$$

$$21x - 14 + 5 = 12x - 6 + 24$$

$$21x - 9 = 12x + 18$$

$$21x - 12x = 18 + 9$$

$$9x = 27$$

$$x = 3$$

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

53. Set  $y_1 - y_2 = 1$ .

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

$$20 \cdot \frac{x-3}{5} - 20 \cdot \frac{x-5}{4} = 20 \cdot 1$$

$$4(x-3) - 5(x-5) = 20$$

$$4x - 12 - 5x + 25 = 20$$

$$-x + 13 = 20$$

$$-x = 7$$

$$x = -7$$

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

54. Set  $y_1 - y_2 = -4$ .

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

$$12 \cdot \frac{x+1}{4} - 12 \cdot \frac{x-2}{3} = 12(-4)$$

$$3(x+1) - 4(x-2) = -48$$

$$3x + 3 - 4x + 8 = -48$$

$$-x + 11 = -48$$

$$-x = -59$$

$$x = 59$$

The solution set is  $\{59\}$ .

55. Set
- $y_1 + y_2 = y_3$
- .

$$\begin{aligned}\frac{5}{x+4} + \frac{3}{x+3} &= \frac{12x+19}{x^2+7x+12} \\ \frac{5}{x+4} + \frac{3}{x+3} &= \frac{12x+19}{(x+4)(x+3)} \\ (x+4)(x+3)\left(\frac{5}{x+4} + \frac{3}{x+3}\right) &= (x+4)(x+3)\frac{12x+19}{(x+4)(x+3)} \\ 5(x+3) + 3(x+4) &= 12x+19 \\ 5x+15+3x+12 &= 12x+19 \\ 8x+27 &= 12x+19 \\ -4x &= -8 \\ x &= 2\end{aligned}$$

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

56. Set
- $y_1 + y_2 = y_3$
- .

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

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

- 57.
- $0 = 4[x - (3 - x)] - 7(x + 1)$

$$0 = 4[x - 3 + x] - 7x - 7$$

$$0 = 4[2x - 3] - 7x - 7$$

$$0 = 8x - 12 - 7x - 7$$

$$0 = x - 19$$

$$-x = -19$$

$$x = 19$$

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

- 58.
- $0 = 2[3x - (4x - 6)] - 5(x - 6)$

$$0 = 2[3x - 4x + 6] - 5x + 30$$

$$0 = 2[-x + 6] - 5x + 30$$

$$0 = -2x + 12 - 5x + 30$$

$$0 = -7x + 42$$

$$7x = 42$$

$$x = 6$$

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

$$\begin{aligned}
 59. \quad 0 &= \frac{x+6}{3x-12} - \frac{5}{x-4} - \frac{2}{3} \\
 0 &= \frac{x+6}{3(x-4)} - \frac{5}{x-4} - \frac{2}{3} \\
 3(x-4) \cdot 0 &= 3(x-4) \left( \frac{x+6}{3(x-4)} - \frac{5}{x-4} - \frac{2}{3} \right) \\
 0 &= \frac{3(x-4)(x+6)}{3(x-4)} - \frac{5 \cdot 3(x-4)}{x-4} - \frac{2 \cdot 3(x-4)}{3} \\
 0 &= (x+6) - 15 - 2(x-4) \\
 0 &= x+6-15-2x+8 \\
 0 &= -x-1 \\
 x &= -1
 \end{aligned}$$

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

$$\begin{aligned}
 60. \quad 0 &= \frac{1}{5x+5} - \frac{3}{x+1} + \frac{7}{5} \\
 0 &= \frac{1}{5(x+1)} - \frac{3}{x+1} + \frac{7}{5} \\
 5(x+1) \cdot 0 &= 5(x+1) \left( \frac{1}{5(x+1)} - \frac{3}{x+1} + \frac{7}{5} \right) \\
 0 &= \frac{1 \cdot 5(x+1)}{5(x+1)} - \frac{3 \cdot 5(x+1)}{x+1} + \frac{7 \cdot 5(x+1)}{5} \\
 0 &= 1 - 15 + 7(x+1) \\
 0 &= 1 - 15 + 7x + 7 \\
 0 &= -7 + 7x \\
 -7x &= -7 \\
 x &= 1
 \end{aligned}$$

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

$$\begin{aligned}
 61. \quad 4(x-7) &= 4x - 28 \\
 4x - 28 &= 4x - 28 \\
 \text{The given equation is an identity.}
 \end{aligned}$$

$$\begin{aligned}
 62. \quad 4(x-7) &= 4x + 28 \\
 4x - 28 &= 4x + 28 \\
 \text{The given equation is an inconsistent equation.}
 \end{aligned}$$

$$\begin{aligned}
 63. \quad 2x + 3 &= 2x - 3 \\
 3 &= -3 \\
 \text{The given equation is an inconsistent equation.}
 \end{aligned}$$

$$\begin{aligned}
 64. \quad \frac{7x}{x} &= 7 \\
 7x &= 7x \\
 \text{The given equation is an identity.}
 \end{aligned}$$

$$\begin{aligned}
 65. \quad 4x + 5x &= 8x \\
 9x &= 8x \\
 x &= 0 \\
 \text{The given equation is a conditional equation.}
 \end{aligned}$$

$$\begin{aligned}
 66. \quad 8x + 2x &= 9x \\
 10x &= 9x \\
 x &= 0 \\
 \text{The given equation is a conditional equation.}
 \end{aligned}$$

$$\begin{aligned}
 67. \quad \frac{2x}{x-3} &= \frac{6}{x-3} + 4 \\
 2x &= 6 + 4(x-3) \\
 2x &= 6 + 4x - 12 \\
 -2x &= -6 \\
 x &= 3 \Rightarrow \text{no solution} \\
 \text{The given equation is an inconsistent equation.}
 \end{aligned}$$

$$68. \quad \frac{3}{x-3} = \frac{x}{x-3} + 3$$

$$3 = x + 3(x-3)$$

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

$$-4x = -12$$

$$x = 3 \Rightarrow \text{no solution}$$

The given equation is an inconsistent equation.

$$69. \quad \frac{x+5}{2} - 4 = \frac{2x-1}{3}$$

$$3(x+5) - 24 = 2(2x-1)$$

$$3x + 15 - 24 = 4x - 2$$

$$-x = 7$$

$$x = -7$$

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

The given equation is a conditional equation.

$$70. \quad \frac{x+2}{7} = 5 - \frac{x+1}{3}$$

$$3(x+2) = 105 - 7(x+1)$$

$$3x + 6 = 105 - 7x - 7$$

$$10x = 92$$

$$x = \frac{92}{10}$$

$$x = \frac{46}{5}$$

The solution set is  $\left\{\frac{46}{5}\right\}$ .

The given equation is a conditional equation.

$$71. \quad \frac{2}{x-2} = 3 + \frac{x}{x-2}$$

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

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

$$-4x = -8$$

$$x = 2 \Rightarrow \text{no solution}$$

The solution set is the empty set,  $\emptyset$ .

The given equation is an inconsistent equation.

$$72. \quad \frac{6}{x+3} + 2 = \frac{-2x}{x+3}$$

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

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

$$4x = -12$$

$$x = -3 \Rightarrow \text{no solution}$$

This equation is not true for any real numbers.

The given equation is an inconsistent equation.

$$73. \quad 8x - (3x + 2) + 10 = 3x$$

$$8x - 3x - 2 + 10 = 3x$$

$$2x = -8$$

$$x = -4$$

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

The given equation is a conditional equation.

$$74. \quad 2(x+2) + 2x = 4(x+1)$$

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

$$0 = 0$$

This equation is true for all real numbers.

The given equation is an identity.

$$75. \quad \frac{2}{x} + \frac{1}{2} = \frac{3}{4}$$

$$8 + 2x = 3x$$

$$-x = -8$$

$$x = 8$$

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

The given equation is a conditional equation.

$$76. \quad \frac{3}{x} - \frac{1}{6} = \frac{1}{3}$$

$$18 - x = 2x$$

$$-3x = -18$$

$$x = 6$$

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

The given equation is a conditional equation.

$$77. \quad \frac{4}{x-2} + \frac{3}{x+5} = \frac{7}{(x+5)(x-2)}$$

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

$$4x + 20 + 3x - 6 = 7$$

$$7x = -7$$

$$x = -1$$

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

The given equation is a conditional equation.

$$78. \quad \frac{1}{x-1} = \frac{1}{(2x+3)(x-1)} + \frac{4}{2x+3}$$

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

$$2x + 3 = 1 + 4x - 4$$

$$-2x = -6$$

$$x = 3$$

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

The given equation is a conditional equation.

$$79. \quad \frac{4x}{x+3} - \frac{12}{x-3} = \frac{4x^2+36}{x^2-9}; x \neq 3, -3$$

$$4x(x-3) - 12(x+3) = 4x^2 + 36$$

$$4x^2 - 12x - 12x - 36 = 4x^2 + 36$$

$$4x^2 - 24x - 36 = 4x^2 + 36$$

$$-24x - 36 = 36$$

$$-24x = 72$$

$$x = -3 \quad \text{No solution}$$

The solution set is  $\{ \}$ .

The given equation is an inconsistent equation.

$$80. \quad \frac{4}{x^2+3x-10} - \frac{1}{x^2+x-6} = \frac{3}{x^2-x-12}$$

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

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

$$4x^2 - 4x - 48 - x^2 - x + 20 = 3x^2 + 9x - 30$$

$$3x^2 - 5x - 28 = 3x^2 + 9x - 30$$

$$2 = 14x$$

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

The solution set is  $\left\{ \frac{1}{7} \right\}$ .

The given equation is a conditional equation.

$$81. \quad \text{The equation is } 3(x-4) = 3(2-2x), \text{ and the solution is } x = 2.$$

$$82. \quad \text{The equation is } 3(2x-5) = 5x+2, \text{ and the solution is } x = 17.$$

$$83. \quad \text{The equation is } -3(x-3) = 5(2-x), \text{ and the solution is } x = 0.5.$$

$$84. \quad \text{The equation is } 2x-5 = 4(3x+1)-2, \text{ and the solution is } x = -0.7.$$

$$85. \quad 4(c-2) + 2 = 4c - 2(2-c)$$

$$4c - 8 + 2 = 4c - 4 + 2c$$

$$4c - 6 = 6c - 4$$

$$4c - 6c = -4 + 6$$

$$-2c = 2$$

$$\frac{-2c}{-2} = \frac{2}{-2}$$

$$c = -1$$

$$f(x) = x^2 - x$$

$$f(c) = c^2 - c$$

$$f(-1) = (-1)^2 - (-1)$$

$$f(-1) = 2$$

86.  $2(c-6) = 3c + 2(2c-1)$

$$2c - 12 = 3c + 4c - 2$$

$$2c - 12 = 7c - 2$$

$$2c - 7c = -2 + 12$$

$$-5c = 10$$

$$\frac{-5c}{-5} = \frac{10}{-5}$$

$$c = -2$$

$$f(x) = x^2 - x$$

$$f(c) = c^2 - c$$

$$f(-2) = (-2)^2 - (-2)$$

$$f(-2) = 4 + 2$$

$$f(-2) = 6$$

87.  $(f \circ g)(x) = -11$

$$f(g(x)) = -11$$

$$3(2x+5) - 2 = -11$$

$$6x + 15 - 2 = -11$$

$$6x + 13 = -11$$

$$6x = -24$$

$$\frac{6x}{6} = \frac{-24}{6}$$

$$x = -4$$

88.  $(f \circ g)(x) = -15$

$$f(g(x)) = -15$$

$$2(4x-1) + 3 = -15$$

$$8x - 2 + 3 = -15$$

$$8x + 1 = -15$$

$$8x = -16$$

$$\frac{8x}{8} = \frac{-16}{8}$$

$$x = -2$$

89.  $f(x) = 2x - 3$

Find  $f^{-1}(x)$ .

$$y = 2x - 3$$

$$x = 2y - 3 \quad \leftarrow \text{interchange } x \text{ and } y.$$

$$y = \frac{x+3}{2} \quad \leftarrow \text{solve for } y.$$

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

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

$$10 = x + 3$$

$$x = 7$$

90.  $f(x) = 4x - 5$

Find  $f^{-1}(x)$ .

$$y = 4x - 5$$

$$x = 4y - 5 \quad \leftarrow \text{interchange } x \text{ and } y.$$

$$y = \frac{x+5}{4} \quad \leftarrow \text{solve for } y.$$

$$f^{-1}(x) = \frac{x+5}{4}$$

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

$$12 = x + 5$$

$$x = 7$$

91.  $D = \frac{1}{9}N + \frac{26}{9}; \quad D = \frac{7}{2}$

$$\frac{7}{2} = \frac{1}{9}N + \frac{26}{9}$$

$$18\left(\frac{7}{2}\right) = 18\left(\frac{1}{9}N + \frac{26}{9}\right)$$

$$63 = 2N + 52$$

$$11 = 2N$$

$$\frac{11}{2} = \frac{2N}{2}$$

$$5.5 = N$$

If the high-humor group averages a level of depression of 3.5 in response to a negative life event, the intensity of that event would be 5.5. The solution is the point along the horizontal axis where the graph for the high-humor group has a value of 3.5 on the vertical axis. This corresponds to the point  $(5.5, 3.5)$  on the high-humor graph.

92. Substitute 10 for  $D$  in the low humor formula. The LCD is 9.

$$10 = \frac{10}{9}N + \frac{53}{9}$$

$$9(10) = 9\left(\frac{10}{9}N\right) + 9\left(\frac{53}{9}\right)$$

$$90 = 10N + 53$$

$$90 - 53 = 10N + 53 - 53$$

$$37 = 10N$$

$$\frac{37}{10} = \frac{10N}{10}$$

$$3.7 = N$$

The intensity of the event was 3.7. This is shown as the point (3.7, 10) on the low-humor graph.

93.  $C = \frac{DA}{A+12}$ ;  $C = 500$ ,  $D = 1000$

$$500 = \frac{1000A}{A+12}$$

$$(A+12) \cdot 500 = (A+12)\left(\frac{1000A}{A+12}\right)$$

$$500A + 6000 = 1000A$$

$$6000 = 500A$$

$$12 = A$$

The child's age is 12 years old.

94.  $C = \frac{DA}{A+12}$ ;  $C = 300$ ,  $D = 1000$

$$300 = \frac{1000A}{A+12}$$

$$\text{LCD} = A+12$$

$$(A+12) \cdot 300 = (A+12)\left(\frac{1000A}{A+12}\right)$$

$$300A + 3600 = 1000A$$

$$3600 = 700A$$

$$\frac{3600}{700} = A$$

$$A = \frac{36}{7} \approx 5.14$$

To the nearest year, the child is 5 years old.

95. The solution is the point (12, 500) on the blue graph.
96. The solution is the point (5, 300) on the blue graph.

97. No, because the graphs cross, neither formula gives a consistently smaller dosage.

98. Yes, the dosage given by Cowling's Rule becomes greater at about 10 years.

99. 11 learning trials; represented by the point (11, 0.95) on the graph.

100. 1 learning trial; represented by the point (1, 0.5) on the graph.

101.  $C = \frac{x + 0.1(500)}{x + 500}$

$$0.28 = \frac{x + 0.1(500)}{x + 500}$$

$$0.28(x + 500) = x + 0.1(500)$$

$$0.28x + 140 = x + 50$$

$$-0.72x = -90$$

$$\frac{-0.72x}{-0.72} = \frac{-90}{-0.72}$$

$$x = 125$$

125 liters of pure peroxide must be added.

102. a.  $C = \frac{x + 0.35(200)}{x + 200}$

b.  $0.74 = \frac{x + 0.35(200)}{x + 200}$

$$0.74(x + 200) = x + 0.35(200)$$

$$0.74x + 148 = x + 70$$

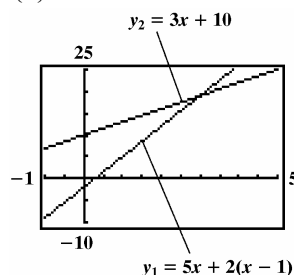
$$-0.26x = -78$$

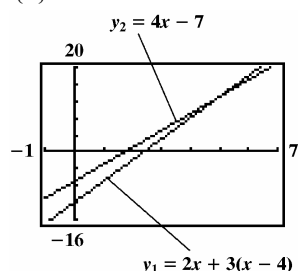
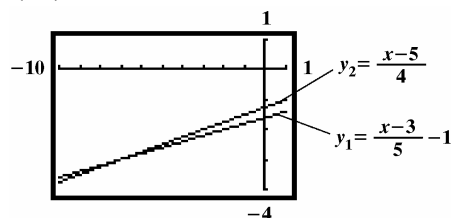
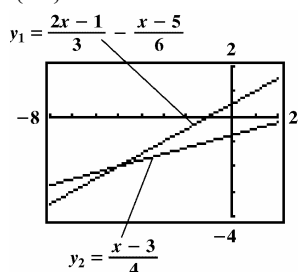
$$\frac{-0.26x}{-0.26} = \frac{-78}{-0.26}$$

$$x = 300$$

300 liters of pure acid must be added.

112. {3}



113.  $\{5\}$ 114.  $\{-7\}$ 115.  $\{-5\}$ 

116. a. False;  $-7x = x$   
 $-8x = 0$   
 $x = 0$   
 The equation  $-7x = x$  has the solution  $x = 0$ .

- b. False;  $\frac{x}{x-4} = \frac{4}{x-4}$  ( $x \neq 4$ )  
 $x = 4$   $\square$  no solution  
 The equations  $\frac{x}{x-4} = \frac{4}{x-4}$  and  $x = 4$  are not equivalent.

- c. True;  
 $3y - 1 = 11$       $3y - 7 = 5$   
 $3y = 12$       $3y = 12$   
 $y = 4$       $y = 4$   
 The equations  $3y - 1 = 11$  and  $3y - 7 = 5$  are equivalent since they are both equivalent to the equation  $y = 4$ .

- d. False; if  $a = 0$ , then  $ax + b = 0$  is equivalent to  $b = 0$ , which either has no solution ( $b \neq 0$ ) or infinitely many solutions ( $b = 0$ ).  
 (c) is true.

$$\begin{aligned}
 118. \quad & \frac{7x+4}{b} + 13 = x \\
 & \frac{7(-6)+4}{b} + 13 = -6 \\
 & \frac{-42+4}{b} + 13 = -6 \\
 & \frac{-38}{b} + 13 = -6 \\
 & \frac{-38}{b} = -19 \\
 & -38 = -19b \\
 & b = 2
 \end{aligned}$$

$$\begin{aligned}
 119. \quad & \frac{4x-b}{x-5} = 3 \\
 & 4x-b = 3(x-5) \\
 & \text{The solution set will be } \emptyset \text{ if } x = 5. \\
 & 4(5)-b = 3(5-5) \\
 & 20-b = 0 \\
 & 20 = b \\
 & b = 20
 \end{aligned}$$

## Section 2.2

## Check Point Exercises

1. Let  $x$  = the number of football injuries  
 Let  $x + 0.6$  = the number of basketball injuries  
 Let  $x + 0.3$  = the number of bicycling injuries  
 $x + (x + 0.6) + (x + 0.3) = 3.9$   
 $x + x + 0.6 + x + 0.3 = 3.9$   
 $3x + 0.9 = 3.9$   
 $3x = 3$   
 $x = 1$   
 $x + 0.6 = 1 + 0.6 = 1.6$   
 $x + 0.3 = 1 + 0.3 = 1.3$   
 In 2004 there were 1 million football injuries, 1.6 million basketball injuries, and 1.3 million bicycling injuries.

2. Let  $x$  = the number of years after 2004 that it will take until Americans will purchase 79.9 million gallons of organic milk.

$$40.7 + 5.6x = 79.9$$

$$5.6x = 79.9 - 40.7$$

$$5.6x = 39.2$$

$$x = \frac{39.2}{5.6}$$

$$x = 7$$

Americans will purchase 79.9 million gallons of organic milk 7 years after 2004, or 2011.

3. Let  $x$  = the number of minutes at which the costs of the two plans are the same.

$$\begin{array}{cc} \text{Plan A} & \text{Plan B} \\ 15 + 0.08x & = 3 + 0.12x \end{array}$$

$$15 + 0.08x - 15 = 3 + 0.12x - 15$$

$$0.08x = 0.12x - 12$$

$$0.08x - 0.12x = 0.12x - 12 - 0.12x$$

$$-0.04x = -12$$

$$\frac{-0.04x}{-0.04} = \frac{-12}{-0.04}$$

$$x = 300$$

The two plans are the same at 300 minutes.

4. Let  $x$  = the computer's price before the reduction.

$$x - 0.30x = 840$$

$$0.70x = 840$$

$$x = \frac{840}{0.70}$$

$$x = 1200$$

Before the reduction the computer's price was \$1200.

5. Let  $x$  = the amount invested at 9%.  
Let  $5000 - x$  = the amount invested at 11%.

$$0.09x + 0.11(5000 - x) = 487$$

$$0.09x + 550 - 0.11x = 487$$

$$-0.02x + 550 = 487$$

$$-0.02x = -63$$

$$x = \frac{-63}{-0.02}$$

$$x = 3150$$

$$5000 - x = 1850$$

\$3150 was invested at 9% and \$1850 was invested at 11%.

6. Let  $x$  = the width of the court.  
Let  $x + 44$  = the length of the court.

$$2l + 2w = P$$

$$2(x + 44) + 2x = 288$$

$$2x + 88 + 2x = 288$$

$$4x + 88 = 288$$

$$4x = 200$$

$$x = \frac{200}{4}$$

$$x = 50$$

$$x + 44 = 94$$

The dimensions of the court are 50 by 94.

### Exercise Set 2.2

1. Let  $x$  = the number

$$5x - 4 = 26$$

$$5x = 30$$

$$x = 6$$

The number is 6.

2. Let  $x$  = the number

$$2x - 3 = 11$$

$$2x = 14$$

$$x = 7$$

The number is 7.

3. Let  $x$  = the number

$$x - 0.20x = 20$$

$$0.80x = 20$$

$$x = 25$$

The number is 25.

4. Let  $x$  = the number

$$x - 0.30x = 28$$

$$0.70x = 28$$

$$x = 40$$

The number is 40.

5. Let  $x$  = the number

$$0.60x + x = 192$$

$$1.6x = 192$$

$$x = 120$$

The number is 120.

6. Let  $x$  = the number

$$0.80x + x = 252$$

$$1.8x = 252$$

$$x = 140$$

The number is 140.

7. Let  $x$  = the number  
 $0.70x = 224$   
 $x = 320$   
 The number is 320.

8. Let  $x$  = the number  
 $0.70x = 252$   
 $x = 360$   
 The number is 360.

9. Let  $x$  = the number  
 $x + 26$  = the other number  
 $x + (x + 26) = 64$   
 $x + x + 26 = 64$   
 $2x + 26 = 64$   
 $2x = 38$   
 $x = 19$   
 If  $x = 19$ , then  $x + 26 = 45$ .  
 The numbers are 19 and 45.

10. Let  $x$  = the number,  
 Let  $x + 24$  = the other number  
 $x + (x + 24) = 58$   
 $x + x + 24 = 58$   
 $2x + 24 = 58$   
 $2x = 34$   
 $x = 17$   
 If  $x = 17$ , then  $x + 24 = 41$ .  
 The numbers are 17 and 41.

11.  $y_1 - y_2 = 2$   
 $(13x - 4) - (5x + 10) = 2$   
 $13x - 4 - 5x - 10 = 2$   
 $8x - 14 = 2$   
 $8x = 16$   
 $\frac{8x}{8} = \frac{16}{8}$   
 $x = 2$

12.  $y_1 - y_2 = 3$   
 $(10x + 6) - (12x - 7) = 3$   
 $10x + 6 - 12x + 7 = 3$   
 $-2x + 13 = 3$   
 $-2x = -10$   
 $\frac{-2x}{-2} = \frac{-10}{-2}$   
 $x = 5$

13.  $y_1 = 8y_2 + 14$   
 $10(2x - 1) = 8(2x + 1) + 14$   
 $20x - 10 = 16x + 8 + 14$   
 $20x - 10 = 16x + 22$   
 $4x = 32$   
 $\frac{4x}{4} = \frac{32}{4}$   
 $x = 8$

14.  $y_1 = 12y_2 - 51$   
 $9(3x - 5) = 12(3x - 1) - 51$   
 $27x - 45 = 36x - 12 - 51$   
 $27x - 45 = 36x - 63$   
 $-9x = -18$   
 $\frac{-9x}{-9} = \frac{-18}{-9}$   
 $x = 2$

15.  $3y_1 - 5y_2 = y_3 - 22$   
 $3(2x + 6) - 5(x + 8) = (x) - 22$   
 $6x + 18 - 5x - 40 = x - 22$   
 $x - 22 = x - 22$   
 $x - x = -22 + 22$   
 $0 = 0$

The solution set is the set of all real numbers.

16.  $2y_1 - 3y_2 = 4y_3 - 8$   
 $2(2.5) - 3(2x + 1) = 4(x) - 8$   
 $5 - 6x - 3 = 4x - 8$   
 $-6x + 2 = 4x - 8$   
 $-10x = -10$   
 $\frac{-10x}{-10} = \frac{-10}{-10}$   
 $x = 1$

17.  $3y_1 + 4y_2 = 4y_3$

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

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

$$\frac{5}{x} = \frac{4}{x-1}$$

$$\frac{5x(x-1)}{x} = \frac{4x(x-1)}{x-1}$$

$$5(x-1) = 4x$$

$$5x - 5 = 4x$$

$$x = 5$$

18.  $6y_1 - 3y_2 = 7y_3$

$$6\left(\frac{1}{x}\right) - 3\left(\frac{1}{x^2 - x}\right) = 7\left(\frac{1}{x-1}\right)$$

$$\frac{6}{x} - \frac{3}{x^2 - x} = \frac{7}{x-1}$$

$$\frac{6}{x} - \frac{3}{x(x-1)} = \frac{7}{x-1}$$

$$x(x-1)\left(\frac{6}{x} - \frac{3}{x(x-1)}\right) = x(x-1)\frac{7}{x-1}$$

$$\frac{6x(x-1)}{x} - \frac{3x(x-1)}{x(x-1)} = \frac{7x(x-1)}{x-1}$$

$$6(x-1) - 3 = 7x$$

$$6x - 6 - 3 = 7x$$

$$6x - 9 = 7x$$

$$6x - 7x = 9$$

$$-x = 9$$

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

$$x = -9$$

19. Let  $x$  = the number of births (in thousands)  
Let  $x - 229$  = the number of deaths (in thousands).

$$x + (x - 229) = 521$$

$$x + x - 229 = 521$$

$$2x - 229 = 521$$

$$2x - 229 + 229 = 521 + 229$$

$$2x = 750$$

$$\frac{2x}{2} = \frac{750}{2}$$

$$x = 375$$

There are 375 thousand births and

$375 - 229 = 146$  thousand deaths each day.

20. Let  $x$  = the number responding yes.

Let  $82 - x$  = the number responding no.

$$(82 - x) - x = 36$$

$$82 - x - x = 36$$

$$82 - 2x = 36$$

$$-2x = 36 - 82$$

$$-2x = -46$$

$$\frac{-2x}{-2} = \frac{-46}{-2}$$

$$x = 23$$

$$82 - x = 59$$

23% responded yes and 59% responded no.

21. Let  $x$  = the number of Internet users in China.  
 $x + 10$  = the number of Internet users in Japan.  
 $x + 123$  = the number of Internet users in the United States.

$$x + (x + 10) + (x + 123) = 271$$

$$3x + 133 = 271$$

$$3x = 138$$

$$x = 46$$

If  $x = 46$ , then  $x + 10 = 56$  and  $x + 123 = 169$ .

Thus, there are 46 million Internet users in China, 56 million Internet users in Japan, and 169 Internet users in the United States.

22. Let  $x$  = energy percentage used by Russia.  
 $x + 6$  = energy percentage used by China.  
 $x + 16.4$  = energy percentage used by the United States.

$$x + (x + 6) + (x + 16.4) = 40.4$$

$$x + x + 6 + x + 16.4 = 40.4$$

$$3x + 22.4 = 40.4$$

$$3x = 18$$

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

$$x = 6$$

$$x + 6 = 12$$

$$x + 16.4 = 22.4$$

Thus, Russia uses 6%, China uses 12%, and the United States uses 22.4% of global energy.

23. Let  $x$  = the percentage of Conservatives.  
Let  $2x + 4.4$  = the percentage of Liberals.

$$x + (2x + 4.4) = 57.2$$

$$x + 2x + 4.4 = 57.2$$

$$3x + 4.4 = 57.2$$

$$3x + 4.4 - 4.4 = 57.2 - 4.4$$

$$3x = 52.8$$

$$\frac{3x}{3} = \frac{52.8}{3}$$

$$x = 17.6$$

$$2x + 4.4 = 39.6$$

The percentage of Conservatives is 17.6% and the percentage of Liberals is 39.6%

24. Let  $x$  = the number of hate crimes based on sexual orientation.  
 $3x + 127$  = the number of hate crimes based on race.

$$(3x + 127) + 1343 + x + 1026 + 33 = 7485$$

$$3x + 127 + 1343 + x + 1026 + 33 = 7485$$

$$4x + 2529 = 7485$$

$$4x = 4956$$

$$\frac{4x}{4} = \frac{4956}{4}$$

$$x = 1239$$

$$3x + 127 = 3844$$

Thus, there were 3844 hate crimes based on race and 1239 based on sexual orientation.

25. Let  $L$  = the life expectancy of an American man.  
 $y$  = the number of years after 1900.

$$L = 55 + 0.2y$$

$$85 = 55 + 0.2y$$

$$30 = 0.2y$$

$$150 = y$$

The life expectancy will be 85 years in the year  $1900 + 150 = 2050$ .

26. Let  $L$  = the life expectancy of an American man,  
Let  $y$  = the number of years after 1900

$$L = 55 + 0.2y$$

$$91 = 55 + 0.2y$$

$$36 = 0.2y$$

$$180 = y$$

The life expectancy will be 91 years in the year  $1900 + 180 = 2080$ .

27. a.  $y = 1.7x + 39.8$

b.  $1.7x + 39.8 = 44.9 + 8.5$

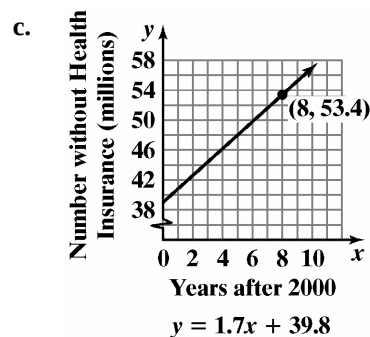
$$1.7x + 39.8 = 53.4$$

$$1.7x = 13.6$$

$$\frac{1.7x}{1.7} = \frac{13.6}{1.7}$$

$$x = 8$$

The number of Americans without health insurance will exceed 44.9 million by 8.5 million 8 years after 2000, or 2008.



28. a.  $y = 1.7x + 39.8$

b.  $1.7x + 39.8 = 44.9 + 10.2$

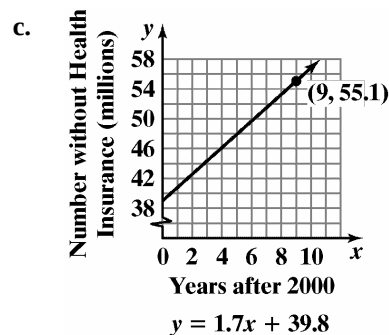
$$1.7x + 39.8 = 55.1$$

$$1.7x = 15.3$$

$$\frac{1.7x}{1.7} = \frac{15.3}{1.7}$$

$$x = 9$$

The number of Americans without health insurance will exceed 44.9 million by 10.2 million 9 years after 2000, or 2009.



- 29.** Let  $v$  = the car's value.  
 $y$  = the number of years (after 2003).  
 $v = 80,500 - 8705y$   
 $19,565 = 80,500 - 8705y$   
 $-60,935 = -8705y$   
 $7 = y$   
 The car's value will be \$19,565 after 7 years.
- 30.** Let  $v$  = the car's value.  
 $y$  = the number of years (after 2003).  
 $v = 80,500 - 8705y$   
 $36,975 = 80,500 - 8705y$   
 $-43,525 = -8705y$   
 $5 = y$   
 The car's value will be \$36,975 after 5 years.
- 31.** Let  $x$  = the number of months.  
 The cost for Club A:  $25x + 40$   
 The cost for Club B:  $30x + 15$   
 $25x + 40 = 30x + 15$   
 $-5x + 40 = 15$   
 $-5x = -25$   
 $x = 5$   
 The total cost for the clubs will be the same at 5 months. The cost will be  
 $25(5) + 40 = 30(5) + 15 = \$165$
- 32.** Let  $g$  = the number of video games rented  
 $9g = 4g + 50$   
 $5g = 50$   
 $g = 10$   
 The total amount spent at each store will be the same after 10 rentals.  
 $9g = 9(10) = 90$   
 The total amount spent will be \$90.
- 33.** Let  $x$  = the number of uses.  
 Cost without coupon book:  $1.25x$   
 Cost with coupon book:  $15 + 0.75x$   
 $1.25x = 15 + 0.75x$   
 $0.50x = 15$   
 $x = 30$   
 The bus must be used 30 times in a month for the costs to be equal.
- 34.** Cost per crossing:  $\$5x$   
 Cost with coupon book:  $\$30 + \$3.50x$   
 $5x = 30 + 3.50x$   
 $1.50x = 30$   
 $x = 20$   
 The bridge must be used 20 times in a month for the costs to be equal.
- 35. a.** Let  $x$  = the number of years (after 2005).  
 College A's enrollment:  $13,300 + 1000x$   
 College B's enrollment:  $26,800 - 500x$   
 $13,300 + 1000x = 26,800 - 500x$   
 $13,300 + 1500x = 26,800$   
 $1500x = 13,500$   
 $x = 9$   
 The two colleges will have the same enrollment in the year  $2005 + 9 = 2014$ .  
 That year the enrollments will be  
 $13,300 + 1000(9)$   
 $= 26,800 - 500(9)$   
 $= 22,300$  students
- b.** Check points to determine that  
 $y_1 = 13,300 + 1000x$  and  
 $y_2 = 26,800 - 500x$ .
- 36.** Let  $x$  = the number of years after 2000  
 $10,600,000 - 28,000x = 10,200,000 - 12,000x$   
 $-16,000x = -400,000$   
 $x = 25$   
 The countries will have the same population 25 years after the year 2000, or the year 2025.  
 $10,200,000 - 12,000x = 10,200,000 - 12,000(25)$   
 $= 10,200,000 - 300,000$   
 $= 9,900,000$   
 The population in the year 2025 will be 9,900,000.
- 37.** Let  $x$  = the cost of the television set.  
 $x - 0.20x = 336$   
 $0.80x = 336$   
 $x = 420$   
 The television set's price is \$420.
- 38.** Let  $x$  = the cost of the dictionary  
 $x - 0.30x = 30.80$   
 $0.70x = 30.80$   
 $x = 44$   
 The dictionary's price before the reduction was \$44.

39. Let  $x$  = the nightly cost  
 $x + 0.08x = 162$

$$1.08x = 162$$

$$x = 150$$

The nightly cost is \$150.

40. Let  $x$  = the nightly cost  
 $x + 0.05x = 252$

$$1.05x = 252$$

$$x = 240$$

The nightly cost is \$240.

41. Let  $x$  = the annual salary for men whose highest educational attainment is a high school degree.

$$x + 0.22x = 44,000$$

$$1.22x = 44,000$$

$$x \approx 36,000$$

The annual salary for men whose highest educational attainment is a high school degree is about \$36,000.

42. Let  $x$  = the annual salary with a high school degree

$$34,000 = x + 0.26x$$

$$34,000 = 1.26x$$

$$26984.13 \div x$$

The annual salary for women with a high school degree is approximately \$27,000.

43. Let  $c$  = the dealer's cost  
 $584 = c + 0.25c$

$$584 = 1.25c$$

$$467.20 = c$$

The dealer's cost is \$467.20.

44. Let  $c$  = the dealer's cost  
 $15 = c + 0.25c$

$$15 = 1.25c$$

$$12 = c$$

The dealer's cost is \$12.

45. Let  $x$  = the amount invested at 6%.  
 Let  $7000 - x$  = the amount invested at 8%.

$$0.06x + 0.08(7000 - x) = 520$$

$$0.06x + 560 - 0.08x = 520$$

$$-0.02x + 560 = 520$$

$$-0.02x = -40$$

$$x = \frac{-40}{-0.02}$$

$$x = 2000$$

$$7000 - x = 5000$$

\$2000 was invested at 6% and \$5000 was invested at 8%.

46. Let  $x$  = the amount invested in stocks.  
 Let  $11,000 - x$  = the amount invested in bonds.

$$0.05x + 0.08(11,000 - x) = 730$$

$$0.05x + 880 - 0.08x = 730$$

$$-0.03x + 880 = 730$$

$$-0.03x = -150$$

$$x = \frac{-150}{-0.03}$$

$$x = 5000$$

$$11,000 - x = 6000$$

\$5000 was invested in stocks and \$6000 was invested in bonds.

47. Let  $x$  = amount invested at 12%  
 $8000 - x$  = amount invested at 5% loss

$$.12x - .05(8000 - x) = 620$$

$$.12x - 400 + .05x = 620$$

$$.17x = 1020$$

$$x = 6000$$

$$8000 - x = 2000$$

\$6000 at 12%, \$2000 at 5% loss

48. Let  $x$  = amount at 14%

$$12000 - x = \text{amount at 6\%}$$

$$.14x - 0.6(12000 - x) = 680$$

$$.14x - 720 + .06x = 680$$

$$.2x = 1400$$

$$x = 7000$$

$$12000 - 7000 = 5000$$

\$7000 at 14%, \$5000 at 6% loss

49. Let  $w$  = the width of the field  
 Let  $2w$  = the length of the field  
 $P = 2(\text{length}) + 2(\text{width})$   
 $300 = 2(2w) + 2(w)$   
 $300 = 4w + 2w$   
 $300 = 6w$   
 $50 = w$   
 If  $w = 50$ , then  $2w = 100$ . Thus, the dimensions are 50 yards by 100 yards.
50. Let  $w$  = the width of the swimming pool,  
 Let  $3w$  = the length of the swimming pool  
 $P = 2(\text{length}) + 2(\text{width})$   
 $320 = 2(3w) + 2(w)$   
 $320 = 6w + 2w$   
 $320 = 8w$   
 $40 = w$   
 If  $w = 40$ ,  $3w = 3(40) = 120$ .  
 The dimensions are 40 feet by 120 feet.
51. Let  $w$  = the width of the field  
 Let  $2w + 6$  = the length of the field  
 $228 = 6w + 12$   
 $216 = 6w$   
 $36 = w$   
 If  $w = 36$ , then  $2w + 6 = 2(36) + 6 = 78$ . Thus, the dimensions are 36 feet by 78 feet.
52. Let  $w$  = the width of the pool,  
 Let  $2w - 6$  = the length of the pool  
 $P = 2(\text{length}) + 2(\text{width})$   
 $126 = 2(2w - 6) + 2(w)$   
 $126 = 4w - 12 + 2w$   
 $126 = 6w - 12$   
 $138 = 6w$   
 $23 = w$   
 Find the length.  
 $2w - 6 = 2(23) - 6 = 46 - 6 = 40$   
 The dimensions are 23 meters by 40 meters.
53. Let  $x$  = the width of the frame.  
 Total length:  $16 + 2x$   
 Total width:  $12 + 2x$   
 $P = 2(\text{length}) + 2(\text{width})$   
 $72 = 2(16 + 2x) + 2(12 + 2x)$   
 $72 = 32 + 4x + 24 + 4x$   
 $72 = 8x + 56$   
 $16 = 8x$   
 $2 = x$   
 The width of the frame is 2 inches.
54. Let  $w$  = the width of the path  
 Let  $40 + 2w$  = the width of the pool and path  
 Let  $60 + 2w$  = the length of the pool and path  
 $2(40 + 2w) + 2(60 + 2w) = 248$   
 $80 + 4w + 120 + 4w = 248$   
 $200 + 8w = 248$   
 $8w = 48$   
 $w = 6$   
 The width of the path is 6 feet.
55. Let  $x$  = number of hours  
 $35x$  = labor cost  
 $35x + 63 = 448$   
 $35x = 385$   
 $x = 11$   
 It took 11 hours.
56. Let  $x$  = number of hours  
 $63x$  = labor cost  
 $63x + 532 = 1603$   
 $63x = 1071$   
 $x = 17$   
 17 hours were required to repair the yacht.
57. Let  $x$  = inches over 5 feet  
 $100 + 5x = 135$   
 $5x = 35$   
 $x = 7$   
 A height of 5 feet 7 inches corresponds to 135 pounds.
58. Let  $g$  = the gross amount of the paycheck  
 Yearly Salary =  $2(12)g + 750$   
 $33150 = 24g + 750$   
 $32400 = 24g$   
 $1350 = g$   
 The gross amount of each paycheck is \$1350.

59. Let
- $x$
- = the weight of unpeeled bananas.

$$\frac{7}{8}x = \text{weight of peeled bananas}$$

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

$$\frac{1}{8}x = \frac{7}{8}$$

$$x = 7$$

The banana with peel weighs 7 ounces.

60. Let
- $x$
- = the length of the call.

$$0.43 + 0.32(x - 1) + 2.10 = 5.73$$

$$0.43 + 0.32x - 0.32 + 2.10 = 5.73$$

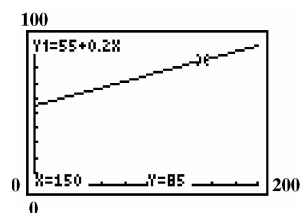
$$0.32x + 2.21 = 5.73$$

$$0.32x = 3.52$$

$$x = 11$$

The person talked for 11 minutes.

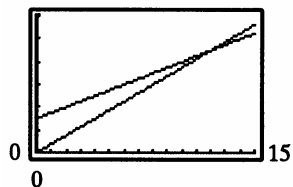
67. Consider Exercise 25.



The life expectancy will be 85 years in the year  
 $1900 + 150 = 2050$ .

68. a.
- $F = 30 + 5x$
- 
- $F = 7.5x$

- b. 120



- c. Calculator shows the graphs to intersect at
- $(12, 90)$
- ; the two options both cost \$90 when 12 hours court time is used per month.

- d.
- $30 + 5x = 7.5x$
- 
- $30 = 2.5x$
- 
- $x = 12$

Rent the court 12 hours per month.

- 69.
- $.1x + .9(1000 - x) = 420$

$$.1 + 900 - .9x = 420$$

$$-.8x = -480$$

$$x = 600$$

600 students at the north campus, 400 students at south campus.

70. Let
- $x$
- = original price

$$x - 0.4x = 0.6x = \text{price after first reduction}$$

$$0.6x - 0.4(0.6x) = \text{price after second reduction}$$

$$0.6x - 0.24x = 72$$

$$0.36x = 72$$

$$x = 200$$

The original price was \$200.

71. Let
- $x$
- = woman's age

$$3x = \text{Coburn's age}$$

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

$$3x + 20 = 2x + 40$$

$$x + 20 = 40$$

$$x = 20$$

Coburn is 60 years old the woman is 20 years old.

72. Let
- $x$
- = correct answers

$$26 - x = \text{incorrect answers}$$

$$8x - 5(26 - x) = 0$$

$$8x - 130 + 5x = 0$$

$$13x - 130 = 0$$

$$13x = 130$$

$$x = 10$$

10 problems were solved correctly.

73. Let
- $x$
- = mother's amount

$$2x = \text{boy's amount}$$

$$\frac{x}{2} = \text{girl's amount}$$

$$x + 2x + \frac{x}{2} = 14,000$$

$$\frac{7}{2}x = 14,000$$

$$x = \$4,000$$

The mother received \$4000, the boy received \$8000, and the girl received \$2000.

74. Let  $x$  = the number of plants originally stolen  
 After passing the first security guard, the thief  
 has:  $x - \left(\frac{1}{2}x + 2\right) = x - \frac{1}{2}x - 2 = \frac{1}{2}x - 2$   
 After passing the second security guard, the thief  
 has:  $\frac{1}{2}x - 2 - \left(\frac{\frac{1}{2}x - 2}{2} + 2\right) = \frac{1}{4}x - 3$   
 After passing the third security guard, the thief  
 has:  $\frac{1}{4}x - 3 - \left(\frac{\frac{1}{4}x - 3}{4} + 2\right) = \frac{1}{8}x - \frac{7}{2}$   
 Thus,  $\frac{1}{8}x - \frac{7}{2} = 1$   
 $x - 28 = 8$   
 $x = 36$   
 The thief stole 36 plants.

## Section 2.3

## Check Point Exercises

1. a.  $(5 - 2i) + (3 + 3i)$   
 $= 5 - 2i + 3 + 3i$   
 $= (5 + 3) + (-2 + 3)i$   
 $= 8 + i$
- b.  $(2 + 6i) - (12 - i)$   
 $= 2 + 6i - 12 + i$   
 $= (2 - 12) + (6 + 1)i$   
 $= -10 + 7i$
2. a.  $7i(2 - 9i) = 7i(2) - 7i(9i)$   
 $= 14i - 63i^2$   
 $= 14i - 63(-1)$   
 $= 63 + 14i$
- b.  $(5 + 4i)(6 - 7i) = 30 - 35i + 24i - 28i^2$   
 $= 30 - 35i + 24i - 28(-1)$   
 $= 30 + 28 - 35i + 24i$   
 $= 58 - 11i$

$$\begin{aligned}
 3. \quad \frac{5+4i}{4-i} &= \frac{5+4i}{4-i} \cdot \frac{4+i}{4+i} \\
 &= \frac{20+5i+16i+4i^2}{16+4i-4i-i^2} \\
 &= \frac{20+21i-4}{16+1} \\
 &= \frac{16+21i}{17} \\
 &= \frac{16}{17} + \frac{21}{17}i
 \end{aligned}$$

$$\begin{aligned}
 4. \quad \text{a.} \quad & \\
 \text{b.} \quad & (-2 + \sqrt{-3})^2 = (-2 + i\sqrt{3})^2 \\
 &= (-2)^2 + 2(-2)(i\sqrt{3}) + (i\sqrt{3})^2 \\
 &= 4 - 4i\sqrt{3} + 3i^2 \\
 &= 4 - 4i\sqrt{3} + 3(-1) \\
 &= 1 - 4i\sqrt{3}
 \end{aligned}$$

$$\begin{aligned}
 \text{c.} \quad \frac{-14 + \sqrt{-12}}{2} &= \frac{-14 + i\sqrt{12}}{2} \\
 &= \frac{-14 + 2i\sqrt{3}}{2} \\
 &= \frac{-14}{2} + \frac{2i\sqrt{3}}{2} \\
 &= -7 + i\sqrt{3}
 \end{aligned}$$

## Exercise Set 2.3

1.  $(7 + 2i) + (1 - 4i) = 7 + 2i + 1 - 4i$   
 $= 7 + 1 + 2i - 4i$   
 $= 8 - 2i$
2.  $(-2 + 6i) + \sqrt{-27} + \sqrt{-48} = i\sqrt{27} + i\sqrt{48} \quad (4 -$   
 $= i\sqrt{9 \cdot 3} + i\sqrt{16 \cdot 3}$   
 $= 3i\sqrt{3} + 4i\sqrt{3}$   
 $= 7i\sqrt{3}$   
 $i)$   
 $= -2 + 6i + 4 - i$   
 $= -2 + 4 + 6i - i$   
 $= 2 + 5i$
3.  $(3 + 2i) - (5 - 7i) = 3 - 5 + 2i + 7i$   
 $= 3 + 2i - 5 + 7i$   
 $= -2 + 9i$

$$\begin{aligned} 4. \quad (-7 + 5i) - (-9 - 11i) &= -7 + 5i + 9 + 11i \\ &= -7 + 9 + 5i + 11i \\ &= 2 + 16i \end{aligned}$$

$$\begin{aligned} 5. \quad 6 - (-5 + 4i) - (-13 - i) &= 6 + 5 - 4i + 13 + i \\ &= 24 - 3i \end{aligned}$$

$$\begin{aligned} 6. \quad 7 - (-9 + 2i) - (-17 - i) &= 7 + 9 - 2i + 17 + i \\ &= 33 - i \end{aligned}$$

$$\begin{aligned} 7. \quad 8i - (14 - 9i) &= 8i - 14 + 9i \\ &= -14 + 8i + 9i \\ &= -14 + 17i \end{aligned}$$

$$\begin{aligned} 8. \quad 15i - (12 - 11i) &= 15i - 12 + 11i \\ &= -12 + 15i + 11i \\ &= -12 + 26i \end{aligned}$$

$$\begin{aligned} 9. \quad -3i(7i - 5) &= -21i^2 + 15i \\ &= -21(-1) + 15i \\ &= 21 + 15i \end{aligned}$$

$$\begin{aligned} 10. \quad -8i(2i - 7) &= -16i^2 + 56i = -16(-1) + 56i \\ &= 9 - 25i^2 = 9 + 25 = 34 = 16 + 56i \end{aligned}$$

$$\begin{aligned} 11. \quad (-5 + 4i)(3 + i) &= -15 - 5i + 12i + 4i^2 \\ &= -15 + 7i - 4 \\ &= -19 + 7i \end{aligned}$$

$$\begin{aligned} 12. \quad (-4 - 8i)(3 + i) &= -12 - 4i - 24i - 8i^2 \\ &= -12 - 28i + 8 \\ &= -4 - 28i \end{aligned}$$

$$\begin{aligned} 13. \quad (7 - 5i)(-2 - 3i) &= -14 - 21i + 10i + 15i^2 \\ &= -14 - 15 - 11i \\ &= -29 - 11i \end{aligned}$$

$$\begin{aligned} 14. \quad (8 - 4i)(-3 + 9i) &= -24 + 72i + 12i - 36i^2 \\ &= -24 + 36 + 84i \\ &= 12 + 84i \end{aligned}$$

$$15. \quad (3 + 5i)(3 - 5i)$$

$$16. \quad (2 + 7i)(2 - 7i) = 4 - 49i^2 = 4 + 49 = 53$$

$$\begin{aligned} 17. \quad (-5 + i)(-5 - i) &= 25 + 5i - 5i - i^2 \\ &= 25 + 1 \\ &= 26 \end{aligned}$$

$$\begin{aligned} 18. \quad (-7 + i)(-7 - i) &= 49 + 7i - 7i - i^2 \\ &= 49 + 1 \\ &= 50 \end{aligned}$$

$$\begin{aligned} 19. \quad (2 + 3i)^2 &= 4 + 12i + 9i^2 \\ &= 4 + 12i - 9 \\ &= -5 + 12i \end{aligned}$$

$$\begin{aligned} 20. \quad (5 - 2i)^2 &= 25 - 20i + 4i^2 \\ &= 25 - 20i - 4 \\ &= 21 - 20i \end{aligned}$$

$$\begin{aligned} 21. \quad \frac{2}{3-i} &= \frac{2}{3-i} \cdot \frac{3+i}{3+i} \\ &= \frac{2(3+i)}{9+1} \\ &= \frac{2(3+i)}{10} \\ &= \frac{3+i}{5} \\ &= \frac{3}{5} + \frac{1}{5}i \end{aligned}$$

$$\begin{aligned} 22. \quad \frac{3}{4+i} &= \frac{3}{4+i} \cdot \frac{4-i}{4-i} \\ &= \frac{3(4-i)}{16-i^2} \\ &= \frac{3(4-i)}{17} \\ &= \frac{12}{17} - \frac{3}{17}i \end{aligned}$$

$$23. \quad \frac{2i}{1+i} = \frac{2i}{1+i} \cdot \frac{1-i}{1-i} = \frac{2i-2i^2}{1+1} = \frac{2+2i}{2} = 1+i$$

$$\begin{aligned} 24. \quad \frac{5i}{2-i} &= \frac{5i}{2-i} \cdot \frac{2+i}{2+i} \\ &= \frac{10i+5i^2}{4+1} \\ &= \frac{-5+10i}{5} \\ &= -1+2i \end{aligned}$$

$$\begin{aligned}
 25. \quad \frac{8i}{4-3i} &= \frac{8i}{4-3i} \cdot \frac{4+3i}{4+3i} \\
 &= \frac{32i + 24i^2}{16+9} \\
 &= \frac{-24+32i}{25} \\
 &= -\frac{24}{25} + \frac{32}{25}i
 \end{aligned}$$

$$\begin{aligned}
 26. \quad \frac{-6i}{3+2i} &= \frac{-6i}{3+2i} \cdot \frac{3-2i}{3-2i} = \frac{-18i+12i^2}{9+4} \\
 &= \frac{-12-18i}{13} = -\frac{12}{13} - \frac{18}{13}i
 \end{aligned}$$

$$\begin{aligned}
 27. \quad \frac{2+3i}{2+i} &= \frac{2+3i}{2+i} \cdot \frac{2-i}{2-i} \\
 &= \frac{4+4i-3i^2}{4+1} \\
 &= \frac{7+4i}{5} \\
 &= \frac{7}{5} + \frac{4}{5}i
 \end{aligned}$$

$$\begin{aligned}
 28. \quad \frac{3-4i}{4+3i} &= \frac{3-4i}{4+3i} \cdot \frac{4-3i}{4-3i} \\
 &= \frac{12-25i+12i^2}{16+9} \\
 &= \frac{-25i}{25} \\
 &= -i
 \end{aligned}$$

$$\begin{aligned}
 29. \quad \sqrt{-64} - \sqrt{-25} &= i\sqrt{64} - i\sqrt{25} \\
 &= 8i - 5i = 3i
 \end{aligned}$$

$$\begin{aligned}
 30. \quad \sqrt{-81} - \sqrt{-144} &= i\sqrt{81} - i\sqrt{144} = 9i - 12i \\
 &= -3i
 \end{aligned}$$

$$\begin{aligned}
 31. \quad 5\sqrt{-16} + 3\sqrt{-81} &= 5(4i) + 3(9i) \\
 &= 20i + 27i = 47i
 \end{aligned}$$

$$\begin{aligned}
 32. \quad 5\sqrt{-8} + 3\sqrt{-18} \\
 &= 5i\sqrt{8} + 3i\sqrt{18} = 5i\sqrt{4 \cdot 2} + 3i\sqrt{9 \cdot 2} \\
 &= 10i\sqrt{2} + 9i\sqrt{2} \\
 &= 19i\sqrt{2}
 \end{aligned}$$

$$\begin{aligned}
 33. \quad (-2 + \sqrt{-4})^2 &= (-2 + 2i)^2 \\
 &= 4 - 8i + 4i^2 \\
 &= 4 - 8i - 4 \\
 &= -8i
 \end{aligned}$$

$$\begin{aligned}
 34. \quad (-5 - \sqrt{-9})^2 &= (-5 - i\sqrt{9})^2 = (-5 - 3i)^2 \\
 &= 25 + 30i + 9i^2 \\
 &= 25 + 30i - 9 \\
 &= 16 + 30i
 \end{aligned}$$

$$\begin{aligned}
 35. \quad (-3 - \sqrt{-7})^2 &= (-3 - i\sqrt{7})^2 \\
 &= 9 + 6i\sqrt{7} + i^2(7) \\
 &= 9 - 7 + 6i\sqrt{7} \\
 &= 2 + 6i\sqrt{7}
 \end{aligned}$$

$$\begin{aligned}
 36. \quad (-2 + \sqrt{-11})^2 &= (-2 + i\sqrt{11})^2 \\
 &= 4 - 4i\sqrt{11} + i^2(11) \\
 &= 4 - 11 - 4i\sqrt{11} \\
 &= -7 - 4i\sqrt{11}
 \end{aligned}$$

$$\begin{aligned}
 37. \quad \frac{-8 + \sqrt{-32}}{24} &= \frac{-8 + i\sqrt{32}}{24} \\
 &= \frac{-8 + i\sqrt{16 \cdot 2}}{24} \\
 &= \frac{-8 + 4i\sqrt{2}}{24} \\
 &= -\frac{1}{3} + \frac{\sqrt{2}}{6}i
 \end{aligned}$$

$$\begin{aligned}
 38. \quad \frac{-12 + \sqrt{-28}}{32} &= \frac{-12 + i\sqrt{28}}{32} = \frac{-12 + i\sqrt{4 \cdot 7}}{32} \\
 &= \frac{-12 + 2i\sqrt{7}}{32} = -\frac{3}{8} + \frac{\sqrt{7}}{16}i
 \end{aligned}$$

$$\begin{aligned}
 39. \quad \frac{-6 - \sqrt{-12}}{48} &= \frac{-6 - i\sqrt{12}}{48} \\
 &= \frac{-6 - i\sqrt{4 \cdot 3}}{48} \\
 &= \frac{-6 - 2i\sqrt{3}}{48} \\
 &= -\frac{1}{8} - \frac{\sqrt{3}}{24}i
 \end{aligned}$$

$$\begin{aligned}
 40. \quad \frac{-15 - \sqrt{-18}}{33} &= \frac{-15 - i\sqrt{18}}{33} = \frac{-15 - i\sqrt{9 \cdot 2}}{33} \\
 &= \frac{-15 - 3i\sqrt{2}}{33} = -\frac{5}{11} - \frac{\sqrt{2}}{11}i
 \end{aligned}$$

$$\begin{aligned}
 41. \quad \sqrt{-8}(\sqrt{-3} - \sqrt{5}) &= i\sqrt{8}(i\sqrt{3} - \sqrt{5}) \\
 &= 2i\sqrt{2}(i\sqrt{3} - \sqrt{5}) \\
 &= -2\sqrt{6} - 2i\sqrt{10}
 \end{aligned}$$

$$\begin{aligned}
 42. \quad \sqrt{-12}(\sqrt{-4} - \sqrt{2}) &= i\sqrt{12}(i\sqrt{4} - \sqrt{2}) \\
 &= 2i\sqrt{3}(2i - \sqrt{2}) \\
 &= 4i^2\sqrt{3} - 2i\sqrt{6} \\
 &= -4\sqrt{3} - 2i\sqrt{6}
 \end{aligned}$$

$$\begin{aligned}
 43. \quad (3\sqrt{-5})(-4\sqrt{-12}) &= (3i\sqrt{5})(-8i\sqrt{3}) \\
 &= -24i^2\sqrt{15} \\
 &= 24\sqrt{15}
 \end{aligned}$$

$$\begin{aligned}
 44. \quad (3\sqrt{-7})(2\sqrt{-8}) &= (3i\sqrt{7})(2i\sqrt{8}) = (3i\sqrt{7})(2i\sqrt{4 \cdot 2}) \\
 &= (3i\sqrt{7})(4i\sqrt{2}) = 12i^2\sqrt{14} = -12\sqrt{14}
 \end{aligned}$$

$$\begin{aligned}
 45. \quad (2-3i)(1-i) - (3-i)(3+i) &= (2-2i-3i+3i^2) - (3^2 - i^2) \\
 &= 2-5i+3i^2-9+i^2 \\
 &= -7-5i+4i^2 \\
 &= -7-5i+4(-1) \\
 &= -11-5i
 \end{aligned}$$

$$\begin{aligned}
 46. \quad (8+9i)(2-i) - (1-i)(1+i) &= (16-8i+18i-9i^2) - (1^2 - i^2) \\
 &= 16+10i-9i^2-1+i^2 \\
 &= 15+10i-8i^2 \\
 &= 15+10i-8(-1) \\
 &= 23+10i
 \end{aligned}$$

$$\begin{aligned}
 47. \quad (2+i)^2 - (3-i)^2 &= (4+4i+i^2) - (9-6i+i^2) \\
 &= 4+4i+i^2-9+6i-i^2 \\
 &= -5+10i
 \end{aligned}$$

$$\begin{aligned}
 48. \quad (4-i)^2 - (1+2i)^2 &= (16-8i+i^2) - (1+4i+4i^2) \\
 &= 16-8i+i^2-1-4i-4i^2 \\
 &= 15-12i-3i^2 \\
 &= 15-12i-3(-1) \\
 &= 18-12i
 \end{aligned}$$

$$\begin{aligned}
 49. \quad 5\sqrt{-16} + 3\sqrt{-81} &= 5\sqrt{16}\sqrt{-1} + 3\sqrt{81}\sqrt{-1} \\
 &= 5 \cdot 4i + 3 \cdot 9i \\
 &= 20i + 27i \\
 &= 47i \quad \text{or} \quad 0 + 47i
 \end{aligned}$$

$$\begin{aligned}
 50. \quad 5\sqrt{-8} + 3\sqrt{-18} &= 5\sqrt{4}\sqrt{2}\sqrt{-1} + 3\sqrt{9}\sqrt{2}\sqrt{-1} \\
 &= 5 \cdot 2\sqrt{2}i + 3 \cdot 3\sqrt{2}i \\
 &= 10i\sqrt{2} + 9i\sqrt{2} \\
 &= (10+9)i\sqrt{2} \\
 &= 19i\sqrt{2} \quad \text{or} \quad 0 + 19i\sqrt{2}
 \end{aligned}$$

$$\begin{aligned}
 51. \quad f(x) &= x^2 - 2x + 2 \\
 f(1+i) &= (1+i)^2 - 2(1+i) + 2 \\
 &= 1+2i+i^2-2-2i+2 \\
 &= 1+i^2 \\
 &= 1-1 \\
 &= 0
 \end{aligned}$$

$$\begin{aligned}
 52. \quad f(x) &= x^2 - 2x + 5 \\
 f(1-2i) &= (1-2i)^2 - 2(1-2i) + 5 \\
 &= 1-4i+4i^2-2+4i+5 \\
 &= 4+4i^2 \\
 &= 4-4 \\
 &= 0
 \end{aligned}$$

$$\begin{aligned}
 53. \quad (fg)(-1) &= (-1-3i)(4(-1)+2i) \\
 &= (-1-3i)(-4+2i) \\
 &= 4-2i+12i-6i^2 \\
 &= 4+10i+6 \\
 &= 10+10i
 \end{aligned}$$

$$\begin{aligned}
 54. \quad (fg)\left(-\frac{1}{3}\right) &= \left(12\left(-\frac{1}{3}\right) - i\right)\left(6\left(-\frac{1}{3}\right) + 3i\right) \\
 &= (-4 - i)(-2 + 3i) \\
 &= 8 - 12i + 2i - 3i^2 \\
 &= 8 - 10i + 3 \\
 &= 11 - 10i
 \end{aligned}$$

$$\begin{aligned}
 55. \quad f(x) &= \frac{x^2 + 19}{2 - x} \\
 f(3i) &= \frac{(3i)^2 + 19}{2 - 3i} \\
 &= \frac{9i^2 + 19}{2 - 3i} \\
 &= \frac{-9 + 19}{2 - 3i} \\
 &= \frac{10}{2 - 3i} \\
 &= \frac{10}{2 - 3i} \cdot \frac{2 + 3i}{2 + 3i} \\
 &= \frac{20 + 30i}{4 - 9i^2} \\
 &= \frac{20 + 30i}{4 + 9} \\
 &= \frac{20 + 30i}{13} \\
 &= \frac{20}{13} + \frac{30}{13}i
 \end{aligned}$$

$$\begin{aligned}
 56. \quad f(x) &= \frac{x^2 + 11}{3 - x} \\
 f(4i) &= \frac{(4i)^2 + 11}{3 - 4i} = \frac{16i^2 + 11}{3 - 4i} \\
 &= \frac{-16 + 11}{3 - 4i} \\
 &= \frac{-5}{3 - 4i} \\
 &= \frac{-5}{3 - 4i} \cdot \frac{3 + 4i}{3 + 4i} \\
 &= \frac{-15 - 20i}{9 - 16i^2} \\
 &= \frac{-15 - 20i}{9 + 16} \\
 &= \frac{-15 - 20i}{25} \\
 &= \frac{-15}{25} - \frac{20}{25}i \\
 &= -\frac{3}{5} - \frac{4}{5}i
 \end{aligned}$$

$$\begin{aligned}
 57. \quad E = IR &= (4 - 5i)(3 + 7i) \\
 &= 12 + 28i - 15i - 35i^2 \\
 &= 12 + 13i - 35(-1) \\
 &= 12 + 35 + 13i = 47 + 13i \\
 \text{The voltage of the circuit is} \\
 & (47 + 13i) \text{ volts.}
 \end{aligned}$$

$$\begin{aligned}
 58. \quad E = IR &= (2 - 3i)(3 + 5i) \\
 &= 6 + 10i - 9i - 15i^2 = 6 + i - 15(-1) \\
 &= 6 + i + 15 = 21 + i \\
 \text{The voltage of the circuit is } & (21 + i) \text{ volts.}
 \end{aligned}$$

$$\begin{aligned}
 59. \quad \text{Sum:} \\
 & (5 + i\sqrt{15}) + (5 - i\sqrt{15}) \\
 &= 5 + i\sqrt{15} + 5 - i\sqrt{15} \\
 &= 5 + 5 \\
 &= 10 \\
 \text{Product:} \\
 & (5 + i\sqrt{15})(5 - i\sqrt{15}) \\
 &= 25 - 5i\sqrt{15} + 5i\sqrt{15} - 15i^2 \\
 &= 25 + 15 \\
 &= 40
 \end{aligned}$$

69. a. False; all irrational numbers are complex numbers.

b. False;  $(3 + 7i)(3 - 7i) = 9 + 49 = 58$  is a real number.

c. False;  $\frac{7+3i}{5+3i} = \frac{7+3i}{5+3i} \cdot \frac{5-3i}{5-3i}$   
 $= \frac{44-6i}{34} = \frac{22}{17} - \frac{3}{17}i$

d. True;

$$(x + yi)(x - yi) = x^2 - (yi)^2 = x^2 + y^2$$

(d) is true.

$$\begin{aligned} 70. \quad \frac{4}{(2+i)(3-i)} &= \frac{4}{6-2i+3i-i^2} \\ &= \frac{4}{6+i+1} \\ &= \frac{4}{7+i} \\ &= \frac{4}{7+i} \cdot \frac{7-i}{7-i} \\ &= \frac{28-4i}{49-i^2} \\ &= \frac{28-4i}{49+1} \\ &= \frac{28-4i}{50} \\ &= \frac{28}{50} - \frac{4}{50}i \\ &= \frac{14}{25} - \frac{2}{25}i \end{aligned}$$

$$\begin{aligned} 71. \quad \frac{1+i}{1+2i} + \frac{1-i}{1-2i} &= \frac{(1+i)(1-2i)}{(1+2i)(1-2i)} + \frac{(1-i)(1+2i)}{(1-2i)(1+2i)} \\ &= \frac{(1+i)(1-2i) + (1-i)(1+2i)}{(1+2i)(1-2i)} \\ &= \frac{1-2i+i-2i^2 + 1+2i-i-2i^2}{1-4i^2} \\ &= \frac{1-2i+i+2+1+2i-i+2}{1+4} \\ &= \frac{6}{5} \\ &= \frac{6}{5} + 0i \end{aligned}$$

$$\begin{aligned} 72. \quad \frac{8}{1+\frac{2}{i}} &= \frac{8}{\frac{i}{i} + \frac{2}{i}} \\ &= \frac{8}{\frac{2+i}{i}} \\ &= \frac{8i}{2+i} \\ &= \frac{8i}{2+i} \cdot \frac{2-i}{2-i} \\ &= \frac{16i-8i^2}{4-i^2} \\ &= \frac{16i+8}{4+1} \\ &= \frac{8+16i}{5} \\ &= \frac{8}{5} + \frac{16}{5}i \end{aligned}$$

## Section 2.4

### Check Point Exercises

1. a.  $3x^2 - 9x = 0$   
 $3x(x-3) = 0$   
 $3x = 0$  or  $x-3 = 0$   
 $x = 0$  or  $x = 3$   
The solution set is  $\{0, 3\}$ .

b.  $2x^2 + x = 1$   
 $2x^2 + x - 1 = 0$   
 $(2x-1)(x+1) = 0$   
 $2x-1 = 0$  or  $x+1 = 0$   
 $2x = 1$  or  $x = -1$   
 $x = \frac{1}{2}$  or  $x = -1$   
The solution set is  $\left\{-1, \frac{1}{2}\right\}$ .

2. a.  $3x^2 = 21$   
 $\frac{3x^2}{3} = \frac{21}{3}$   
 $x^2 = 7$   
 $x = \pm\sqrt{7}$   
The solution set is  $\{-\sqrt{7}, \sqrt{7}\}$ .

b.  $5x^2 + 45 = 0$

$$5x^2 = -45$$

$$x^2 = -9$$

$$x = \pm\sqrt{-9}$$

$$x = \pm 3i$$

c.  $(x+5)^2 = 11$

$$x+5 = \pm\sqrt{11}$$

$$x = -5 \pm \sqrt{11}$$

The solution set is  $\{-5 + \sqrt{11}, -5 - \sqrt{11}\}$ .

3.  $x^2 + 4x - 1 = 0$

$$x^2 + 4x = 1$$

$$x^2 + 4x + 4 = 1 + 4$$

$$(x+2)^2 = 5$$

$$x+2 = \pm\sqrt{5}$$

$$x = -2 \pm \sqrt{5}$$

4.  $2x^2 + 3x - 4 = 0$

$$x^2 + \frac{3}{2}x - 2 = 0$$

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

$$x^2 + \frac{3}{2}x + \frac{9}{16} = 2 + \frac{9}{16}$$

$$\left(x + \frac{3}{4}\right)^2 = \frac{41}{16}$$

$$x + \frac{3}{4} = \pm\sqrt{\frac{41}{16}}$$

$$x + \frac{3}{4} = \pm\frac{\sqrt{41}}{4}$$

$$x = -\frac{3}{4} \pm \frac{\sqrt{41}}{4}$$

$$x = \frac{-3 \pm \sqrt{41}}{4}$$

5.  $2x^2 + 2x - 1 = 0$

$$a = 2, b = 2, c = -1$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$= \frac{-2 \pm \sqrt{2^2 - 4(2)(-1)}}{2(2)}$$

$$= \frac{-2 \pm \sqrt{4+8}}{4}$$

$$= \frac{-2 \pm \sqrt{12}}{4}$$

$$= \frac{-2 \pm 2\sqrt{3}}{4}$$

$$= \frac{2(-1 \pm \sqrt{3})}{4}$$

$$= \frac{-1 \pm \sqrt{3}}{2}$$

The solution set is  $\left\{\frac{-1+\sqrt{3}}{2}, \frac{-1-\sqrt{3}}{2}\right\}$ .

6.  $x^2 - 2x + 2 = 0$

$$a = 1, b = -2, c = 2$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$x = \frac{-(-2) \pm \sqrt{(-2)^2 - 4(1)(2)}}{2(1)}$$

$$x = \frac{2 \pm \sqrt{4-8}}{2}$$

$$x = \frac{2 \pm \sqrt{-4}}{2}$$

$$x = \frac{2 \pm 2i}{2}$$

$$x = 1 \pm i$$

The solution set is  $\{1+i, 1-i\}$ .

7. a.  $a = 1, b = 6, c = 9$

$$b^2 - 4ac = (6)^2 - 4(1)(9)$$

$$= 36 - 36$$

$$= 0$$

Since  $b^2 - 4ac = 0$ , the equation has one real solution.

b.  $a = 2, b = -7, c = -4$

$$\begin{aligned} b^2 - 4ac &= (-7)^2 - 4(2)(-4) \\ &= 49 + 32 \\ &= 81 \end{aligned}$$

Since  $b^2 - 4ac > 0$ , the equation has two real solutions. Since 81 is a perfect square, the two solutions are rational.

c.  $a = 3, b = -2, c = 4$

$$\begin{aligned} b^2 - 4ac &= (-2)^2 - 4(3)(4) \\ &= 4 - 48 \\ &= -44 \end{aligned}$$

Since  $b^2 - 4ac < 0$ , the equation has two imaginary solutions that are complex conjugates.

8.  $P = 0.01A^2 + 0.05A + 107$

$$115 = 0.01A^2 + 0.05A + 107$$

$$0 = 0.01A^2 + 0.05A - 8$$

$$a = 0.01, b = 0.05, c = -8$$

$$A = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$A = \frac{-(0.05) \pm \sqrt{(0.05)^2 - 4(0.01)(-8)}}{2(0.01)}$$

$$A = \frac{-0.05 \pm \sqrt{0.3225}}{0.02}$$

$$A \approx \frac{-0.05 + \sqrt{0.3225}}{0.02} \quad A \approx \frac{-0.05 - \sqrt{0.3225}}{0.02}$$

$$A \approx 26$$

$$A \approx -31$$

Age cannot be negative, reject the negative answer.

Thus, a woman whose normal systolic blood pressure is 115 mm Hg is 26 years old.

9.  $w^2 + 9^2 = 15^2$

$$w^2 + 81 = 225$$

$$w^2 = 144$$

$$w = \pm\sqrt{144}$$

$$w = \pm 12$$

The width of the television is 12 inches.

### Exercise Set 2.4

1.  $x^2 - 3x - 10 = 0$

$$(x + 2)(x - 5) = 0$$

$$x + 2 = 0 \quad \text{or} \quad x - 5 = 0$$

$$x = -2 \quad \text{or} \quad x = 5$$

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

2.  $x^2 - 13x + 36 = 0$

$$(x - 4)(x - 9) = 0$$

$$x - 4 = 0 \quad \text{or} \quad x - 9 = 0$$

$$x = 4 \quad \text{or} \quad x = 9$$

The solution set is  $\{4, 9\}$ .

3.  $x^2 = 8x - 15$

$$x^2 - 8x + 15 = 0$$

$$(x - 3)(x - 5) = 0$$

$$x - 3 = 0 \quad \text{or} \quad x - 5 = 0$$

$$x = 3 \quad \text{or} \quad x = 5$$

The solution set is  $\{3, 5\}$ .

4.  $x^2 = -11x - 10$

$$x^2 + 11x + 10 = 0$$

$$(x + 10)(x + 1) = 0$$

$$x + 10 = 0 \quad \text{or} \quad x + 1 = 0$$

$$x = -10 \quad \text{or} \quad x = -1$$

The solution set is  $\{-10, -1\}$ .

5.  $6x^2 + 11x - 10 = 0$

$$(2x + 5)(3x - 2) = 0$$

$$2x + 5 = 0 \quad \text{or} \quad 3x - 2 = 0$$

$$2x = -5 \quad 3x = 2$$

$$x = -\frac{5}{2} \quad \text{or} \quad x = \frac{2}{3}$$

The solution set is  $\left\{-\frac{5}{2}, \frac{2}{3}\right\}$ .

6.  $9x^2 + 9x + 2 = 0$

$$(3x + 2)(3x + 1) = 0$$

$$3x + 2 = 0 \quad \text{or} \quad 3x + 1 = 0$$

$$x = -\frac{2}{3} \quad \text{or} \quad x = -\frac{1}{3}$$

The solution set is  $\left\{-\frac{2}{3}, -\frac{1}{3}\right\}$ .

$$\begin{aligned}
 7. \quad & 3x^2 - 2x = 8 \\
 & 3x^2 - 2x - 8 = 0 \\
 & (3x + 4)(x - 2) = 0 \\
 & 3x + 4 = 0 \quad \text{or} \quad x - 2 = 0 \\
 & 3x = -4 \\
 & x = -\frac{4}{3} \quad \text{or} \quad x = 2
 \end{aligned}$$

The solution set is  $\left\{-\frac{4}{3}, 2\right\}$ .

$$\begin{aligned}
 8. \quad & 4x^2 - 13x = -3 \\
 & 4x^2 - 13x + 3 = 0 \\
 & (4x - 1)(x - 3) = 0 \\
 & 4x - 1 = 0 \quad \text{or} \quad x - 3 = 0 \\
 & 4x = 1 \\
 & x = \frac{1}{4} \quad \text{or} \quad x = 3
 \end{aligned}$$

The solution set is  $\left\{\frac{1}{4}, 3\right\}$ .

$$\begin{aligned}
 9. \quad & 3x^2 + 12x = 0 \\
 & 3x(x + 4) = 0 \\
 & 3x = 0 \quad \text{or} \quad x + 4 = 0 \\
 & x = 0 \quad \text{or} \quad x = -4 \\
 & \text{The solution set is } \{-4, 0\}.
 \end{aligned}$$

$$\begin{aligned}
 10. \quad & 5x^2 - 20x = 0 \\
 & 5x(x - 4) = 0 \\
 & 5x = 0 \quad \text{or} \quad x - 4 = 0 \\
 & x = 0 \quad \text{or} \quad x = 4 \\
 & \text{The solution set is } \{0, 4\}.
 \end{aligned}$$

$$\begin{aligned}
 11. \quad & 2x(x - 3) = 5x^2 - 7x \\
 & 2x^2 - 6x - 5x^2 + 7x = 0 \\
 & -3x^2 + x = 0 \\
 & x(-3x + 1) = 0 \\
 & x = 0 \quad \text{or} \quad -3x + 1 = 0 \\
 & \quad \quad -3x = -1 \\
 & \quad \quad x = \frac{1}{3}
 \end{aligned}$$

The solution set is  $\left\{0, \frac{1}{3}\right\}$ .

$$\begin{aligned}
 12. \quad & 16x(x - 2) = 8x - 25 \\
 & 16x^2 - 32x - 8x + 25 = 0 \\
 & \quad \quad 16x^2 - 40x + 25 = 0 \\
 & \quad \quad (4x - 5)(4x - 5) = 0 \\
 & \quad \quad \quad 4x - 5 = 0 \\
 & \quad \quad \quad 4x = 5 \\
 & \quad \quad \quad x = \frac{5}{4}
 \end{aligned}$$

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

$$\begin{aligned}
 13. \quad & 7 - 7x = (3x + 2)(x - 1) \\
 & 7 - 7x = 3x^2 - x - 2 \\
 & 7 - 7x - 3x^2 + x + 2 = 0 \\
 & -3x^2 - 6x + 9 = 0 \\
 & -3(x + 3)(x - 1) = 0 \\
 & x + 3 = 0 \quad \text{or} \quad x - 1 = 0 \\
 & x = -3 \quad \text{or} \quad x = 1
 \end{aligned}$$

The solution set is  $\{-3, 1\}$ .

$$\begin{aligned}
 14. \quad & 10x - 1 = (2x + 1)^2 \\
 & 10x - 1 = 4x^2 + 4x + 1 \\
 & 10x - 1 - 4x^2 - 4x - 1 = 0 \\
 & \quad \quad -4x^2 + 6x - 2 = 0 \\
 & \quad \quad -2(2x - 1)(x - 1) = 0 \\
 & 2x - 1 = 0 \quad \text{or} \quad x - 1 = 0 \\
 & 2x = 1 \\
 & x = \frac{1}{2} \quad \text{or} \quad x = 1
 \end{aligned}$$

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

$$\begin{aligned}
 15. \quad & 3x^2 = 27 \\
 & x^2 = 9 \\
 & x = \pm\sqrt{9} = \pm 3 \\
 & \text{The solution set is } \{-3, 3\}.
 \end{aligned}$$

$$\begin{aligned}
 16. \quad & 5x^2 = 45 \\
 & x^2 = 9 \\
 & x = \pm\sqrt{9} = \pm 3 \\
 & \text{The solution set is } \{-3, 3\}.
 \end{aligned}$$

$$\begin{aligned}
 17. \quad & 5x^2 + 1 = 51 \\
 & 5x^2 = 50 \\
 & x^2 = 10 \\
 & x = \pm\sqrt{10} \\
 & \text{The solution set is } \{-\sqrt{10}, \sqrt{10}\}.
 \end{aligned}$$

18.  $3x^2 - 1 = 47$

$3x^2 = 48$

$x^2 = 16$

$x = \pm\sqrt{16} = \pm 4$

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

19.  $2x^2 - 5 = -55$

$2x^2 = -50$

$x^2 = -25$

$x = \pm\sqrt{-25} = \pm 5i$

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

20.  $2x^2 - 7 = -15$

$2x^2 = -8$

$x^2 = -4$

$x = \pm\sqrt{-4} = \pm 2i$

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

21.  $(x+2)^2 = 25$

$x+2 = \pm\sqrt{25}$

$x+2 = \pm 5$

$x = -2 \pm 5$

$x = -2 + 5 \quad \text{or} \quad x = -2 - 5$

$x = 3 \quad \quad \quad x = -7$

The solution set is  $\{-7, 3\}$ .

22.  $(x-3)^2 = 36$

$x-3 = \pm\sqrt{36}$

$x-3 = \pm 6$

$x = 3 \pm 6$

$x = 3 + 6 \quad \text{or} \quad x = 3 - 6$

$x = 9 \quad \quad \quad x = -3$

The solution set is  $\{-3, 9\}$ .

23.  $3(x-4)^2 = 15$

$(x-4)^2 = 5$

$x-4 = \pm\sqrt{5}$

$x = 4 \pm \sqrt{5}$

The solution set is  $\{4 + \sqrt{5}, 4 - \sqrt{5}\}$ .

24.  $3(x+4)^2 = 21$

$(x+4)^2 = 7$

$x+4 = \pm\sqrt{7}$

$x = -4 \pm \sqrt{7}$

The solution set is  $\{-4 + \sqrt{7}, -4 - \sqrt{7}\}$ .

25.  $(x+3)^2 = -16$

$x+3 = \pm\sqrt{-16}$

$x+3 = \pm 4i$

$x = -3 \pm 4i$

The solution set is  $\{-3 + 4i, -3 - 4i\}$ .

26.  $(x-1)^2 = -9$

$x-1 = \pm\sqrt{-9}$

$x-1 = \pm 3i$

$x = 1 \pm 3i$

The solution set is  $\{1 + 3i, 1 - 3i\}$ .

27.  $(x-3)^2 = -5$

$x-3 = \pm\sqrt{-5}$

$x-3 = \pm i\sqrt{5}$

$x = 3 \pm i\sqrt{5}$

The solution set is  $\{3 + i\sqrt{5}, 3 - i\sqrt{5}\}$ .

28.  $(x+2)^2 = -7$

$x+2 = \pm\sqrt{-7}$

$x+2 = \pm i\sqrt{7}$

$x = -2 \pm i\sqrt{7}$

The solution set is  $\{-2 + i\sqrt{7}, -2 - i\sqrt{7}\}$ .

29.  $(3x+2)^2 = 9$

$3x+2 = \pm\sqrt{9} = \pm 3$

$3x+2 = -3 \quad \text{or} \quad 3x+2 = 3$

$3x = -5 \quad \quad \quad 3x = 1$

$x = -\frac{5}{3} \quad \quad \quad \text{or} \quad x = \frac{1}{3}$

The solution set is  $\{-\frac{5}{3}, \frac{1}{3}\}$ .

30.  $(4x-1)^2 = 16$

$$4x-1 = \pm\sqrt{16} = \pm 4$$

$$4x-1 = -4 \quad \text{or} \quad 4x-1 = 4$$

$$4x = -3 \quad \quad \quad 4x = 5$$

$$x = \frac{-3}{4} \quad \quad \quad \text{or} \quad x = \frac{5}{4}$$

The solution set is  $\left\{-\frac{3}{4}, \frac{5}{4}\right\}$ .

31.  $(5x-1)^2 = 7$

$$5x-1 = \pm\sqrt{7}$$

$$5x = 1 \pm \sqrt{7}$$

$$x = \frac{1 \pm \sqrt{7}}{5}$$

The solution set is  $\left\{\frac{1-\sqrt{7}}{5}, \frac{1+\sqrt{7}}{5}\right\}$ .

32.  $(8x-3)^2 = 5$

$$8x-3 = \pm\sqrt{5}$$

$$8x = 3 \pm \sqrt{5}$$

$$x = \frac{3 \pm \sqrt{5}}{8}$$

The solution set is  $\left\{\frac{3-\sqrt{5}}{8}, \frac{3+\sqrt{5}}{8}\right\}$ .

33.  $(3x-4)^2 = 8$

$$3x-4 = \pm\sqrt{8} = \pm 2\sqrt{2}$$

$$3x = 4 \pm 2\sqrt{2}$$

$$x = \frac{4 \pm 2\sqrt{2}}{3}$$

The solution set is  $\left\{\frac{4-2\sqrt{2}}{3}, \frac{4+2\sqrt{2}}{3}\right\}$ .

34.  $(2x+8)^2 = 27$

$$2x+8 = \pm\sqrt{27} = \pm 3\sqrt{3}$$

$$2x = -8 \pm 3\sqrt{3}$$

$$x = \frac{-8 \pm 3\sqrt{3}}{2}$$

The solution set is  $\left\{\frac{-8-3\sqrt{3}}{2}, \frac{-8+3\sqrt{3}}{2}\right\}$ .

35.  $x^2 + 6x = 7$

$$x^2 + 6x + 9 = 7 + 9$$

$$(x+3)^2 = 16$$

$$x+3 = \pm 4$$

$$x = -3 \pm 4$$

The solution set is  $\{-7, 1\}$ .

36.  $x^2 + 6x = -8$

$$x^2 + 6x + 9 = -8 + 9$$

$$(x+3)^2 = 1$$

$$x+3 = \pm 1$$

$$x = -3 \pm 1$$

The solution set is  $\{-4, -2\}$ .

37.  $x^2 - 2x = 2$

$$x^2 - 2x + 1 = 2 + 1$$

$$(x-1)^2 = 3$$

$$x-1 = \pm\sqrt{3}$$

$$x = 1 \pm \sqrt{3}$$

The solution set is  $\{1+\sqrt{3}, 1-\sqrt{3}\}$ .

38.  $x^2 + 4x = 12$

$$x^2 + 4x + 4 = 12 + 4$$

$$(x+2)^2 = 16$$

$$x+2 = \pm 4$$

$$x = -2 \pm 4$$

The solution set is  $\{-6, 2\}$ .

39.  $x^2 - 6x - 11 = 0$

$$x^2 - 6x = 11$$

$$x^2 - 6x + 9 = 11 + 9$$

$$(x-3)^2 = 20$$

$$x-3 = \pm\sqrt{20}$$

$$x = 3 \pm 2\sqrt{5}$$

The solution set is  $\{3+2\sqrt{5}, 3-2\sqrt{5}\}$ .

40.  $x^2 - 2x - 5 = 0$

$$x^2 - 2x = 5$$

$$x^2 - 2x + 1 = 5 + 1$$

$$(x-1)^2 = 6$$

$$x-1 = \pm\sqrt{6}$$

$$x = 1 \pm \sqrt{6}$$

The solution set is  $\{1 + \sqrt{6}, 1 - \sqrt{6}\}$ .

41.  $x^2 + 4x + 1 = 0$

$$x^2 + 4x = -1$$

$$x^2 + 4x + 4 = -1 + 4$$

$$(x+2)^2 = 3$$

$$x+2 = \pm\sqrt{3}$$

$$x = -2 \pm \sqrt{3}$$

The solution set is  $\{-2 + \sqrt{3}, -2 - \sqrt{3}\}$ .

42.  $x^2 + 6x - 5 = 0$

$$x^2 + 6x = 5$$

$$x^2 + 6x + 9 = 5 + 9$$

$$(x+3)^2 = 14$$

$$x+3 = \pm\sqrt{14}$$

$$x = -3 \pm \sqrt{14}$$

The solution set is  $\{-3 + \sqrt{14}, -3 - \sqrt{14}\}$ .

43.  $x^2 - 5x + 6 = 0$

$$x^2 - 5x = -6$$

$$x^2 - 5x + \frac{25}{4} = -6 + \frac{25}{4}$$

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

$$x - \frac{5}{2} = \pm\sqrt{\frac{1}{4}}$$

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

$$x = \frac{5}{2} \pm \frac{1}{2}$$

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

$$x = 3 \quad \quad \quad x = 2$$

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

44.  $x^2 + 7x - 8 = 0$

$$x^2 + 7x = 8$$

$$x^2 + 7x + \frac{49}{4} = 8 + \frac{49}{4}$$

$$\left(x + \frac{7}{2}\right)^2 = \frac{81}{4}$$

$$x + \frac{7}{2} = \pm\sqrt{\frac{81}{4}}$$

$$x + \frac{7}{2} = \pm\frac{9}{2}$$

$$x = -\frac{7}{2} \pm \frac{9}{2}$$

$$x = -\frac{7}{2} + \frac{9}{2} \quad \text{or} \quad x = -\frac{7}{2} - \frac{9}{2}$$

$$x = 1 \quad \quad \quad x = -8$$

The solution set is  $\{-8, 1\}$ .

45.  $x^2 + 3x - 1 = 0$

$$x^2 + 3x = 1$$

$$x^2 + 3x + \frac{9}{4} = 1 + \frac{9}{4}$$

$$\left(x + \frac{3}{2}\right)^2 = \frac{13}{4}$$

$$x + \frac{3}{2} = \pm\sqrt{\frac{13}{4}}$$

$$x = \frac{-3 \pm \sqrt{13}}{2}$$

The solution set is  $\left\{\frac{-3 + \sqrt{13}}{2}, \frac{-3 - \sqrt{13}}{2}\right\}$ .

46.  $x^2 - 3x - 5 = 0$

$$x^2 - 3x = 5$$

$$x^2 - 3x + \frac{9}{4} = 5 + \frac{9}{4}$$

$$\left(x - \frac{3}{2}\right)^2 = \frac{29}{4}$$

$$x - \frac{3}{2} = \pm\sqrt{\frac{29}{4}}$$

$$x = \frac{3 \pm \sqrt{29}}{2}$$

The solution set is  $\left\{\frac{3 + \sqrt{29}}{2}, \frac{3 - \sqrt{29}}{2}\right\}$ .

47.  $2x^2 - 7x + 3 = 0$

$$x^2 - \frac{7}{2}x + \frac{3}{2} = 0$$

$$x^2 - \frac{7}{2}x = -\frac{3}{2}$$

$$x^2 - \frac{7}{2}x + \frac{49}{16} = -\frac{3}{2} + \frac{49}{16}$$

$$\left(x - \frac{7}{4}\right)^2 = \frac{25}{16}$$

$$x - \frac{7}{4} = \pm \frac{5}{4}$$

$$x = \frac{7}{4} \pm \frac{5}{4}$$

The solution set is  $\left\{\frac{1}{2}, 3\right\}$ .

48.  $2x^2 + 5x - 3 = 0$

$$x^2 + \frac{5}{2}x - \frac{3}{2} = 0$$

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

$$x^2 + \frac{5}{2}x + \frac{25}{16} = \frac{3}{2} + \frac{25}{16}$$

$$\left(x + \frac{5}{4}\right)^2 = \frac{49}{16}$$

$$x + \frac{5}{4} = \pm \frac{7}{4}$$

$$x = -\frac{5}{4} \pm \frac{7}{4}$$

$$x = \frac{1}{2}; -3$$

The solution set is  $\left\{-3, \frac{1}{2}\right\}$ .

49.  $4x^2 - 4x - 1 = 0$

$$4x^2 - 4x - 1 = 0$$

$$x^2 - x - \frac{1}{4} = 0$$

$$x^2 - x = \frac{1}{4}$$

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

$$\left(x - \frac{1}{2}\right)^2 = \frac{2}{4}$$

$$x - \frac{1}{2} = \pm \frac{\sqrt{2}}{2}$$

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

The solution set is  $\left\{\frac{1+\sqrt{2}}{2}, \frac{1-\sqrt{2}}{2}\right\}$ .

50.  $2x^2 - 4x - 1 = 0$

$$x^2 - 2x - \frac{1}{2} = 0$$

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

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

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

$$x-1 = \pm \sqrt{\frac{3}{2}}$$

$$x = 1 \pm \frac{\sqrt{6}}{2}$$

$$x = \frac{2 \pm \sqrt{6}}{2}$$

The solution set is  $\left\{\frac{2+\sqrt{6}}{2}, \frac{2-\sqrt{6}}{2}\right\}$ .

51.  $3x^2 - 2x - 2 = 0$

$$x^2 - \frac{2}{3}x - \frac{2}{3} = 0$$

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

$$x^2 - \frac{2}{3}x + \frac{1}{9} = \frac{2}{3} + \frac{1}{9}$$

$$\left(x - \frac{1}{3}\right)^2 = \frac{7}{9}$$

$$x - \frac{1}{3} = \frac{\pm\sqrt{7}}{3}$$

$$x = \frac{1 \pm \sqrt{7}}{3}$$

The solution set is  $\left\{\frac{1+\sqrt{7}}{3}, \frac{1-\sqrt{7}}{3}\right\}$ .

52.  $3x^2 - 5x - 10 = 0$

$$x^2 - \frac{5}{3}x - \frac{10}{3} = 0$$

$$x^2 - \frac{5}{3}x = \frac{10}{3}$$

$$x^2 - \frac{5}{3}x + \frac{25}{36} = \frac{10}{3} + \frac{25}{36}$$

$$\left(x - \frac{5}{6}\right)^2 = \frac{145}{36}$$

$$x - \frac{5}{6} = \frac{\pm\sqrt{145}}{6}$$

$$x = \frac{5 \pm \sqrt{145}}{6}$$

The solution set is  $\left\{\frac{5+\sqrt{145}}{6}, \frac{5-\sqrt{145}}{6}\right\}$ .

53.  $x^2 + 8x + 15 = 0$

$$x = \frac{-8 \pm \sqrt{8^2 - 4(1)(15)}}{2(1)}$$

$$x = \frac{-8 \pm \sqrt{64 - 60}}{2}$$

$$x = \frac{-8 \pm \sqrt{4}}{2}$$

$$x = \frac{-8 \pm 2}{2}$$

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

54.  $x^2 + 8x + 12 = 0$

$$x = \frac{-8 \pm \sqrt{8^2 - 4(1)(12)}}{2(1)}$$

$$x = \frac{-8 \pm \sqrt{64 - 48}}{2}$$

$$x = \frac{-8 \pm \sqrt{16}}{2}$$

$$x = \frac{-8 \pm 4}{2}$$

The solution set is  $\{-6, -2\}$ .

55.  $x^2 + 5x + 3 = 0$

$$x = \frac{-5 \pm \sqrt{5^2 - 4(1)(3)}}{2(1)}$$

$$x = \frac{-5 \pm \sqrt{25 - 12}}{2}$$

$$x = \frac{-5 \pm \sqrt{13}}{2}$$

The solution set is  $\left\{\frac{-5+\sqrt{13}}{2}, \frac{-5-\sqrt{13}}{2}\right\}$ .

56.  $x^2 + 5x + 2 = 0$

$$x = \frac{-5 \pm \sqrt{5^2 - 4(1)(2)}}{2(1)}$$

$$x = \frac{-5 \pm \sqrt{25 - 8}}{2}$$

$$x = \frac{-5 \pm \sqrt{17}}{2}$$

The solution set is  $\left\{\frac{-5+\sqrt{17}}{2}, \frac{-5-\sqrt{17}}{2}\right\}$ .

57.  $3x^2 - 3x - 4 = 0$

$$x = \frac{3 \pm \sqrt{(-3)^2 - 4(3)(-4)}}{2(3)}$$

$$x = \frac{3 \pm \sqrt{9 + 48}}{6}$$

$$x = \frac{3 \pm \sqrt{57}}{6}$$

The solution set is  $\left\{\frac{3+\sqrt{57}}{6}, \frac{3-\sqrt{57}}{6}\right\}$ .

58.  $5x^2 + x - 2 = 0$

$$x = \frac{-1 \pm \sqrt{1^2 - 4(5)(-2)}}{2(5)}$$

$$x = \frac{-1 \pm \sqrt{1+40}}{10}$$

$$x = \frac{-1 \pm \sqrt{41}}{10}$$

The solution set is  $\left\{ \frac{-1 + \sqrt{41}}{10}, \frac{-1 - \sqrt{41}}{10} \right\}$ .

59.  $4x^2 = 2x + 7$

$$4x^2 - 2x - 7 = 0$$

$$x = \frac{2 \pm \sqrt{(-2)^2 - 4(4)(-7)}}{2(4)}$$

$$x = \frac{2 \pm \sqrt{4+112}}{8}$$

$$x = \frac{2 \pm \sqrt{116}}{8}$$

$$x = \frac{2 \pm 2\sqrt{29}}{8}$$

$$x = \frac{1 \pm \sqrt{29}}{4}$$

The solution set is  $\left\{ \frac{1 + \sqrt{29}}{4}, \frac{1 - \sqrt{29}}{4} \right\}$ .

60.  $3x^2 = 6x - 1$

$$3x^2 - 6x + 1 = 0$$

$$x = \frac{6 \pm \sqrt{(-6)^2 - 4(3)(1)}}{2(3)}$$

$$x = \frac{6 \pm \sqrt{36-12}}{6}$$

$$x = \frac{6 \pm \sqrt{24}}{6}$$

$$x = \frac{6 \pm 2\sqrt{6}}{6}$$

$$x = \frac{3 \pm \sqrt{6}}{3}$$

The solution set is  $\left\{ \frac{3 + \sqrt{6}}{3}, \frac{3 - \sqrt{6}}{3} \right\}$ .

61.  $x^2 - 6x + 10 = 0$

$$x = \frac{6 \pm \sqrt{(-6)^2 - 4(1)(10)}}{2(1)}$$

$$x = \frac{6 \pm \sqrt{36-40}}{2}$$

$$x = \frac{6 \pm \sqrt{-4}}{2}$$

$$x = \frac{6 \pm 2i}{2}$$

$$x = 3 \pm i$$

The solution set is  $\{3 + i, 3 - i\}$ .

62.  $x^2 - 2x + 17 = 0$

$$x = \frac{2 \pm \sqrt{(-2)^2 - 4(1)(17)}}{2(1)}$$

$$x = \frac{2 \pm \sqrt{4-68}}{2}$$

$$x = \frac{2 \pm \sqrt{-64}}{2}$$

$$x = \frac{2 \pm 8i}{2}$$

$$x = 1 \pm 4i$$

The solution set is  $\{1 + 4i, 1 - 4i\}$ .

63.  $x^2 - 4x - 5 = 0$

$$(-4)^2 - 4(1)(-5)$$

$$= 16 + 20$$

$$= 36; 2 \text{ unequal real solutions}$$

64.  $4x^2 - 2x + 3 = 0$

$$(-2)^2 - 4(4)(3)$$

$$= 4 - 48$$

$$= -44; 2 \text{ complex imaginary solutions}$$

65.  $2x^2 - 11x + 3 = 0$

$$(-11)^2 - 4(2)(3)$$

$$= 121 - 24$$

$$= 97; 2 \text{ unequal real solutions}$$

66.  $2x^2 + 11x - 6 = 0$

$$11^2 - 4(2)(-6)$$

$$= 121 + 48$$

$$= 169; 2 \text{ unequal real solutions}$$

67.  $x^2 - 2x + 1 = 0$

$$(-2)^2 - 4(1)(1)$$

$$= 4 - 4$$

$$= 0; 1 \text{ real solution}$$

68.  $3x^2 = 2x - 1$

$$3x^2 - 2x + 1 = 0$$

$$(-2)^2 - 4(3)(1)$$

$$= 4 - 12$$

$$= -8; 2 \text{ complex imaginary solutions}$$

69.  $x^2 - 3x - 7 = 0$

$$(-3)^2 - 4(1)(-7)$$

$$= 9 + 28$$

$$= 37; 2 \text{ unequal real solutions}$$

70.  $3x^2 + 4x - 2 = 0$

$$4^2 - 4(3)(-2)$$

$$= 16 + 24$$

$$= 40; 2 \text{ unequal real solutions}$$

71.

$$2x^2 - x = 1$$

$$2x^2 - x - 1 = 0$$

$$(2x+1)(x-1) = 0$$

$$2x+1 = 0 \text{ or } x-1 = 0$$

$$2x = -1$$

$$x = -\frac{1}{2} \text{ or } x = 1$$

$$\text{The solution set is } \left\{-\frac{1}{2}, 1\right\}.$$

72.  $3x^2 - 4x = 4$

$$3x^2 - 4x - 4 = 0$$

$$(3x+2)(x-2) = 0$$

$$3x+2 \text{ or } x-2 = 0$$

$$3x = -2$$

$$x = -\frac{2}{3} \text{ or } x = -3$$

$$\text{The solution set is } \left\{-\frac{2}{3}, -3\right\}.$$

73.  $5x^2 + 2 = 11x$

$$5x^2 - 11x + 2 = 0$$

$$(5x-1)(x-2) = 0$$

$$5x-1 = 0 \text{ or } x-2 = 0$$

$$5x = 1$$

$$x = \frac{1}{5} \text{ or } x = 2$$

$$\text{The solution set is } \left\{\frac{1}{5}, 2\right\}.$$

74.  $5x^2 = 6 - 13x$

$$5x^2 + 13x - 6 = 0$$

$$(5x-2)(x+3) = 0$$

$$5x-2 = 0 \text{ or } x+3 = 0$$

$$5x = 2$$

$$x = \frac{2}{5} \text{ or } x = -3$$

$$\text{The solution set is } \left\{\frac{2}{5}, -3\right\}.$$

75.  $3x^2 = 60$

$$x^2 = 20$$

$$x = \pm\sqrt{20}$$

$$x = \pm 2\sqrt{5}$$

$$\text{The solution set is } \{-2\sqrt{5}, 2\sqrt{5}\}.$$

76.  $2x^2 = 250$

$$x^2 = 125$$

$$x = \pm\sqrt{125}$$

$$x = \pm 5\sqrt{5}$$

$$\text{The solution set is } \{-5\sqrt{5}, 5\sqrt{5}\}.$$

77.  $x^2 - 2x = 1$

$$x^2 - 2x + 1 = 1 + 1$$

$$(x-1)^2 = 2$$

$$x-1 = \pm\sqrt{2}$$

$$x = 1 \pm \sqrt{2}$$

$$\text{The solution set is } \{1+\sqrt{2}, 1-\sqrt{2}\}.$$

78.  $2x^2 + 3x = 1$

$$2x^2 + 3x - 1 = 0$$

$$x = \frac{-3 \pm \sqrt{3^2 - 4(2)(-1)}}{2(2)}$$

$$x = \frac{-3 \pm \sqrt{9+8}}{4}$$

$$x = \frac{-3 \pm \sqrt{17}}{4}$$

The solution set is  $\left\{ \frac{-3 + \sqrt{17}}{4}, \frac{-3 - \sqrt{17}}{4} \right\}$ .

79.  $(2x+3)(x+4) = 1$

$$2x^2 + 8x + 3x + 12 = 1$$

$$2x^2 + 11x + 11 = 0$$

$$x = \frac{-11 \pm \sqrt{11^2 - 4(2)(11)}}{2(2)}$$

$$x = \frac{-11 \pm \sqrt{121-88}}{4}$$

$$x = \frac{-11 \pm \sqrt{33}}{4}$$

The solution set is  $\left\{ \frac{-11 + \sqrt{33}}{4}, \frac{-11 - \sqrt{33}}{4} \right\}$ .

80.  $(2x-5)(x+1) = 2$

$$2x^2 + 2x - 5x - 5 = 2$$

$$2x^2 - 3x - 7 = 0$$

$$x = \frac{3 \pm \sqrt{(-3)^2 - 4(2)(-7)}}{2(2)}$$

$$x = \frac{3 \pm \sqrt{9+56}}{4}$$

$$x = \frac{3 \pm \sqrt{65}}{4}$$

The solution set is  $\left\{ \frac{3 + \sqrt{65}}{4}, \frac{3 - \sqrt{65}}{4} \right\}$ .

81.  $(3x-4)^2 = 16$

$$3x-4 = \pm\sqrt{16}$$

$$3x-4 = \pm 4$$

$$3x = 4 \pm 4$$

$$3x = 8 \text{ or } 3x = 0$$

$$x = \frac{8}{3} \text{ or } x = 0$$

The solution set is  $\left\{ 0, \frac{8}{3} \right\}$ .

82.  $(2x+7)^2 = 25$

$$2x+7 = \pm 5$$

$$2x = -7 \pm 5$$

$$2x = -12 \text{ or } 2x = -2$$

$$x = 6 \text{ or } x = -1$$

The solution set is  $\{-6, -1\}$ .

83.  $3x^2 - 12x + 12 = 0$

$$x^2 - 4x + 4 = 0$$

$$(x-2)(x-2) = 0$$

$$x-2 = 0$$

$$x = 2$$

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

84.  $9 - 6x + x^2 = 0$

$$x^2 - 6x + 9 = 0$$

$$(x-3)(x-3) = 0$$

$$x-3 = 0$$

$$x = 3$$

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

85.  $4x^2 - 16 = 0$

$$4x^2 = 16$$

$$x^2 = 4$$

$$x = \pm 2$$

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

86.  $3x^2 - 27 = 0$

$$3x^2 = 27$$

$$x^2 = 9$$

$$x = \pm 3$$

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

87.  $x^2 - 6x + 13 = 0$

$$x^2 - 6x = -13$$

$$x^2 - 6x + 9 = -13 + 9$$

$$(x-3)^2 = -4$$

$$x-3 = \pm 2i$$

$$x = 3 \pm 2i$$

The solution set is  $\{3+2i, 3-2i\}$ .

88.  $x^2 - 4x + 29 = 0$

$$x^2 - 4x = -29$$

$$x^2 - 4x + 4 = -29 + 4$$

$$(x-2)^2 = -25$$

$$x-2 = \pm 5i$$

$$x = 2 \pm 5i$$

The solution set is  $\{2+5i, 2-5i\}$ .

89.  $x^2 = 4x - 7$

$$x^2 - 4x = -7$$

$$x^2 - 4x + 4 = -7 + 4$$

$$(x-2)^2 = -3$$

$$x-2 = \pm i\sqrt{3}$$

$$x = 2 \pm i\sqrt{3}$$

The solution set is  $\{2+i\sqrt{3}, 2-i\sqrt{3}\}$ .

90.  $5x^2 = 2x - 3$

$$5x^2 - 2x + 3 = 0$$

$$x = \frac{2 \pm \sqrt{(-2)^2 - 4(5)(3)}}{2(5)}$$

$$x = \frac{2 \pm \sqrt{4-60}}{10}$$

$$x = \frac{2 \pm \sqrt{-56}}{10}$$

$$x = \frac{2 \pm 2i\sqrt{14}}{10}$$

$$x = \frac{1 \pm i\sqrt{14}}{5}$$

The solution set is  $\left\{\frac{1+i\sqrt{14}}{5}, \frac{1-i\sqrt{14}}{5}\right\}$ .

91.  $2x^2 - 7x = 0$

$$x(2x-7) = 0$$

$$x = 0 \text{ or } 2x-7 = 0$$

$$2x = 7$$

$$x = 0 \text{ or } x = \frac{7}{2}$$

The solution set is  $\left\{0, \frac{7}{2}\right\}$ .

92.  $2x^2 + 5x = 3$

$$2x^2 + 5x - 3 = 0$$

$$x = \frac{-5 \pm \sqrt{5^2 - 4(2)(-3)}}{2(2)}$$

$$x = \frac{-5 \pm \sqrt{25+24}}{4}$$

$$x = \frac{-5 \pm \sqrt{49}}{4}$$

$$x = \frac{-5 \pm 7}{4}$$

$$x = -3, \frac{1}{2}$$

The solution set is  $\left\{-3, \frac{1}{2}\right\}$ .

93.  $\frac{1}{x} + \frac{1}{x+2} = \frac{1}{3}; x \neq 0, -2$

$$3x+6+3x = x^2+2x$$

$$0 = x^2 - 4x - 6$$

$$x = \frac{-(-4) \pm \sqrt{(-4)^2 - 4(1)(-6)}}{2(1)}$$

$$x = \frac{4 \pm \sqrt{16+24}}{2}$$

$$x = \frac{4 \pm \sqrt{40}}{2}$$

$$x = \frac{4 \pm 2\sqrt{10}}{2}$$

$$x = 2 \pm \sqrt{10}$$

The solution set is  $\{2+\sqrt{10}, 2-\sqrt{10}\}$ .

94.  $\frac{1}{x} + \frac{1}{x+3} = \frac{1}{4}; x \neq 0, -3$

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

$$0 = x^2 - 5x - 12$$

$$x = \frac{-(-5) \pm \sqrt{(-5)^2 - 4(1)(-12)}}{2(1)}$$

$$x = \frac{5 \pm \sqrt{25 + 48}}{2}$$

$$x = \frac{5 \pm \sqrt{73}}{2}$$

The solution set is  $\left\{ \frac{5 + \sqrt{73}}{2}, \frac{5 - \sqrt{73}}{2} \right\}$ .

95.  $\frac{2x}{x-3} + \frac{6}{x+3} = \frac{-28}{x^2-9}; x \neq 3, -3$

$$2x(x+3) + 6(x-3) = -28$$

$$2x^2 + 6x + 6x - 18 = -28$$

$$2x^2 + 12x + 10 = 0$$

$$x^2 + 6x + 5 = 0$$

$$(x+1)(x+5) = 0$$

The solution set is  $\{-5, -1\}$ .

96.  $\frac{3}{x-3} + \frac{5}{x-4} = \frac{x^2-20}{x^2-7x+12}; x \neq 3, 4$

$$3x - 12 + 5x - 15 = x^2 - 20$$

$$0 = x^2 - 8x + 7$$

$$0 = (x-7)(x-1)$$

$$x = 7 \quad x = 1$$

The solution set is  $\{1, 7\}$ .

97.  $x^2 - 4x - 5 = 0$

$$(x+1)(x-5) = 0$$

$$x+1=0 \quad \text{or} \quad x-5=0$$

$$x=-1 \quad \text{or} \quad x=5$$

This equation matches graph (d).

98.  $x^2 - 6x + 7 = 0$

$$a=1, \quad b=-6, \quad c=7$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$x = \frac{-(-6) \pm \sqrt{(-6)^2 - 4(1)(7)}}{2(1)}$$

$$x = \frac{6 \pm \sqrt{8}}{2}$$

$$x = 3 \pm \sqrt{2}$$

$$x \approx 1.6, \quad x \approx 4.4$$

This equation matches graph (a).

99.  $0 = -(x+1)^2 + 4$

$$(x+1)^2 = 4$$

$$x+1 = \pm 2$$

$$x = -1 \pm 2$$

$$x = -3, \quad x = 1$$

This equation matches graph (f).

100.  $0 = -(x+3)^2 + 1$

$$(x+3)^2 = 1$$

$$x+3 = \pm 1$$

$$x = -3 \pm 1$$

$$x = -4, \quad x = -2$$

This equation matches graph (e).

101.  $x^2 - 2x + 2 = 0$

$$a=1, \quad b=-2, \quad c=2$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$x = \frac{-(-2) \pm \sqrt{(-2)^2 - 4(1)(2)}}{2(1)}$$

$$x = \frac{2 \pm \sqrt{-4}}{2}$$

$$x = \frac{2 \pm 2i}{2}$$

$$x = 1 \pm i$$

This equation has no real roots. Thus, its equation has no x-intercepts. This equation matches graph (b).

102.  $x^2 + 6x + 9 = 0$

$$(x+3)(x+3) = 0$$

$$x+3 = 0$$

$$x = -3$$

This equation matches graph (c).

$$103. \quad y = 2x^2 - 3x$$

$$2 = 2x^2 - 3x$$

$$0 = 2x^2 - 3x - 2$$

$$0 = (2x+1)(x-2)$$

$$x = -\frac{1}{2}, \quad x = 2$$

$$104. \quad y = 5x^2 + 3x$$

$$2 = 5x^2 + 3x$$

$$0 = 5x^2 + 3x - 2$$

$$0 = (x+1)(5x-2)$$

$$x = -1, \quad x = \frac{2}{5}$$

$$107. \quad y_1 + y_2 = 1$$

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

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

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

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

$$2x^2 + 8x + 3x + 6 = x^2 + 6x + 8$$

$$x^2 + 5x - 2 = 0$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$x = \frac{-(5) \pm \sqrt{(5)^2 - 4(1)(-2)}}{2(1)}$$

$$x = \frac{-5 \pm \sqrt{33}}{2}$$

$$\text{The solution set is } \left\{ \frac{-5 + \sqrt{33}}{2}, \frac{-5 - \sqrt{33}}{2} \right\}.$$

$$105. \quad y_1 y_2 = 14$$

$$(x-1)(x+4) = 14$$

$$x^2 + 3x - 4 = 14$$

$$x^2 + 3x - 18 = 0$$

$$(x+6)(x-3) = 0$$

$$x = -6, \quad x = 3$$

$$106. \quad y_1 y_2 = -30$$

$$(x-3)(x+8) = -30$$

$$x^2 + 5x - 24 = -30$$

$$x^2 + 5x + 6 = 0$$

$$(x+3)(x+2) = 0$$

$$x = -3, \quad x = -2$$

108.

$$y_1 + y_2 = 3$$

$$\frac{3}{x-1} + \frac{8}{x} = 3$$

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

$$\frac{3x(x-1)}{x-1} + \frac{8x(x-1)}{x} = 3x(x-1)$$

$$3x + 8(x-1) = 3x^2 - 3x$$

$$3x + 8x - 8 = 3x^2 - 3x$$

$$11x - 8 = 3x^2 - 3x$$

$$0 = 3x^2 - 14x + 8$$

$$0 = (3x-2)(x-4)$$

$$x = \frac{2}{3}, \quad x = 4$$

The solution set is  $\left\{\frac{2}{3}, 4\right\}$ .

109.

$$y_1 - y_2 = 0$$

$$(2x^2 + 5x - 4) - (-x^2 + 15x - 10) = 0$$

$$2x^2 + 5x - 4 + x^2 - 15x + 10 = 0$$

$$3x^2 - 10x + 6 = 0$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$x = \frac{-(-10) \pm \sqrt{(-10)^2 - 4(3)(6)}}{2(3)}$$

$$x = \frac{10 \pm \sqrt{28}}{6}$$

$$x = \frac{10 \pm 2\sqrt{7}}{6}$$

$$x = \frac{5 \pm \sqrt{7}}{3}$$

The solution set is  $\left\{\frac{5+\sqrt{7}}{3}, \frac{5-\sqrt{7}}{3}\right\}$ .

110.

$$y_1 - y_2 = 0$$

$$(-x^2 + 4x - 2) - (-3x^2 + x - 1) = 0$$

$$-x^2 + 4x - 2 + 3x^2 - x + 1 = 0$$

$$2x^2 + 3x - 1 = 0$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$x = \frac{-(-3) \pm \sqrt{(-3)^2 - 4(2)(-1)}}{2(2)}$$

$$x = \frac{-3 \pm \sqrt{17}}{4}$$

The solution set is  $\left\{\frac{-3+\sqrt{17}}{4}, \frac{-3-\sqrt{17}}{4}\right\}$ .

- 111.** Values that make the denominator zero must be excluded.

$$2x^2 + 4x - 9 = 0$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$x = \frac{-(-4) \pm \sqrt{(4)^2 - 4(2)(-9)}}{2(2)}$$

$$x = \frac{-4 \pm \sqrt{88}}{4}$$

$$x = \frac{-4 \pm 2\sqrt{22}}{4}$$

$$x = \frac{-2 \pm \sqrt{22}}{2}$$

- 112.** Values that make the denominator zero must be excluded.

$$2x^2 - 8x + 5 = 0$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$x = \frac{-(-8) \pm \sqrt{(-8)^2 - 4(2)(5)}}{2(2)}$$

$$x = \frac{8 \pm \sqrt{24}}{4}$$

$$x = \frac{8 \pm 2\sqrt{6}}{4}$$

$$x = \frac{4 \pm \sqrt{6}}{2}$$

- 113.**  $(g \circ f)(x) = 50$

$$g(f(x)) = 50$$

$$g(x-3) = 50$$

$$2(x-3)^2 = 50$$

$$(x-3)^2 = 25$$

$$x-3 = \pm\sqrt{25}$$

$$x-3 = \pm 5$$

$$x = 3 \pm 5$$

$$x = -2, 8$$

- 114.**  $(g \circ f)(x) = 12$

$$g(f(x)) = 12$$

$$g(x+4) = 12$$

$$3(x+4)^2 = 12$$

$$(x+4)^2 = 4$$

$$x+4 = \pm\sqrt{4}$$

$$x+4 = \pm 2$$

$$x = -4 \pm 2$$

$$x = -6, -2$$

- 115.**  $(f \circ g)(x) = 7$

$$f(g(x)) = 7$$

$$f(x^2 - 3x + 8) = 7$$

$$2(x^2 - 3x + 8) - 5 = 7$$

$$2x^2 - 6x + 16 - 5 = 7$$

$$2x^2 - 6x + 4 = 0$$

$$x^2 - 3x + 2 = 0$$

$$(x-2)(x-1) = 0$$

$$x = 1, 2$$

- 116.**  $(f \circ g)(x) = -5$

$$f(g(x)) = -5$$

$$f(3x^2 + x - 1) = -5$$

$$1 - 2(3x^2 + x - 1) = -5$$

$$1 - 6x^2 - 2x + 2 = -5$$

$$-6x^2 - 2x + 8 = 0$$

$$3x^2 + x - 4 = 0$$

$$(3x+4)(x-1) = 0$$

$$x = -\frac{4}{3}, 1$$

117.  $x^2 - (6 + 2x) = 0$

$$x^2 - 2x - 6 = 0$$

Apply the quadratic formula.

$$a = 1 \quad b = -2 \quad c = -6$$

$$x = \frac{-(-2) \pm \sqrt{(-2)^2 - 4(1)(-6)}}{2(1)}$$

$$= \frac{2 \pm \sqrt{4 - (-24)}}{2}$$

$$= \frac{2 \pm \sqrt{28}}{2}$$

$$= \frac{2 \pm \sqrt{4 \cdot 7}}{2} = \frac{2 \pm 2\sqrt{7}}{2} = 1 \pm \sqrt{7}$$

We disregard  $1 - \sqrt{7}$  because it is negative, and we are looking for a positive number.

Thus, the number is  $1 + \sqrt{7}$ .

118. Let  $x$  = the number.

$$2x^2 - (1 + 2x) = 0$$

$$2x^2 - 2x - 1 = 0$$

Apply the quadratic formula.

$$a = 2 \quad b = -2 \quad c = -1$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$x = \frac{-(-2) \pm \sqrt{(-2)^2 - 4(2)(-1)}}{2(2)}$$

$$= \frac{2 \pm \sqrt{4 - (-8)}}{4}$$

$$= \frac{2 \pm \sqrt{12}}{4} = \frac{2 \pm \sqrt{4 \cdot 3}}{4} = \frac{2 \pm 2\sqrt{3}}{4} = \frac{1 \pm \sqrt{3}}{2}$$

We disregard  $\frac{1 + \sqrt{3}}{2}$  because it is positive, and we are looking for a negative number. The number is  $\frac{1 - \sqrt{3}}{2}$ .

119.

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

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

Multiply both sides of the equation by the least common denominator,  $(x-1)(x-2)(x+2)$ . This results in the following:

$$x + 2 = (x-1)(x-2) + 5(x-1)$$

$$x + 2 = x^2 - 2x - x + 2 + 5x - 5$$

$$x + 2 = x^2 + 2x - 3$$

$$0 = x^2 + x - 5$$

Apply the quadratic formula:

$$a = 1 \quad b = 1 \quad c = -5$$

$$x = \frac{-1 \pm \sqrt{1^2 - 4(1)(-5)}}{2(1)} = \frac{-1 \pm \sqrt{1 - (-20)}}{2}$$

$$= \frac{-1 \pm \sqrt{21}}{2}$$

The solutions are  $\frac{-1 \pm \sqrt{21}}{2}$ , and the solution set is

$$\left\{ \frac{-1 \pm \sqrt{21}}{2} \right\}.$$

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

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

Multiply both sides of the equation by the least common denominator,  $(x-2)(x-3)$ . This results in the following:

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

$$x^2 - x - 3x + 3 + x^2 - 2x = 1$$

$$2x^2 - 6x + 3 = 1$$

$$2x^2 - 6x + 2 = 0$$

Apply the quadratic formula:

$$a = 2 \quad b = -6 \quad c = 2$$

$$x = \frac{-(-6) \pm \sqrt{(-6)^2 - 4(2)(2)}}{2(2)}$$

$$= \frac{6 \pm \sqrt{36 - 16}}{4} = \frac{6 \pm \sqrt{20}}{4}$$

$$= \frac{6 \pm \sqrt{4 \cdot 5}}{4} = \frac{6 \pm 2\sqrt{5}}{4}$$

$$= \frac{3 \pm \sqrt{5}}{2}$$

The solutions are  $\frac{3 \pm \sqrt{5}}{2}$ , and the solution set is

$$\left\{ \frac{3 \pm \sqrt{5}}{2} \right\}.$$

121.  $\sqrt{2}x^2 + 3x - 2\sqrt{2} = 0$

Apply the quadratic formula:

$$a = \sqrt{2} \quad b = 3 \quad c = -2\sqrt{2}$$

$$x = \frac{-3 \pm \sqrt{3^2 - 4(\sqrt{2})(-2\sqrt{2})}}{2(\sqrt{2})}$$

$$= \frac{-3 \pm \sqrt{9 - (-16)}}{2\sqrt{2}}$$

$$= \frac{-3 \pm \sqrt{25}}{2\sqrt{2}} = \frac{-3 \pm 5}{2\sqrt{2}}$$

Evaluate the expression to obtain two solutions.

$$x = \frac{-3 - 5}{2\sqrt{2}} \quad \text{or} \quad x = \frac{-3 + 5}{2\sqrt{2}}$$

$$= \frac{-8}{2\sqrt{2}} \cdot \frac{\sqrt{2}}{\sqrt{2}} = \frac{2}{2\sqrt{2}} \cdot \frac{\sqrt{2}}{\sqrt{2}}$$

$$= \frac{-8\sqrt{2}}{4} = \frac{2\sqrt{2}}{4}$$

$$= -2\sqrt{2} = \frac{\sqrt{2}}{2}$$

The solutions are  $-2\sqrt{2}$  and  $\frac{\sqrt{2}}{2}$ , and the solution

$$\text{set is } \left\{ -2\sqrt{2}, \frac{\sqrt{2}}{2} \right\}.$$

122.  $\sqrt{3}x^2 + 6x + 7\sqrt{3} = 0$

Apply the quadratic formula:

$$a = \sqrt{3} \quad b = 6 \quad c = 7\sqrt{3}$$

$$x = \frac{-6 \pm \sqrt{6^2 - 4(\sqrt{3})(7\sqrt{3})}}{2(\sqrt{3})}$$

$$= \frac{-6 \pm \sqrt{36 - 84}}{2\sqrt{3}}$$

$$= \frac{-6 \pm \sqrt{-48}}{2\sqrt{3}}$$

$$= \frac{-6 \pm \sqrt{16 \cdot 3 \cdot (-1)}}{2\sqrt{3}}$$

$$= \frac{-6 \pm 4\sqrt{3}i}{2\sqrt{3}}$$

$$= \frac{-6}{2\sqrt{3}} \pm \frac{4\sqrt{3}i}{2\sqrt{3}} = -\sqrt{3} \pm 2i$$

The solutions are  $-\sqrt{3} \pm 2i$ , and the solution

$$\text{set is } \{-\sqrt{3} \pm 2i\}.$$

123.  $f(x) = 0.013x^2 - 1.19x + 28.24$

$$3 = 0.013x^2 - 1.19x + 28.24$$

$$0 = 0.013x^2 - 1.19x + 25.24$$

Apply the quadratic formula:

$$a = 0.013 \quad b = -1.19 \quad c = 25.24$$

$$x = \frac{-(-1.19) \pm \sqrt{(-1.19)^2 - 4(0.013)(25.24)}}{2(0.013)}$$

$$= \frac{1.19 \pm \sqrt{1.4161 - 1.31248}}{0.026}$$

$$= \frac{1.19 \pm \sqrt{0.10362}}{0.026}$$

$$\approx \frac{1.19 \pm 0.32190}{0.026}$$

$$\approx 58.15 \quad \text{or} \quad 33.39$$

The solutions are approximately 33.39 and 58.15.

Thus, 33 year olds and 58 year olds are expected to be in 3 fatal crashes per 100 million miles driven.

The function models the actual data well.

124.  $f(x) = 0.013x^2 - 1.19x + 28.24$

$$10 = 0.013x^2 - 1.19x + 28.24$$

$$0 = 0.013x^2 - 1.19x + 18.24$$

$$a = 0.013 \quad b = -1.19 \quad c = 18.24$$

$$x = \frac{-(-1.19) \pm \sqrt{(-1.19)^2 - 4(0.013)(18.24)}}{2(0.013)}$$

$$= \frac{1.19 \pm \sqrt{1.4161 - 0.94848}}{0.026}$$

$$= \frac{1.19 \pm \sqrt{0.46762}}{0.026} \approx \frac{1.19 \pm 0.68383}{0.026}$$

Evaluate the expression to obtain two solutions.

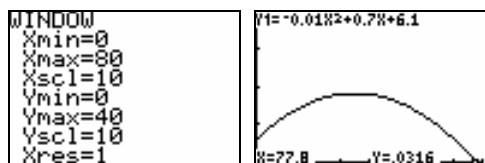
$$x = \frac{1.19 + 0.68383}{0.026} \quad \text{or} \quad x = \frac{1.19 - 0.68383}{0.026}$$

$$x = \frac{1.87383}{0.026} \quad x = \frac{0.50617}{0.026}$$

$$x \approx 72.1 \quad x \approx 19$$

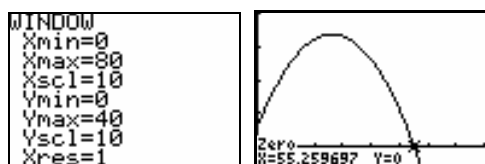
Drivers of approximately age 19 and age 72 are expected to be involved in 10 fatal crashes per 100 million miles driven. The formula does not model the data very well. The formula overestimates the number of fatal accidents.

125. Let  $y_1 = -0.01x^2 + 0.7x + 6.1$



Using the TRACE feature, we find that the height of the shot put is approximately 0 feet when the distance is 77.8 feet. Graph (b) shows the shot's path.

126. Let  $y_1 = -0.04x^2 + 2.1x + 6.1$



Using the ZERO feature, we find that the height of the shot put is approximately 0 feet when the distance is 55.3 feet. Graph (a) shows the shot's path.

127. Ignoring the thickness of the panel, we essentially need to find the diagonal of the rectangular opening.

$$a^2 + b^2 = c^2$$

$$4^2 + 8^2 = c^2$$

$$16 + 64 = c^2$$

$$80 = c^2$$

$$c = \pm\sqrt{80} = \pm 4\sqrt{5}$$

Since we are looking for a length, we discard the negative solution. The solution is  $4\sqrt{5} \approx 8.9$  and we conclude that a panel that is about 8.9 feet long is the longest that can be taken through the door diagonally.

128.  $90^2 + 90^2 = x^2$

$$8100 + 8100 = x^2$$

$$16200 = x^2$$

$$x \approx \pm 127.28$$

The distance is 127.28 feet.

129.  $15^2 + x^2 = 20^2$

$$225 + x^2 = 400$$

$$x^2 = 175$$

$$x \approx \pm 13.23$$

13.23

The ladder reaches 13.23 feet up.

130.  $x^2 + 10^2 = 30^2$

$$x^2 + 100 = 900$$

$$x^2 = 800$$

Apply the square root property.

$$x = \pm\sqrt{800} = \pm\sqrt{400 \cdot 2} = \pm 20\sqrt{2}$$

We disregard  $-20\sqrt{2}$  because we can't have a negative length measurement. The solution is  $20\sqrt{2}$ . We conclude that the ladder reaches  $20\sqrt{2}$  feet, or approximately 28.3 feet, up the house.

131. Let  $w$  = the width

Let  $w + 3$  = the length

$$\text{Area} = lw$$

$$54 = (w + 3)w$$

$$54 = w^2 + 3w$$

$$0 = w^2 + 3w - 54$$

$$0 = (w + 9)(w - 6)$$

Apply the zero product principle.

$$w + 9 = 0$$

$$w - 6 = 0$$

$$w = -9$$

$$w = 6$$

The solution set is  $\{-9, 6\}$ . Disregard  $-9$

because we can't have a negative length measurement. The width is 6 feet and the length is  $6 + 3 = 9$  feet.

132. Let  $w$  = the width

Let  $w + 3$  = the width

$$\text{Area} = lw$$

$$180 = (w + 3)w$$

$$180 = w^2 + 3w$$

$$0 = w^2 + 3w - 180$$

$$0 = (w + 15)(w - 12)$$

$$w + 15 = 0$$

$$w - 12 = 0$$

$$w = -15$$

$$w = 12$$

The width is 12 yards and the length is 12 yards + 3 yards = 15 yards.

- 133.** Let  $x$  = the length of the side of the original square  
Let  $x + 3$  = the length of the side of the new, larger square

$$(x+3)^2 = 64$$

$$x^2 + 6x + 9 = 64$$

$$x^2 + 6x - 55 = 0$$

$$(x+11)(x-5) = 0$$

Apply the zero product principle.

$$x+11=0 \quad x-5=0$$

$$x=-11 \quad x=5$$

The solution set is  $\{-11, 5\}$ . Disregard  $-11$  because we can't have a negative length measurement. This means that  $x$ , the length of the side of the original square, is 5 inches.

- 134.** Let  $x$  = the side of the original square,  
Let  $x + 2$  = the side of the new, larger square

$$(x+2)^2 = 36$$

$$x^2 + 4x + 4 = 36$$

$$x^2 + 4x - 32 = 0$$

$$(x+8)(x-4) = 0$$

$$x+8=0 \quad x-4=0$$

$$\cancel{x=-8} \quad x=4$$

The length of the side of the original square, is 4 inches.

- 135.** Let  $x$  = the width of the path

$$(20+2x)(10+2x) = 600$$

$$200 + 40x + 20x + 4x^2 = 600$$

$$200 + 60x + 4x^2 = 600$$

$$4x^2 + 60x + 200 = 600$$

$$4x^2 + 60x - 400 = 0$$

$$4(x^2 + 15x - 100) = 0$$

$$4(x+20)(x-5) = 0$$

Apply the zero product principle.

$$4(x+20)=0 \quad x-5=0$$

$$x+20=0 \quad x=5$$

$$x=-20$$

The solution set is  $\{-20, 5\}$ . Disregard  $-20$

because we can't have a negative width measurement. The width of the path is 5 meters.

- 136.** Let  $x$  = the width of the path

$$(12+2x)(15+2x) = 378$$

$$180 + 24x + 30x + 4x^2 = 378$$

$$4x^2 + 54x + 180 = 378$$

$$4x^2 + 54x - 198 = 0$$

$$2(2x^2 + 27x - 99) = 0$$

$$2(2x+33)(x-3) = 0$$

$$2(2x+33)=0 \quad x-3=0$$

$$2x+33=0 \quad x=3$$

$$2x=-33$$

$$\cancel{x = -\frac{33}{2}}$$

The width of the path is 3 meters.

- 137.**  $x(x)(2) = 200$

$$2x^2 = 200$$

$$x^2 = 100$$

$$x = \pm 10$$

The length and width are 10 inches.

- 138.**  $x(x)(3) = 75$

$$3x^2 = 75$$

$$x^2 = 25$$

$$x = \pm 5$$

The length and width is 5 inches.

- 139.**  $x(20-2x) = 13$

$$20x - 2x^2 = 13$$

$$0 = 2x^2 - 20x + 13$$

$$x = \frac{-(-20) \pm \sqrt{(-20)^2 - 4(2)(13)}}{2(2)}$$

$$x = \frac{20 \pm \sqrt{296}}{4}$$

$$x = \frac{10 \pm 17.2}{4}$$

$$x = 9.3, 0.7$$

9.3 in and 0.7 in

$$140. \left(\frac{x}{4}\right)^2 + \left(\frac{8-x}{4}\right)^2 = 2$$

$$\frac{x^2}{16} + \frac{64-16x+x^2}{16} = 2$$

$$x^2 + 64 - 16x + x^2 = 32$$

$$2x^2 - 16x + 32 = 0$$

$$x^2 - 8x + 16 = 0$$

$$(x-4)(x-4) = 0$$

$$x = 4 \text{ in}$$

Both are 4 inches.

152. a. False;

$$(2x-3)^2 = 25$$

$$2x-3 = \pm 5$$

b. False;

Consider  $x^2 = 0$ , then  $x = 0$  is the only distinct solution.

c. True

d. False;

$$ax^2 + c = 0$$

$$x = \frac{0 \pm \sqrt{0-4ac}}{2a} = \frac{2i\sqrt{ac}}{2a} = \frac{i\sqrt{ac}}{a}$$

(c) is true.

$$153. (x+3)(x-5) = 0$$

$$x^2 - 5x + 3x - 15 = 0$$

$$x^2 - 2x - 15 = 0$$

$$154. s = -16t^2 + v_0t$$

$$0 = -16t^2 + v_0t - s$$

$$a = -16, b = v_0, c = -s$$

$$t = \frac{-v_0 \pm \sqrt{(v_0)^2 - 4(-16)(-s)}}{2(-16)}$$

$$t = \frac{-v_0 \pm \sqrt{(v_0)^2 - 64s}}{-32}$$

$$t = \frac{v_0 \pm \sqrt{v_0^2 - 64s}}{32}$$

155. The dimensions of the pool are 12 meters by 8 meters. With the tile, the dimensions will be  $12 + 2x$  meters by  $8 + 2x$  meters. If we take the area of the pool with the tile and subtract the area of the pool without the tile, we are left with the area of the tile only.

$$(12 + 2x)(8 + 2x) - 12(8) = 120$$

$$\cancel{96} + 24x + 16x + 4x^2 - \cancel{96} = 120$$

$$4x^2 + 40x - 120 = 0$$

$$x^2 + 10x - 30 = 0$$

$$a = 1 \quad b = 10 \quad c = -30$$

$$x = \frac{-10 \pm \sqrt{10^2 - 4(1)(-30)}}{2(1)}$$

$$= \frac{-10 \pm \sqrt{100 + 120}}{2}$$

$$= \frac{-10 \pm \sqrt{220}}{2} \approx \frac{-10 \pm 14.8}{2}$$

Evaluate the expression to obtain two solutions.

$$x = \frac{-10 + 14.8}{2} \quad \text{or} \quad x = \frac{-10 - 14.8}{2}$$

$$x = \frac{4.8}{2} \quad x = \frac{-24.8}{2}$$

$$x = 2.4 \quad x = -12.4$$

We disregard  $-12.4$  because we can't have a negative width measurement. The solution is  $2.4$  and we conclude that the width of the uniform tile border is  $2.4$  meters. This is more than the  $2$ -meter requirement, so the tile meets the zoning laws.

### Mid-Chapter 2 Check Point

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

$$-5 + 3x + 15 = 6x - 8$$

$$3x + 10 = 6x - 8$$

$$-3x = -18$$

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

$$x = 6$$

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

2.  $5x^2 - 2x = 7$

$$5x^2 - 2x - 7 = 0$$

$$(5x - 7)(x + 1) = 0$$

$$5x - 7 = 0 \quad \text{or} \quad x + 1 = 0$$

$$5x = 7 \quad x = -1$$

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

The solution set is  $\left\{-1, \frac{7}{5}\right\}$ .

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

$$20\left(\frac{x-3}{5} - 1\right) = 20\left(\frac{x-5}{4}\right)$$

$$\frac{20(x-3)}{5} - 20(1) = \frac{20(x-5)}{4}$$

$$4(x-3) - 20 = 5(x-5)$$

$$4x - 12 - 20 = 5x - 25$$

$$4x - 32 = 5x - 25$$

$$-x = 7$$

$$x = -7$$

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

4.  $3x^2 - 6x - 2 = 0$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$x = \frac{-(-6) \pm \sqrt{(-6)^2 - 4(3)(-2)}}{2(3)}$$

$$x = \frac{6 \pm \sqrt{60}}{6}$$

$$x = \frac{6 \pm 2\sqrt{15}}{6}$$

$$x = \frac{3 \pm \sqrt{15}}{3}$$

The solution set is  $\left\{\frac{3+\sqrt{15}}{3}, \frac{3-\sqrt{15}}{3}\right\}$ .

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

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

$$4x - 2 + 2x = 6x + 3 - 5$$

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

$$0 = 0$$

The solution set is all real numbers.

6.  $5x^2 + 1 = 37$

$$5x^2 = 36$$

$$\frac{5x^2}{5} = \frac{36}{5}$$

$$x^2 = \frac{36}{5}$$

$$x = \pm \sqrt{\frac{36}{5}}$$

$$x = \pm \frac{6}{\sqrt{5}}$$

$$x = \pm \frac{6}{\sqrt{5}} \cdot \frac{\sqrt{5}}{\sqrt{5}}$$

$$x = \pm \frac{6\sqrt{5}}{5}$$

The solution set is  $\left\{-\frac{6\sqrt{5}}{5}, \frac{6\sqrt{5}}{5}\right\}$ .

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

$$2x^2 - 3x = -4$$

$$2x^2 - 3x + 4 = 0$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$x = \frac{-(-3) \pm \sqrt{(-3)^2 - 4(2)(4)}}{2(2)}$$

$$x = \frac{3 \pm \sqrt{-23}}{4}$$

$$x = \frac{3 \pm i\sqrt{23}}{4}$$

The solution set is  $\left\{\frac{3+i\sqrt{23}}{4}, \frac{3-i\sqrt{23}}{4}\right\}$ .

$$\begin{aligned}
 8. \quad \frac{3x}{4} - \frac{x}{3} + 1 &= \frac{4x}{5} - \frac{3}{20} \\
 \frac{3x}{4} - \frac{x}{3} + 1 &= \frac{4x}{5} - \frac{3}{20} \\
 60\left(\frac{3x}{4} - \frac{x}{3} + 1\right) &= 60\left(\frac{4x}{5} - \frac{3}{20}\right) \\
 \frac{60(3x)}{4} - \frac{60x}{3} + 60(1) &= \frac{60(4x)}{5} - \frac{60(3)}{20} \\
 45x - 20x + 60 &= 48x - 9 \\
 25x + 60 &= 48x - 9 \\
 -23x &= -69 \\
 \frac{-23x}{-23} &= \frac{-69}{-23} \\
 x &= 3
 \end{aligned}$$

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

$$\begin{aligned}
 9. \quad (x+3)^2 &= 24 \\
 x+3 &= \pm\sqrt{24} \\
 x &= -3 \pm 2\sqrt{6}
 \end{aligned}$$

The solution set is  $\{-3+2\sqrt{6}, -3-2\sqrt{6}\}$ .

$$\begin{aligned}
 12. \quad \frac{2x}{x^2+6x+8} &= \frac{x}{x+4} - \frac{2}{x+2}, \quad x \neq -2, x \neq -4 \\
 \frac{2x}{(x+4)(x+2)} &= \frac{x}{x+4} - \frac{2}{x+2} \\
 \frac{2x(x+4)(x+2)}{(x+4)(x+2)} &= (x+4)(x+2)\left(\frac{x}{x+4} - \frac{2}{x+2}\right) \\
 2x &= \frac{x(x+4)(x+2)}{x+4} - \frac{2(x+4)(x+2)}{x+2} \\
 2x &= x(x+2) - 2(x+4) \\
 2x &= x^2 + 2x - 2x - 8 \\
 0 &= x^2 - 2x - 8 \\
 0 &= (x+2)(x-4)
 \end{aligned}$$

$$x+2=0 \quad \text{or} \quad x-4=0$$

$$x=-2 \quad \quad \quad x=4$$

$-2$  must be rejected.

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

$$\begin{aligned}
 10. \quad \frac{1}{x^2} - \frac{4}{x} + 1 &= 0 \\
 x^2\left(\frac{1}{x^2} - \frac{4}{x} + 1\right) &= x^2(0) \\
 \frac{x^2}{x^2} - \frac{4x^2}{x} + x^2 &= 0 \\
 1 - 4x + x^2 &= 0 \\
 x^2 - 4x + 1 &= 0 \\
 x &= \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \\
 x &= \frac{-(-4) \pm \sqrt{(-4)^2 - 4(1)(1)}}{2(1)} \\
 x &= \frac{4 \pm \sqrt{12}}{2} \\
 x &= \frac{4 \pm 2\sqrt{3}}{2} \\
 x &= 2 \pm \sqrt{3} \\
 \text{The solution set is } &\{2+\sqrt{3}, 2-\sqrt{3}\}.
 \end{aligned}$$

$$\begin{aligned}
 11. \quad 3x+1-(x-5) &= 2x-4 \\
 2x+6 &= 2x-4 \\
 6 &= -4 \\
 \text{The solution set is } &\emptyset.
 \end{aligned}$$

13. Let
- $y = 0$
- .

$$0 = x^2 + 6x + 2$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$x = \frac{-(6) \pm \sqrt{(6)^2 - 4(1)(2)}}{2(1)}$$

$$x = \frac{-6 \pm \sqrt{28}}{2}$$

$$x = \frac{-6 \pm 2\sqrt{7}}{2}$$

$$x = -3 \pm \sqrt{7}$$

$$x\text{-intercepts: } -3 + \sqrt{7} \text{ and } -3 - \sqrt{7}.$$

14. Let
- $y = 0$
- .

$$0 = 4(x+1) - 3x - (6-x)$$

$$0 = 4x + 4 - 3x - 6 + x$$

$$0 = 2x - 2$$

$$-2x = -2$$

$$x = 1$$

$$x\text{-intercept: } 1.$$

15. Let
- $y = 0$
- .

$$0 = 2x^2 + 26$$

$$-2x^2 = 26$$

$$x^2 = -13$$

$$x = \pm\sqrt{-13}$$

$$x = \pm i\sqrt{13}$$

$$\text{There are no } x\text{-intercepts.}$$

16. Let
- $y = 0$
- .

$$0 = \frac{x^2}{3} + \frac{x}{2} - \frac{2}{3}$$

$$6(0) = 6\left(\frac{x^2}{3} + \frac{x}{2} - \frac{2}{3}\right)$$

$$0 = \frac{6 \cdot x^2}{3} + \frac{6 \cdot x}{2} - \frac{6 \cdot 2}{3}$$

$$0 = 2x^2 + 3x - 4$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$x = \frac{-(3) \pm \sqrt{(3)^2 - 4(2)(-4)}}{2(2)}$$

$$x = \frac{-3 \pm \sqrt{41}}{4}$$

$$x\text{-intercepts: } \frac{-3 + \sqrt{41}}{4} \text{ and } \frac{-3 - \sqrt{41}}{4}.$$

17. Let
- $y = 0$
- .

$$0 = x^2 - 5x + 8$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$x = \frac{-(-5) \pm \sqrt{(-5)^2 - 4(1)(8)}}{2(1)}$$

$$x = \frac{5 \pm \sqrt{-7}}{2}$$

$$x = \frac{5 \pm i\sqrt{7}}{2}$$

$$\text{There are no } x\text{-intercepts.}$$

- 18.
- $y_1 = y_2$

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

$$6x - 15 - 8x - 2 = -5x - 15 - 2$$

$$-2x - 17 = -5x - 17$$

$$3x = 0$$

$$x = 0$$

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

- 19.
- $y_1 y_2 = 10$

$$(2x+3)(x+2) = 10$$

$$2x^2 + 7x + 6 = 10$$

$$2x^2 + 7x - 4 = 0$$

$$(2x-1)(x+4) = 0$$

$$2x-1=0 \quad \text{or} \quad x+4=0$$

$$x = \frac{1}{2} \quad x = -4$$

$$\text{The solution set is } \left\{-4, \frac{1}{2}\right\}.$$

20.  $x^2 + 10x - 3 = 0$

$$x^2 + 10x = 3$$

Since  $b = 10$ , we add  $\left(\frac{10}{2}\right)^2 = 5^2 = 25$ .

$$x^2 + 10x + 25 = 3 + 25$$

$$(x + 5)^2 = 28$$

Apply the square root principle:

$$x + 5 = \pm\sqrt{28}$$

$$x + 5 = \pm\sqrt{4 \cdot 7} = \pm 2\sqrt{7}$$

$$x = -5 \pm 2\sqrt{7}$$

The solutions are  $-5 \pm 2\sqrt{7}$ , and the solution set is  $\{-5 \pm 2\sqrt{7}\}$ .

21.  $2x^2 + 5x + 4 = 0$

$$a = 2 \quad b = 5 \quad c = 4$$

$$b^2 - 4ac = 5^2 - 4(2)(4)$$

$$= 25 - 32 = -7$$

Since the discriminant is negative, there are no real solutions. There are two imaginary solutions that are complex conjugates.

22.  $10x(x + 4) = 15x - 15$

$$10x^2 + 40x = 15x - 15$$

$$10x^2 - 25x + 15 = 0$$

$$a = 10 \quad b = -25 \quad c = 15$$

$$b^2 - 4ac = (-25)^2 - 4(10)(15)$$

$$= 625 - 600 = 25$$

Since the discriminant is positive and a perfect square, there are two rational solutions.

23. Let  $x$  = the defense budget of Japan in billions

Let  $x + 4$  = the defense budget of Russia in billions

Let  $x + 251$  = the defense budget of U.S. in billions

$$x + (x + 4) + (x + 251) = 375$$

$$3x + 255 = 375$$

$$3x = 120$$

$$x = 40$$

$$x + 4 = 44$$

$$x + 251 = 291$$

The defense budget of Japan is \$40 billion, of Russia \$44 billion, and of the U.S. \$291 billion.

24. Let  $x$  = the number of months it takes for the average female infant to weigh 16 pounds

$$7 + 1.5x = 16$$

$$1.5x = 9$$

$$\frac{1.5x}{1.5} = \frac{9}{1.5}$$

$$x = 6$$

It takes 6 months for the average female infant to weigh 16 pounds.

25. Let  $x$  = the amount invested at 8%.

Let  $25,000 - x$  = the amount invested at 9%.

$$0.08x + 0.09(25,000 - x) = 2135$$

$$0.08x + 2250 - 0.09x = 2135$$

$$-0.01x + 2250 = 2135$$

$$-0.01x = -115$$

$$x = \frac{-115}{-0.01}$$

$$x = 11,500$$

$$25,000 - x = 13,500$$

\$11,500 was invested at 8% and \$13,500 was invested at 9%.

26. Let  $x$  = the number of prints.

Photo Shop A:  $0.11x + 1.60$

Photo Shop B:  $0.13x + 1.20$

$$0.13x + 1.20 = 0.11x + 1.60$$

$$0.02x + 1.20 = 1.60$$

$$0.02x = 0.40$$

$$x = 20$$

The cost will be the same for 20 prints.

That common price is

$$0.11(20) + 1.60 = 0.13(20) + 1.20$$

$$= \$3.80$$

27. Let  $x$  = the average weight for an American woman aged 20 through 29 in 1960.

$$x + 0.22x = 157$$

$$1.22x = 157$$

$$\frac{1.22x}{1.22} = \frac{157}{1.22}$$

$$x \approx 129$$

The average weight for an American woman aged 20 through 29 in 1960 was 129 pounds.

28. Let  $x$  = the amount invested at 4%.  
 Let  $4000 - x$  = the amount invested that lost 3%.  
 $0.04x - 0.03(4000 - x) = 55$

$$0.04x - 120 + 0.03x = 55$$

$$0.07x - 120 = 55$$

$$0.07x = 175$$

$$x = \frac{175}{0.07}$$

$$x = 2500$$

$$4000 - x = 1500$$

\$2500 was invested at 4% and \$1500 lost 3%.

29. Let  $x$  = the width of the rectangle  
 Let  $2x + 5$  = the length of the rectangle

$$2l + 2w = P$$

$$2(2x + 5) + 2x = 46$$

$$4x + 10 + 2x = 46$$

$$6x + 10 = 46$$

$$6x = 36$$

$$\frac{6x}{6} = \frac{36}{6}$$

$$x = 6$$

$$2x + 5 = 17$$

The dimensions of the rectangle are 6 by 17.

30. Let  $x$  = the width of the rectangle  
 Let  $2x - 1$  = the length of the rectangle

$$lw = A$$

$$(2x - 1)x = 28$$

$$2x^2 - x = 28$$

$$2x^2 - x - 28 = 0$$

$$(2x + 7)(x - 4) = 0$$

$$2x + 7 = 0 \quad \text{or} \quad x - 4 = 0$$

$$2x = -7 \quad \quad \quad x = 4$$

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

$$-\frac{7}{2} \text{ must be rejected.}$$

$$\text{If } x = 4, \text{ then } 2x - 1 = 7$$

The dimensions of the rectangle are 4 by 7.

31. Let  $x$  = the height up the pole at which the wires are attached.

$$x^2 + 5^2 = 13^2$$

$$x^2 + 25 = 169$$

$$x^2 = 144$$

$$x = \pm 12$$

$$-12 \text{ must be rejected.}$$

The wires are attached 12 feet up the pole.

32.  $N = 62.2x^2 + 7000$

$$62.2x^2 + 7000 = N$$

$$62.2x^2 + 7000 = 46,000$$

$$62.2x^2 = 39,000$$

$$\frac{62.2x^2}{62.2} = \frac{39,000}{62.2}$$

$$x^2 \approx 627$$

$$x \approx \pm\sqrt{627}$$

$$x \approx \pm 25$$

$$-25 \text{ must be rejected.}$$

The equation predicts that there were 46,000 multinational corporations 25 years after 1970, or 1995. The model describes the actual data shown in the graph quite well.

33.  $P = 0.0049x^2 - 0.359x + 11.78$

$$15 = 0.0049x^2 - 0.359x + 11.78$$

$$0 = 0.0049x^2 - 0.359x - 3.22$$

$$0 = 0.0049x^2 - 0.359x - 3.22$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$x = \frac{-(-0.359) \pm \sqrt{(-0.359)^2 - 4(0.0049)(-3.22)}}{2(0.0049)}$$

$$x = \frac{0.359 \pm \sqrt{0.191993}}{0.0098}$$

$$x \approx 81, \quad x \approx -8 \text{ (rejected)}$$

The percentage of foreign born Americans will be 15% about 81 years after 1930, or 2011.

$$34. (6-2i)-(7-i) = 6-2i-7+i = -1-i$$

$$35. 3i(2+i) = 6i+3i^2 = -3+6i$$

$$36. (1+i)(4-3i) = 4-3i+4i-3i^2 \\ = 4+i+3 \\ = 7+i$$

$$37. \frac{1+i}{1-i} = \frac{1+i}{1-i} \cdot \frac{1+i}{1+i} \\ = \frac{1+i+i+i^2}{1-i^2} \\ = \frac{1+2i-1}{1+1} \\ = \frac{2i}{2} \\ = i$$

$$38. \sqrt{-75} - \sqrt{-12} = 5i\sqrt{3} - 2i\sqrt{3} = 3i\sqrt{3}$$

$$39. (2-\sqrt{-3})^2 = (2-i\sqrt{3})^2 \\ = 4-4i\sqrt{3}+3i^2 \\ = 4-4i\sqrt{3}-3 \\ = 1-4i\sqrt{3}$$

## Section 2.5

## Check Point Exercises

$$1. 4x^4 = 12x^2$$

$$4x^4 - 12x^2 = 0$$

$$4x^2(x^2-3) = 0$$

$$4x^2 = 0 \quad \text{or} \quad x^2 - 3 = 0$$

$$x^2 = 0 \quad x^2 = 3$$

$$x = \pm\sqrt{0} \quad x = \pm\sqrt{3}$$

$$x = 0 \quad x = \pm\sqrt{3}$$

The solution set is  $\{-\sqrt{3}, 0, \sqrt{3}\}$ .

$$2. 2x^3 + 3x^2 = 8x + 12$$

$$x^2(2x+3) - 4(2x+3) = 10$$

$$(2x+3)(x^2-4) = 0$$

$$2x+3=0 \quad \text{or} \quad x^2-4=0$$

$$2x = -3 \quad x^2 = 4$$

$$x = -\frac{3}{2} \quad x = \pm 2$$

The solution set is  $\left\{-2, -\frac{3}{2}, 2\right\}$ .

$$3. \sqrt{x+3} + 3 = x$$

$$\sqrt{x+3} = x-3$$

$$(\sqrt{x+3})^2 = (x-3)^2$$

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

$$0 = x^2-7x+6$$

$$0 = (x-6)(x-1)$$

$$x-6=0 \quad \text{or} \quad x-1=0$$

$$x=6 \quad x=1$$

1 does not check and must be rejected.

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

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

$$\sqrt{x+5} = 2 + \sqrt{x-3}$$

$$(\sqrt{x+5})^2 = (2 + \sqrt{x-3})^2$$

$$x+5 = (2)^2 + 2(2)(\sqrt{x-3}) + (\sqrt{x-3})^2$$

$$x+5 = 4 + 4\sqrt{x-3} + x-3$$

$$4 = 4\sqrt{x-3}$$

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

$$1 = \sqrt{x-3}$$

$$(1)^2 = (\sqrt{x-3})^2$$

$$1 = x-3$$

$$4 = x$$

The check indicates that 4 is a solution.

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

5. a.  $5x^{3/2} - 25 = 0$

$$5x^{3/2} = 25$$

$$x^{3/2} = 5$$

$$(x^{3/2})^{2/3} = (5)^{2/3}$$

$$x = 5^{2/3} \text{ or } \sqrt[3]{25}$$

Check:

$$5(5^{2/3})^{3/2} - 25 = 0$$

$$5(5) - 25 = 0$$

$$25 - 25 = 0$$

$$0 = 0$$

The solution set is  $\{5^{2/3}\}$  or  $\{\sqrt[3]{25}\}$ .

b.

$$\frac{2}{x^3} - 8 = -4$$

$$x^{2/3} = 4$$

$$(x^{2/3})^{3/2} = 4^{3/2} \text{ or }$$

$$x = (2^2)^{3/2}$$

$$x = 2^3 \quad x = (-2)^3$$

$$x = 8 \quad x = -8$$

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

6.  $x^4 - 5x^2 + 6 = 0$

$$(x^2)^2 - 5x^2 + 6 = 0$$

Let  $t = x^2$ .

$$t^2 - 5t + 6 = 0$$

$$(t-3)(t-2) = 0$$

$$t-3 = 0 \quad \text{or} \quad t-2 = 0$$

$$t = 3 \quad \text{or} \quad t = 2$$

$$x^2 = 3 \quad \text{or} \quad x^2 = 2$$

$$x = \pm\sqrt{3} \quad \text{or} \quad x = \pm\sqrt{2}$$

The zeros are  $-\sqrt{3}, \sqrt{3}, -\sqrt{2}$ , and  $\sqrt{2}$ .

7.  $3x^{2/3} - 11x^{1/3} - 4 = 0$

Let  $t = x^{1/3}$ .

$$3t^2 - 11t - 4 = 0$$

$$(3t+1)(t-4) = 0$$

$$3t+1 = 0 \quad \text{or} \quad t-4 = 0$$

$$3t = -1$$

$$t = -\frac{1}{3} \quad t = 4$$

$$x^{1/3} = -\frac{1}{3} \quad x^{1/3} = 4$$

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

$$x = -\frac{1}{27} \quad x = 64$$

The solution set is  $\left\{-\frac{1}{27}, 64\right\}$ .

8.  $|2x-1| = 5$

$$2x-1 = 5 \quad \text{or} \quad 2x-1 = -5$$

$$2x = 6 \quad 2x = -4$$

$$x = 3 \quad x = -2$$

The solution set is  $\{-2, 3\}$ .

9.  $4|1-2x| - 20 = 0$

$$4|1-2x| = 20$$

$$|1-2x| = 5$$

$$1-2x = 5 \quad \text{or} \quad 1-2x = -5$$

$$-2x = 4 \quad -2x = -6$$

$$x = -2 \quad x = 3$$

The zeros are  $-2$ , and  $3$ .

### Exercise Set 2.5

1.  $3x^4 - 48x^2 = 0$

$$3x^2(x^2 - 16) = 0$$

$$3x^2(x+4)(x-4) = 0$$

$$3x^2 = 0 \quad x+4 = 0 \quad x-4 = 0$$

$$x^2 = 0 \quad x = -4 \quad x = 4$$

$$x = 0$$

The solution set is  $\{-4, 0, 4\}$ .

2.  $5x^4 - 20x^2 = 0$

$$5x^2(x^2 - 4) = 0$$

$$5x^2(x+2)(x-2) = 0$$

$$5x^2 = 0 \quad x+2 = 0 \quad x-2 = 0$$

$$x^2 = 0$$

$$x = 0 \quad x = -2 \quad x = 2$$

The solution set is  $\{-2, 0, 2\}$ .

3.  $3x^3 + 2x^2 = 12x + 8$

$$3x^3 + 2x^2 - 12x - 8 = 0$$

$$x^2(3x+2) - 4(3x+2) = 0$$

$$(3x+2)(x^2-4) = 0$$

$$3x+2=0 \quad x^2-4=0$$

$$3x=-2 \quad x^2=4$$

$$x = -\frac{2}{3} \quad x = \pm 2$$

The solution set is  $\left\{-2, -\frac{2}{3}, 2\right\}$ .

4.  $4x^3 - 12x^2 = 9x - 27$

$$4x^3 - 12x^2 - 9x + 27 = 0$$

$$4x^2(x-3) - 9(x-3) = 0$$

$$(x-3)(4x^2-9) = 0$$

$$x-3=0 \quad 4x^2-9=0$$

$$x=3 \quad 4x^2=9$$

$$x^2 = \frac{9}{4}$$

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

The solution set is  $\left\{-\frac{3}{2}, \frac{3}{2}, 3\right\}$ .

5.  $2x-3 = 8x^3 - 12x^2$

$$8x^3 - 12x^2 - 2x + 3 = 0$$

$$4x^2(2x-3) - (2x-3) = 0$$

$$(2x-3)(4x^2-1) = 0$$

$$2x-3=0 \quad 4x^2-1=0$$

$$2x=3 \quad 4x^2=1$$

$$x^2 = \frac{1}{4}$$

$$x = \frac{3}{2} \quad x = \pm \frac{1}{2}$$

The solution set is  $\left\{\frac{3}{2}, \frac{1}{2}, -\frac{1}{2}\right\}$ .

6.  $x+1 = 9x^3 + 9x^2$

$$9x^3 + 9x^2 - x - 1 = 0$$

$$9x^2(x+1) - (x+1) = 0$$

$$(x+1)(9x^2-1) = 0$$

$$x+1=0 \quad 9x^2-1=1$$

$$x=-1 \quad 9x^2=1$$

$$x^2 = \frac{1}{9}$$

$$x = \pm \frac{1}{3}$$

The solution set is  $\left\{-1, -\frac{1}{3}, \frac{1}{3}\right\}$ .

7.  $4y^3 - 2 = y - 8y^2$

$$4y^3 + 8y^2 - y - 2 = 0$$

$$4y^2(y+2) - (y+2) = 0$$

$$(y+2)(4y^2-1) = 0$$

$$y+2=0 \quad 4y^2-1=0$$

$$4y^2=1$$

$$y^2 = \frac{1}{4}$$

$$y = -2 \quad y = \pm \frac{1}{2}$$

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

8.  $9y^3 + 8 = 4y + 18y^2$

$$9y^3 - 18y^2 - 4y + 8 = 0$$

$$9y^2(y-2) - 4(y-2) = 0$$

$$(y-2)(9y^2-4) = 0$$

$$y-2=0 \quad 9y^2-4=0$$

$$y=2 \quad 9y^2=4$$

$$y^2 = \frac{4}{9}$$

$$y = \pm \frac{2}{3}$$

The solution set is  $\left\{-\frac{2}{3}, \frac{2}{3}, 2\right\}$ .

9.  $2x^4 = 16x$

$$2x^4 - 16x = 0$$

$$2x(x^3 - 8) = 0$$

$$2x = 0 \quad x^3 - 8 = 0$$

$$x = 0 \quad (x-2)(x^2 + 2x + 2) = 0$$

$$x - 2 = 0 \quad x^2 + 2x + 4 = 0$$

$$x = 2 \quad x = \frac{-2 \pm \sqrt{2^2 - 4(1)(4)}}{2(1)}$$

$$x = \frac{-2 \pm \sqrt{-12}}{2}$$

$$x = \frac{-2 \pm 2i\sqrt{3}}{2}$$

$$x = -1 \pm i\sqrt{3}$$

The solution set is  $\{0, 2, -1 \pm i\sqrt{3}\}$ .

10.  $3x^4 = 81x$

$$3x^4 - 81x = 0$$

$$3x(x^3 - 27) = 0$$

$$3x = 0 \quad x^3 - 27 = 0$$

$$x = 0;$$

$$(x-3)(x^2 + 3x + 9) = 0$$

$$x - 3 = 0 \quad x^2 + 3x + 9 = 0$$

$$x = 3 \quad x = \frac{-3 \pm \sqrt{3^2 - 4(1)(9)}}{2(1)}$$

$$x = \frac{-3 \pm \sqrt{9 - 36}}{2}$$

$$x = \frac{-3 \pm \sqrt{-27}}{2}$$

$$x = \frac{-3 \pm 3i\sqrt{3}}{2}$$

The solution set is  $\left\{0, 3, \frac{-3 \pm 3i\sqrt{3}}{2}\right\}$ .

11.  $\sqrt{3x+18} = x$

$$3x + 18 = x^2$$

$$x^2 - 3x - 18 = 0$$

$$(x+3)(x-6) = 0$$

$$x + 3 = 0 \quad x - 6 = 0$$

$$x = -3 \quad x = 6$$

$$\sqrt{3(-3)+18} = -3 \quad \sqrt{3(6)+18} = 6$$

$$\sqrt{-9+18} = -3 \quad \sqrt{18+18} = 6$$

$$\sqrt{9} = -3 \quad \text{False} \quad \sqrt{36} = 6$$

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

12.  $\sqrt{20-8x} = x$

$$20 - 8x = x^2$$

$$x^2 + 8x - 20 = 0$$

$$(x+10)(x-2) = 0$$

$$x + 10 = 0 \quad x - 2 = 0$$

$$x = -10 \quad x = 2$$

$$\sqrt{20-8(-10)} = -10 \quad \sqrt{20-8(2)} = 2$$

$$\sqrt{20+80} = -10 \quad \sqrt{20-16} = 2$$

$$\sqrt{100} = -10 \quad \text{False} \quad \sqrt{4} = 2$$

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

13.  $\sqrt{x+3} = x-3$

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

$$x^2 - 7x + 6 = 0$$

$$(x-1)(x-6) = 0$$

$$x - 1 = 0 \quad x - 6 = 0$$

$$x = 1 \quad x = 6$$

$$\sqrt{1+3} = 1-3 \quad \sqrt{6+3} = 6-3$$

$$\sqrt{4} = -2 \quad \text{False} \quad \sqrt{9} = 3$$

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

14.  $\sqrt{x+10} = x-2$

$$x + 10 = (x-2)^2$$

$$x + 10 = x^2 - 4x + 4$$

$$x^2 - 5x - 6 = 0$$

$$(x+1)(x-6) = 0$$

$$x + 1 = 0 \quad x - 6 = 0$$

$$x = -1 \quad x = 6$$

$$\sqrt{-1+10} = -1-2 \quad \sqrt{6+10} = 6-2$$

$$\sqrt{9} = -3 \quad \text{False} \quad \sqrt{16} = 4$$

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

$$\begin{aligned}
 15. \quad & \sqrt{2x+13} = x+7 \\
 & 2x+13 = (x+7)^2 \\
 & 2x+13 = x^2+14x+49 \\
 & x^2+12x+36 = 0 \\
 & (x+6)^2 = 0 \\
 & x+6 = 0 \\
 & x = -6 \\
 & \sqrt{2(-6)+13} = -6+7 \\
 & \sqrt{-12+13} = 1 \\
 & \sqrt{1} = 1
 \end{aligned}$$

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

$$\begin{aligned}
 16. \quad & \sqrt{6x+1} = x-1 \\
 & 6x+1 = (x-1)^2 \\
 & 6x+1 = x^2-2x+1 \\
 & x^2-8x = 0 \\
 & x(x-8) = 0 \\
 & x-8 = 0 \quad x = 0 \\
 & x = 8 \\
 & \sqrt{6(0)+1} = 0-1 \quad \sqrt{6(8)+1} = 8-1 \\
 & \sqrt{0+1} = -1 \quad \sqrt{48+1} = 7 \\
 & \sqrt{1} = -1 \quad \text{False} \quad \sqrt{49} = 7
 \end{aligned}$$

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

$$\begin{aligned}
 17. \quad & x - \sqrt{2x+5} = 5 \\
 & x-5 = \sqrt{2x+5} \\
 & (x-5)^2 = 2x+5 \\
 & x^2-10x+25 = 2x+5 \\
 & x^2-12x+20 = 0 \\
 & (x-2)(x-10) = 0 \\
 & x-2 = 0 \quad x-10 = 0 \\
 & x = 2 \quad x = 10 \\
 & 2 - \sqrt{2(2)+5} = 5 \quad 10 - \sqrt{2(10)+5} = 5 \\
 & 2 - \sqrt{9} = 5 \quad 10 - \sqrt{25} = 5 \\
 & 2 - 3 = 5 \quad \text{False} \quad 10 - 5 = 5
 \end{aligned}$$

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

$$\begin{aligned}
 18. \quad & x - \sqrt{x+11} = 1 \\
 & x-1 = \sqrt{x+11} \\
 & (x-1)^2 = x+11 \\
 & x^2-2x+1 = x+11 \\
 & x^2-3x-10 = 0 \\
 & (x+2)(x-5) = 0 \\
 & x+2 = 0 \quad x-5 = 0 \\
 & x = -2 \quad x = 5 \\
 & -2 - \sqrt{-2+11} = 1 \quad 5 - \sqrt{5+11} = 1 \\
 & -2 - \sqrt{9} = 1 \quad 5 - \sqrt{16} = 1 \\
 & -2 - 3 = 1 \quad \text{False} \quad 5 - 4 = 1
 \end{aligned}$$

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

$$\begin{aligned}
 19. \quad & \sqrt{2x+19} - 8 = x \\
 & \sqrt{2x+19} = x+8 \\
 & (\sqrt{2x+19})^2 = (x+8)^2 \\
 & 2x+19 = x^2+16x+64 \\
 & 0 = x^2+14x+45 \\
 & 0 = (x+9)(x+5) \\
 & x+9 = 0 \quad \text{or} \quad x+5 = 0 \\
 & x = -9 \quad x = -5 \\
 & -9 \text{ does not check and must be rejected.} \\
 & \text{The solution set is } \{-5\}.
 \end{aligned}$$

$$\begin{aligned}
 20. \quad & \sqrt{2x+15} - 6 = x \\
 & \sqrt{2x+15} = x+6 \\
 & (\sqrt{2x+15})^2 = (x+6)^2 \\
 & 2x+15 = x^2+12x+36 \\
 & 0 = x^2+10x+21 \\
 & 0 = (x+3)(x+7) \\
 & x+3 = 0 \quad \text{or} \quad x+7 = 0 \\
 & x = -3 \quad x = -7 \\
 & -7 \text{ does not check and must be rejected.} \\
 & \text{The solution set is } \{-3\}.
 \end{aligned}$$

$$\begin{aligned}
 21. \quad & \sqrt{3x} + 10 = x + 4 \\
 & \sqrt{3x} = x - 6 \\
 & 3x = (x - 6)^2 \\
 & 3x = x^2 - 12x + 36 \\
 & x^2 - 15x + 36 = 0 \\
 & (x - 12)(x - 3) = 0 \\
 & x - 12 = 0 \quad x - 3 = 0 \\
 & x = 12 \quad x = 3 \\
 & \sqrt{3(12)} + 10 = 12 + 4 \quad \sqrt{3(3)} + 10 = 3 + 4 \\
 & \sqrt{36} + 10 = 16 \quad \sqrt{9} + 10 = 7 \\
 & 6 + 10 = 16 \quad 3 + 10 = 7 \text{ False} \\
 & \text{The solution set is } \{12\}.
 \end{aligned}$$

$$\begin{aligned}
 22. \quad & \sqrt{x} - 3 = x - 9 \\
 & \sqrt{x} = x - 6 \\
 & x = (x - 6)^2 \\
 & x = x^2 - 12x + 36 \\
 & x^2 - 13x + 36 = 0 \\
 & (x - 9)(x - 4) = 0 \\
 & x - 9 = 0 \quad x - 4 = 0 \\
 & x = 9 \quad x = 4 \\
 & \sqrt{9} - 3 = 9 - 9 \quad \sqrt{4} - 3 = 4 - 9 \\
 & 3 - 3 = 9 - 9 \quad 2 - 3 = 4 - 9 \text{ False} \\
 & \text{The solution set is } \{9\}.
 \end{aligned}$$

$$\begin{aligned}
 23. \quad & \sqrt{x+8} - \sqrt{x-4} = 2 \\
 & \sqrt{x+8} = \sqrt{x-4} + 2 \\
 & x + 8 = (\sqrt{x-4} + 2)^2 \\
 & x + 8 = x - 4 + 4\sqrt{x-4} + 4 \\
 & x + 8 = x + 4\sqrt{x-4} \\
 & 8 = 4\sqrt{x-4} \\
 & 2 = \sqrt{x-4} \\
 & 4 = x - 4 \\
 & x = 8 \\
 & \sqrt{8+8} - \sqrt{8-4} = 2 \\
 & \sqrt{16} - \sqrt{4} = 2 \\
 & 4 - 2 = 2 \\
 & \text{The solution set is } \{8\}.
 \end{aligned}$$

$$\begin{aligned}
 24. \quad & \sqrt{x+5} - \sqrt{x-3} = 2 \\
 & \sqrt{x+5} = \sqrt{x-3} + 2 \\
 & x + 5 = (\sqrt{x-3} + 2)^2 \\
 & x + 5 = x - 3 + 4\sqrt{x-3} + 4 \\
 & x + 5 = x + 1 + 4\sqrt{x-3} \\
 & 5 = 1 + 4\sqrt{x-3} \\
 & 4 = 4\sqrt{x-3} \\
 & 1 = \sqrt{x-3} \\
 & 1 = x - 3 \\
 & x = 4 \\
 & \sqrt{4+5} - \sqrt{4-3} = 2 \\
 & \sqrt{9} - \sqrt{1} = 2 \\
 & 3 - 1 = 2 \\
 & \text{The solution set is } \{4\}.
 \end{aligned}$$

$$\begin{aligned}
 25. \quad & \sqrt{x-5} - \sqrt{x-8} = 3 \\
 & \sqrt{x-5} = \sqrt{x-8} + 3 \\
 & x - 5 = (\sqrt{x-8} + 3)^2 \\
 & x - 5 = x - 8 + 6\sqrt{x-8} + 9 \\
 & x - 5 = x + 1 + 6\sqrt{x-8} \\
 & -6 = 6\sqrt{x-8} \\
 & -1 = \sqrt{x-8} \\
 & 1 = x - 8 \\
 & x = 9 \\
 & \sqrt{9-5} - \sqrt{9-8} = 3 \\
 & \sqrt{4} - \sqrt{1} = 3 \\
 & 2 - 1 = 3 \text{ False} \\
 & \text{The solution set is the empty set, } \emptyset.
 \end{aligned}$$

26.  $\sqrt{2x-3} - \sqrt{x-2} = 1$

$$\sqrt{2x-3} = \sqrt{x-2} + 1$$

$$2x-3 = (\sqrt{x-2} + 1)^2$$

$$2x-3 = x-2 + 2\sqrt{x-2} + 1$$

$$2x-3 = x-1 + 2\sqrt{x-2}$$

$$x-2 = 2\sqrt{x-2}$$

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

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

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

$$x^2 - 4x + 4 = 4x - 8$$

$$x^2 - 8x + 12 = 0$$

$$(x-6)(x-2) = 0$$

$$x-6=0 \quad x-2=0$$

$$x=6 \quad x=2$$

$$\sqrt{2(6)-3} - \sqrt{6-2} = 1 \quad \sqrt{2(2)-3} - \sqrt{2-2} = 1$$

$$\sqrt{12-3} - \sqrt{4} = 1 \quad \sqrt{4-3} - \sqrt{0} = 1$$

$$\sqrt{9} - \sqrt{4} = 1 \quad \sqrt{1} - 0 = 1$$

$$3-2=1 \quad 1-0=1$$

The solution set is  $\{2, 6\}$ .

27.  $\sqrt{2x+3} + \sqrt{x-2} = 2$

$$\sqrt{2x+3} = 2 - \sqrt{x-2}$$

$$2x+3 = (2 - \sqrt{x-2})^2$$

$$2x+3 = 4 - 4\sqrt{x-2} + x-2$$

$$x+1 = -4\sqrt{x-2}$$

$$(x+1)^2 = 16(x-2)$$

$$x^2 + 2x + 1 = 16x - 32$$

$$x^2 - 14x + 33 = 0$$

$$(x-11)(x-3) = 0$$

$$x-11=0 \quad x-3=0$$

$$x=11 \quad x=3$$

$$\sqrt{2(11)+3} + \sqrt{11-2} = 2$$

$$\sqrt{22+3} + \sqrt{9} = 2$$

$$5+3=2 \text{ False}$$

$$\sqrt{2(3)+3} + \sqrt{3-2} = 2$$

$$\sqrt{6+3} + \sqrt{1} = 2$$

$$3+1=2 \text{ False}$$

The solution set is the empty set,  $\emptyset$ .

28.  $\sqrt{x+2} + \sqrt{3x+7} = 1$

$$\sqrt{x+2} = 1 - \sqrt{3x+7}$$

$$x+2 = (1 - \sqrt{3x+7})^2$$

$$x+2 = 1 - 2\sqrt{3x+7} + 3x+7$$

$$-2x-6 = -2\sqrt{3x+7}$$

$$x+3 = \sqrt{3x+7}$$

$$(x+3)^2 = 3x+7$$

$$x^2 + 6x + 9 = 3x + 7$$

$$x^2 + 3x + 2 = 0$$

$$(x+1)(x+2) = 0$$

$$x+1=0 \quad x+2=0$$

$$x=-1 \quad x=-2$$

$$\sqrt{-1+2} + \sqrt{3(-1)+7} = 1$$

$$\sqrt{1} + \sqrt{4} = 1$$

$$1+2=1 \text{ False}$$

$$\sqrt{-2+2} + \sqrt{3(-2)+7} = 1$$

$$\sqrt{0} + \sqrt{1} = 1$$

$$0+1=1$$

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

29.  $\sqrt{3\sqrt{x+1}} = \sqrt{3x-5}$

$$3\sqrt{x+1} = 3x-5$$

$$9(x+1) = 9x^2 - 30x + 25$$

$$9x^2 - 39x + 16 = 0$$

$$x = \frac{39 \pm \sqrt{945}}{18} = \frac{13 \pm \sqrt{105}}{6}$$

Check proposed solutions.

The solution set is  $\left\{\frac{13 + \sqrt{105}}{6}\right\}$ .

$$30. \quad \sqrt{1+4\sqrt{x}} = 1 + \sqrt{x}$$

$$1 + 4\sqrt{x} = 1 + 2\sqrt{x} + x$$

$$2\sqrt{x} = x$$

$$4x = x^2$$

$$x^2 - 4x = 0$$

$$x(x-4) = 0$$

$$x = 0 \text{ or } x = 4$$

The solution set is  $\{0, 4\}$ .

$$31. \quad x^{3/2} = 8$$

$$(x^{3/2})^{2/3} = 8^{2/3}$$

$$x = \sqrt[3]{8^2}$$

$$x = 2^2$$

$$x = 4$$

$$4^{3/2} = 8$$

$$\sqrt{4^3} = 8$$

$$2^3 = 8$$

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

$$32. \quad x^{3/2} = 27$$

$$(x^{3/2})^{2/3} = 27^{2/3}$$

$$x = \sqrt[3]{27^2}$$

$$x = 3^2$$

$$x = 9$$

$$9^{3/2} = 27$$

$$\sqrt{9^3} = 27$$

$$3^3 = 27$$

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

$$33. \quad (x-4)^{3/2} = 27$$

$$((x-4)^{3/2})^{2/3} = 27^{2/3}$$

$$x-4 = \sqrt[3]{27^2}$$

$$x-4 = 3^2$$

$$x-4 = 9$$

$$x = 13$$

$$(13-4)^{3/2} = 27$$

$$9^{3/2} = 27$$

$$\sqrt{9^3} = 27$$

$$3^3 = 27$$

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

$$34. \quad (x+5)^{3/2} = 8$$

$$((x+5)^{3/2})^{2/3} = 8^{2/3}$$

$$x+5 = \sqrt[3]{8^2}$$

$$x+5 = 2^2$$

$$x+5 = 4$$

$$x = -1$$

$$(-1+5)^{3/2} = 8$$

$$4^{3/2} = 8$$

$$\sqrt{4^3} = 8$$

$$2^3 = 8$$

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

$$35. \quad 6x^{5/2} - 12 = 0$$

$$6x^{5/2} = 12$$

$$x^{5/2} = 2$$

$$(x^{5/2})^{2/5} = 2^{2/5}$$

$$x = \sqrt[5]{2^2}$$

$$x = \sqrt[5]{4}$$

$$6(\sqrt[5]{4})^{5/2} - 12 = 0$$

$$6(4^{1/5})^{5/2} - 12 = 0$$

$$6(4^{1/2}) - 12 = 0$$

$$6(2) - 12 = 0$$

The solution set is  $\{\sqrt[5]{4}\}$ .

$$36. \quad 8x^{5/3} - 24 = 0$$

$$8x^{5/3} = 24$$

$$x^{5/3} = 3$$

$$(x^{5/3})^{3/5} = 3^{3/5}$$

$$x = \sqrt[5]{3^3}$$

$$x = \sqrt[5]{27}$$

$$8(\sqrt[5]{27})^{5/3} - 24 = 0$$

$$8(27^{1/5})^{5/3} - 24 = 0$$

$$8(27^{1/3}) - 24 = 0$$

$$8(3) - 24 = 0$$

The solution set is  $\{\sqrt[5]{27}\}$ .

$$\begin{aligned}
 37. \quad & (x-4)^{2/3} = 16 \\
 & \left[ (x-4)^{2/3} \right]^{3/2} = (16)^{3/2} \\
 & x-4 = \left( 2^4 \right)^{3/2} \\
 & x-4 = 4^3 \quad x-4 = (-4)^3 \\
 & x-4 = 64 \quad x-4 = -64 \\
 & x = 68 \quad x = -60 \\
 & \text{The solution set is } \{-60, 68\}.
 \end{aligned}$$

$$\begin{aligned}
 38. \quad & (x+5)^{2/3} = 4 \\
 & \left[ (x+5)^{2/3} \right]^{3/2} = (4)^{3/2} \\
 & x+5 = \left( 2^2 \right)^{3/2} \\
 & x+5 = 2^3 \quad \text{or} \quad x+5 = (-2)^3 \\
 & x+5 = 8 \quad x+5 = -8 \\
 & x = 3 \quad x = -13 \\
 & \text{The solution set is } \{-13, 3\}.
 \end{aligned}$$

$$\begin{aligned}
 39. \quad & (x^2 - x - 4)^{3/4} - 2 = 6 \\
 & (x^2 - x - 4)^{3/4} = 8 \\
 & ((x^2 - x - 4)^{3/4})^{4/3} = 8^{4/3} \\
 & x^2 - x - 4 = \sqrt[3]{8^4} \\
 & x^2 - x - 4 = 2^4 \\
 & x^2 - x - 4 = 16 \\
 & x^2 - x - 20 = 0 \\
 & (x-5)(x+4) = 0 \\
 & x-5 = 0 \quad x+4 = 0 \\
 & x = 5 \quad x = -4
 \end{aligned}$$

$$\begin{aligned}
 & (5^2 - 5 - 4)^{3/4} - 2 = 6 \\
 & (25 - 9)^{3/4} - 2 = 6 \\
 & 16^{3/4} - 2 = 6 \\
 & \sqrt[4]{16^3} - 2 = 6 \\
 & 2^3 - 2 = 6 \\
 & 8 - 2 = 6 \\
 & ((-4)^2 - (-4) - 4)^{3/4} - 2 = 6 \\
 & (16 + 4 - 4)^{3/4} - 2 = 6 \\
 & 16^{3/4} - 2 = 6 \\
 & \sqrt[4]{16^3} - 2 = 6 \\
 & 2^3 - 2 = 6 \\
 & 8 - 2 = 6 \\
 & \text{The solution set is } \{5, -4\}.
 \end{aligned}$$

$$\begin{aligned}
 40. \quad & (x^2 - 3x + 3)^{3/2} - 1 = 0 \\
 & (x^2 - 3x + 3)^{3/2} = 1 \\
 & x^2 - 3x + 3 = 1^{2/3} \\
 & x^2 - 3x + 3 = 1 \\
 & x^2 - 3x + 2 = 0 \\
 & (x-1)(x-2) = 0 \\
 & x-1 = 0 \quad x-2 = 0 \\
 & x = 1 \quad x = 2 \\
 & (1^2 - 3(1) + 3)^{3/2} - 1 = 0 \\
 & (1 - 3 + 3)^{3/2} - 1 = 0 \\
 & 1^{3/2} - 1 = 0 \\
 & 1 - 1 = 0 \\
 & (2^2 - 3(2) + 3)^{3/2} - 1 = 0 \\
 & (4 - 6 + 3)^{3/2} - 1 = 0 \\
 & 1^{3/2} - 1 = 0 \\
 & 1 - 1 = 0 \\
 & \text{The solution set is } \{1, 2\}.
 \end{aligned}$$

$$\begin{aligned}
 41. \quad & x^4 - 5x^2 + 4 = 0 \text{ let } t = x^2 \\
 & t^2 - 5t + 4 = 0 \\
 & (t-1)(t-4) = 0 \\
 & t-1 = 0 \quad t-4 = 0 \\
 & t = 1 \quad t = 4 \\
 & x^2 = 1 \quad x^2 = 4 \\
 & x = \pm 1 \quad x = \pm 2 \\
 & \text{The solution set is } \{1, -1, 2, -2\}
 \end{aligned}$$

42.  $x^4 - 13x^2 + 36 = 0$  let  $t = x^2$

$$t^2 - 13t + 36 = 0$$

$$(t-4)(t-9) = 0$$

$$t-4=0 \quad t-9=0$$

$$t=4 \quad t=9$$

$$x^2=4 \quad x^2=9$$

$$x=\pm 2 \quad x=\pm 3$$

The solution set is  $\{-3, -2, 2, 3\}$ .

43.  $9x^4 = 25x^2 - 16$

$$9x^4 - 25x^2 + 16 = 0 \text{ let } t = x^2$$

$$9t^2 - 25t + 16 = 0$$

$$(9t-16)(t-1) = 0$$

$$9t-16=0 \quad t-1=0$$

$$9t=16 \quad t=1$$

$$t = \frac{16}{9} \quad x^2 = 1$$

$$x = \pm 1$$

$$x^2 = \frac{16}{9}$$

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

The solution set is  $\left\{1, -1, \frac{4}{3}, -\frac{4}{3}\right\}$ .

44.  $4x^4 = 13x^2 - 9$

$$4x^4 - 13x^2 + 9 = 0 \text{ let } t = x^2$$

$$4t^2 - 13t + 9 = 0$$

$$(4t-9)(t-1) = 0$$

$$4t-9=0 \quad t-1=0$$

$$4t=9 \quad t=1$$

$$t = \frac{9}{4} \quad x^2 = 1$$

$$x^2 = \frac{9}{4} \quad x = \pm 1$$

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

The solution set is  $\left\{-\frac{3}{2}, -1, 1, \frac{3}{2}\right\}$ .

45.  $x - 13\sqrt{x} + 40 = 0$  Let  $t = \sqrt{x}$ .

$$t^2 - 13t + 40 = 0$$

$$(t-8)(t-5) = 0$$

$$t-8=0 \quad t-5=0$$

$$t=8 \quad t=5$$

$$\sqrt{x}=8 \quad \sqrt{x}=5$$

$$x=64 \quad x=25$$

The solution set is  $\{25, 64\}$ .

46.  $2x - 7\sqrt{x} - 30 = 0$  Let  $t = \sqrt{x}$ .

$$2t^2 - 7t - 30 = 0$$

$$(2t+5)(t-6) = 0$$

$$2t+5=0$$

$$t = -\frac{5}{2} \quad t-6=0$$

$$t=6$$

$$\sqrt{x} = -\frac{5}{2} \quad \sqrt{x} = 6$$

$$x = \frac{25}{4} \quad x = 36$$

The solution set is  $\{36\}$  since  $25/4$  does not check in the original equation.

47.  $x^{-2} - x^{-1} - 20 = 0$  Let  $t = x^{-1}$

$$t^2 - t - 20 = 0$$

$$(t-5)(t+4) = 0$$

$$t-5=0 \quad t+4=0$$

$$t=5 \quad t=-4$$

$$x^{-1}=5 \quad x^{-1}=-4$$

$$\frac{1}{x}=5 \quad \frac{1}{x}=-4$$

$$1=5x \quad 1=-4x$$

$$\frac{1}{5}=x \quad -\frac{1}{4}=x$$

The solution set is  $\left\{-\frac{1}{4}, \frac{1}{5}\right\}$ .

48.  $x^{-2} - x^{-1} - 6 = 0$  Let  $t = x^{-1}$ .

$$t^2 - t - 6 = 0$$

$$(t-3)(t+2) = 0$$

$$t-3=0 \quad t+2=0$$

$$t=3 \quad t=-2$$

$$x^{-1}=3 \quad x^{-1}=-2$$

$$\frac{1}{x}=3 \quad \frac{1}{x}=-2$$

$$1=3x \quad 1=-2x$$

$$\frac{1}{3}=x \quad -\frac{1}{2}=x$$

The solution set is  $\left\{-\frac{1}{2}, \frac{1}{3}\right\}$ .

49.  $x^{2/3} - x^{1/3} - 6 = 0$  let  $t = x^{1/3}$

$$t^2 - t - 6 = 0$$

$$(t-3)(t+2) = 0$$

$$t-3=0 \quad t+2=0$$

$$t=3 \quad t=-2$$

$$x^{1/3}=3 \quad x^{1/3}=-2$$

$$x=3^3 \quad x=(-2)^3$$

$$x=27 \quad x=-8$$

The solution set is  $\{27, -8\}$ .

50.  $2x^{2/3} + 7x^{1/3} - 15 = 0$  let  $t = x^{1/3}$

$$2t^2 + 7t - 15 = 0$$

$$(2t-3)(t+5) = 0$$

$$2t-3=0 \quad t+5=0$$

$$2t=3 \quad t=-5$$

$$t=\frac{3}{2} \quad x^{1/3}=-5$$

$$x^{1/3}=\frac{3}{2} \quad x=(-5)^2$$

$$x=\left(\frac{3}{2}\right)^3 \quad x=-125$$

$$x=\frac{27}{8}$$

The solution set is  $\left\{-125, \frac{27}{8}\right\}$ .

51.  $x^{3/2} - 2x^{3/4} + 1 = 0$  let  $t = x^{3/4}$

$$t^2 - 2t + 1 = 0$$

$$(t-1)(t-1) = 0$$

$$t-1=0$$

$$t=1$$

$$x^{3/4}=1$$

$$x=1^{4/3}$$

$$x=1$$

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

52.  $x^{2/5} + x^{1/5} - 6 = 0$  let  $t = x^{1/5}$

$$t^2 + t - 6 = 0$$

$$(t+3)(t-2) = 0$$

$$t+3=0 \quad t-2=0$$

$$t=-3 \quad t=2$$

$$x^{1/5}=-3 \quad x^{1/5}=2$$

$$x=(-3)^5 \quad x=2^5$$

$$x=-243 \quad x=32$$

The solution set is  $\{-243, 32\}$ .

53.  $2x - 3x^{1/2} + 1 = 0$  let  $t = x^{1/2}$

$$2t^2 - 3t + 1 = 0$$

$$(2t-1)(t-1) = 0$$

$$2t-1=0 \quad t-1=0$$

$$2t=1$$

$$t=\frac{1}{2} \quad t=1$$

$$x^{1/2}=\frac{1}{2} \quad x^{1/2}=1$$

$$x=\left(\frac{1}{2}\right)^2 \quad x=1^2$$

$$x=\frac{1}{4} \quad x=1$$

The solution set is  $\left\{\frac{1}{4}, 1\right\}$ .

54.  $x + 3x^{1/2} - 4 = 0$  let  $t = x^{1/2}$

$$t^2 + 3t - 4 = 0$$

$$(t-1)(t+4) = 0$$

$$t-1=0 \quad t+4=0$$

$$t=1 \quad t=-4$$

$$x^{1/2}=1 \quad x^{1/2}=-4$$

$$x=1^2 \quad x=(-4)^2$$

$$x=1 \quad x=16$$

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

55.  $(x-5)^2 - 4(x-5) - 21 = 0$  let  $t = x-5$

$$t^2 - 4t - 21 = 0$$

$$(t+3)(t-7) = 0$$

$$t+3=0 \quad t-7=0$$

$$t=-3 \quad t=7$$

$$x-5=-3 \quad x-5=7$$

$$x=2 \quad x=12$$

The solution set is  $\{2, 12\}$ .

56.  $(x+3)^2 + 7(x+3) - 18 = 0$  let  $t = x+3$

$$t^2 + 7t - 18 = 0$$

$$(t+9)(t-2) = 0$$

$$t+9=0 \quad t-2=0$$

$$t=-9 \quad t=2$$

$$x+3=-9 \quad x+3=2$$

$$x=-12 \quad x=-1$$

The solution set is  $\{-12, -1\}$ .

57.  $(x^2 - x)^2 - 14(x^2 - x) + 24 = 0$

Let  $t = x^2 - x$ .

$$t^2 - 14t + 24 = 0$$

$$(t-2)(t-12) = 0$$

$$t=2 \text{ or } t=12$$

$$x^2 - x = 2 \quad \text{or} \quad x^2 - x = 12$$

$$x^2 - x - 2 = 0 \quad x^2 - x - 12 = 0$$

$$(x-2)(x+1) = 0 \quad (x-4)(x+3) = 0$$

The solution set is  $\{-3, -1, 2, 4\}$ .

58.  $(x^2 - 2x)^2 - 11(x^2 - 2x) + 24 = 0$

Let  $t = x^2 - 2x$

$$t^2 - 11t + 24 = 0$$

$$(t-3)(t-8) = 0$$

$$t=3 \text{ or } t=8$$

$$x^2 - 2x = 3 \quad \text{or} \quad x^2 - 2x = 8$$

$$x^2 - 2x - 3 = 0 \quad x^2 - 2x - 8 = 0$$

$$(x-3)(x+1) = 0 \quad (x-4)(x+2) = 0$$

The solution set is  $\{-2, -1, 3, 4\}$ .

59.  $\left(y - \frac{8}{y}\right)^2 + 5\left(y - \frac{8}{y}\right) - 14 = 0$

Let  $t = y - \frac{8}{y}$ .

$$t^2 + 5t - 14 = 0$$

$$(t+7)(t-2) = 0$$

$$t=-7 \text{ or } t=2$$

$$y - \frac{8}{y} = -7 \quad \text{or} \quad y - \frac{8}{y} = 2$$

$$y^2 + 7y - 8 = 0 \quad y^2 - 2y - 8 = 0$$

$$(y+8)(y-1) = 0 \quad (y-4)(y+2) = 0$$

The solution set is  $\{-8, -2, 1, 4\}$ .

60.  $\left(y - \frac{10}{y}\right)^2 + 6\left(y - \frac{10}{y}\right) - 27 = 0$

Let  $t = y - \frac{10}{y}$ .

$$t^2 + 6t - 27 = 0$$

$$(t+9)(t-3) = 0$$

$$t=-9 \text{ or } t=3$$

$$y - \frac{10}{y} = -9 \quad \text{or} \quad y - \frac{10}{y} = 3$$

$$y^2 + 9y - 10 = 0 \quad y^2 - 3y - 10 = 0$$

$$(y+10)(y-1) = 0 \quad (y-5)(y+2) = 0$$

The solution set is  $\{-10, -2, 1, 5\}$

61.  $|x| = 8$

$$x = 8, x = -8$$

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

62.  $|x| = 6$

$$x = 6, x = -6$$

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

63.  $|x-2| = 7$

$$x-2=7 \quad x-2=-7$$

$$x=9 \quad x=-5$$

The solution set is  $\{9, -5\}$ .

64.  $|x+1| = 5$

$$x+1=5 \quad x+1=-5$$

$$x=4 \quad x=-6$$

The solution set is  $\{-6, 4\}$ .

65.  $|2x - 1| = 5$

$2x - 1 = 5 \quad 2x - 1 = -5$

$2x = 6 \quad 2x = -4$

$x = 3 \quad x = -2$

The solution set is  $\{3, -2\}$ .

66.  $|2x - 3| = 11$

$2x - 3 = 11 \quad 2x - 3 = -11$

$2x = 14 \quad 2x = -8$

$x = 7 \quad x = -4$

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

67.  $2|3x - 2| = 14$

$|3x - 2| = 7$

$3x - 2 = 7 \quad 3x - 2 = -7$

$3x = 9 \quad 3x = -5$

$x = 3 \quad x = -5/3$

The solution set is  $\{3, -5/3\}$ 

68.  $3|2x - 1| = 21$

$|2x - 1| = 7$

$2x - 1 = 7 \quad \text{or} \quad 2x - 1 = -7$

$2x = 8 \quad 2x = -6$

$x = 4 \quad x = -3$

The solution set is  $\{4, -3\}$ 

69.  $7|5x| + 2 = 16$

$7|5x| = 14$

$|5x| = 2$

$5x = 2 \quad 5x = -2$

$x = 2/5 \quad x = -2/5$

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

70.  $7|3x| + 2 = 16$

$7|3x| = 14$

$|3x| = 2$

$3x = 2 \quad \text{or} \quad 3x = -2$

$x = 2/3 \quad x = -2/3$

The solution set is  $\{-2/3, 2/3\}$ 

71.  $2\left|4 - \frac{5}{2}x\right| + 6 = 18$

$2\left|4 - \frac{5}{2}x\right| = 12$

$\left|4 - \frac{5}{2}x\right| = 6$

$4 - \frac{5}{2}x = 6 \quad \text{or} \quad 4 - \frac{5}{2}x = -6$

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

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

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

$x = 4$

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

72.  $4\left|1 - \frac{3}{4}x\right| + 7 = 10$

$4\left|1 - \frac{3}{4}x\right| = 3$

$\left|1 - \frac{3}{4}x\right| = \frac{3}{4}$

$$\begin{array}{lcl}
 1 - \frac{3}{4}x = \frac{3}{4} & \text{or} & 1 - \frac{3}{4}x = -\frac{3}{4} \\
 -\frac{3}{4}x = -\frac{1}{4} & & -\frac{3}{4}x = -\frac{7}{4} \\
 -\frac{4}{3}\left(-\frac{3}{4}\right)x = -\frac{4}{3}\left(-\frac{1}{4}\right) & & -\frac{4}{3}\left(-\frac{3}{4}\right)x = -\frac{4}{3}\left(-\frac{7}{4}\right) \\
 x = \frac{1}{3} & & x = \frac{7}{3}
 \end{array}$$

The solution set is  $\left\{\frac{1}{3}, \frac{7}{3}\right\}$ .

73.  $|x + 1| + 5 = 3$

$$|x + 1| = -2$$

No solution

The solution set is  $\{\}$ .

74.  $|x + 1| + 6 = 2$

$$|x + 1| = -4 \quad \text{The solution set is } \{\}.$$

75.  $|2x - 1| + 3 = 3$

$$|2x - 1| = 0$$

$$2x - 1 = 0$$

$$2x = 1$$

$$x = 1/2$$

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

76.  $|3x - 2| + 4 = 4$

$$|3x - 2| = 0$$

$$3x - 2 = 0$$

$$3x = 2$$

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

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

77.  $|3x - 1| = |x + 5|$

$$3x - 1 = x + 5$$

$$3x - 1 = -x - 5$$

$$2x - 1 = 5$$

$$4x - 1 = -5$$

$$2x = 6$$

$$4x = -4$$

$$x = 3$$

$$x = -1$$

The solution set is  $\{3, -1\}$ .

78.  $|2x - 7| = |x + 3|$

$$2x - 7 = x + 3 \quad \text{or} \quad 2x - 7 = -(x + 3)$$

$$x = 10$$

$$2x - 7 = -x - 3$$

$$3x = 4$$

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

The solution set is  $\left\{10, \frac{4}{3}\right\}$

79. Set  $y = 0$  to find the  $x$ -intercept(s).

$$0 = \sqrt{x+2} + \sqrt{x-1} - 3$$

$$-\sqrt{x+2} = \sqrt{x-1} - 3$$

$$\left(-\sqrt{x+2}\right)^2 = \left(\sqrt{x-1} - 3\right)^2$$

$$x+2 = \left(\sqrt{x-1}\right)^2 - 2\left(\sqrt{x-1}\right)(3) + (3)^2$$

$$x+2 = x-1-6\sqrt{x-1}+9$$

$$x+2 = x-1-6\sqrt{x-1}+9$$

$$2 = 8-6\sqrt{x-1}$$

$$-6 = -6\sqrt{x-1}$$

$$\frac{-6}{-6} = \frac{-6\sqrt{x-1}}{-6}$$

$$1 = \sqrt{x-1}$$

$$(1)^2 = \left(\sqrt{x-1}\right)^2$$

$$1 = x-1$$

$$2 = x$$

The  $x$ -intercept is 2.

The corresponding graph is graph (c).

80. Set
- $y = 0$
- to find the
- $x$
- intercept(s).

$$\begin{aligned}
 0 &= \sqrt{x-4} + \sqrt{x+4} - 4 \\
 -\sqrt{x-4} &= \sqrt{x+4} - 4 \\
 (-\sqrt{x-4})^2 &= (\sqrt{x+4} - 4)^2 \\
 x-4 &= (\sqrt{x+4})^2 - 2(\sqrt{x+4})(4) + (4)^2 \\
 x-4 &= x+4 - 8\sqrt{x+4} + 16 \\
 -4 &= 20 - 8\sqrt{x+4} \\
 -24 &= -8\sqrt{x+4} \\
 \frac{-24}{-8} &= \frac{-8\sqrt{x+4}}{-8} \\
 3 &= \sqrt{x+4} \\
 (3)^2 &= (\sqrt{x+4})^2 \\
 9 &= x+4 \\
 5 &= x
 \end{aligned}$$

The  $x$ -intercept is 5.

The corresponding graph is graph (a).

81. Set
- $y = 0$
- to find the
- $x$
- intercept(s).

$$\begin{aligned}
 0 &= x^{\frac{1}{3}} + 2x^{\frac{1}{6}} - 3 \\
 \text{Let } t &= x^{\frac{1}{6}}. \\
 x^{\frac{1}{3}} + 2x^{\frac{1}{6}} - 3 &= 0
 \end{aligned}$$

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

$$(t+3)(t-1) = 0$$

$$t+3=0 \quad \text{or} \quad t-1=0$$

$$t=-3 \quad \quad \quad t=1$$

Substitute  $x^{\frac{1}{6}}$  for  $t$ .

$$x^{\frac{1}{6}} = -3 \quad \text{or} \quad x^{\frac{1}{6}} = 1$$

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

$$x = 729$$

$$x = 1$$

729 does not check and must be rejected.

The  $x$ -intercept is 1.

The corresponding graph is graph (e).

82. Set
- $y = 0$
- to find the
- $x$
- intercept(s).

$$0 = x^{-2} - x^{-1} - 6$$

$$\text{Let } t = x^{-1}.$$

$$x^{-2} - x^{-1} - 6 = 0$$

$$(x^{-1})^2 - x^{-1} - 6 = 0$$

$$t^2 - t - 6 = 0$$

$$(t+2)(t-3) = 0$$

$$t+2=0 \quad \text{or} \quad t-3=0$$

$$t=-2 \quad \quad \quad t=3$$

Substitute  $x^{-1}$  for  $t$ .

$$x^{-1} = -2 \quad \text{or} \quad x^{-1} = 3$$

$$x = -\frac{1}{2} \quad \quad \quad x = \frac{1}{3}$$

The  $x$ -intercepts are  $-\frac{1}{2}$  and  $\frac{1}{3}$ .

The corresponding graph is graph (b).

83. Set
- $y = 0$
- to find the
- $x$
- intercept(s).

$$(x+2)^2 - 9(x+2) + 20 = 0$$

$$\text{Let } t = x+2.$$

$$(x+2)^2 - 9(x+2) + 20 = 0$$

$$t^2 - 9t + 20 = 0$$

$$(t-5)(t-4) = 0$$

$$t-5=0 \quad \text{or} \quad t-4=0$$

$$t=5 \quad \quad \quad t=4$$

Substitute  $x+2$  for  $t$ .

$$x+2=5 \quad \text{or} \quad x+2=4$$

$$x=3 \quad \quad \quad x=2$$

The  $x$ -intercepts are 2 and 3.

The corresponding graph is graph (f).

84. Set
- $y = 0$
- to find the
- $x$
- intercept(s).

$$0 = 2(x+2)^2 + 5(x+2) - 3$$

$$\text{Let } t = x+2.$$

$$2(x+2)^2 + 5(x+2) - 3 = 0$$

$$2t^2 + 5t - 3 = 0$$

$$(2t-1)(t+3) = 0$$

$$2t-1=0 \quad \text{or} \quad t+3=0$$

$$2t=1 \quad \quad \quad t=-3$$

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

Substitute  $x+2$  for  $t$ .

$$\begin{aligned}
 x+2 &= \frac{1}{2} & \text{or} & & x+2 &= -3 \\
 & & & & x &= -5 \\
 x &= \frac{1}{2} - 2 \\
 x &= -\frac{3}{2}
 \end{aligned}$$

The  $x$ -intercepts are  $-5$  and  $-\frac{3}{2}$ .

The corresponding graph is graph (d).

$$\begin{aligned}
 85. \quad |5-4x| &= 11 \\
 5-4x &= 11 & 5-4x &= -11 \\
 -4x &= 6 & \text{or} & & -4x &= -16 \\
 x &= -\frac{3}{2} & & & x &= 4
 \end{aligned}$$

The solution set is  $\left\{-\frac{3}{2}, 4\right\}$ .

$$\begin{aligned}
 86. \quad |2-3x| &= 13 \\
 2-3x &= 13 & 2-3x &= -13 \\
 -3x &= 11 & \text{or} & & -3x &= -15 \\
 x &= -\frac{11}{3} & & & x &= 5
 \end{aligned}$$

The solution set is  $\left\{-\frac{11}{3}, 5\right\}$ .

$$\begin{aligned}
 87. \quad x + \sqrt{x+5} &= 7 \\
 \sqrt{x+5} &= 7-x \\
 (\sqrt{x+5})^2 &= (7-x)^2 \\
 x+5 &= 49-14x+x^2 \\
 0 &= x^2-15x+44 \\
 0 &= (x-4)(x-11) \\
 x-4 &= 0 & \text{or} & & x-11 &= 0 \\
 x &= 4 & & & x &= 11
 \end{aligned}$$

11 does not check and must be rejected.

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

$$\begin{aligned}
 88. \quad x - \sqrt{x-2} &= 4 \\
 -\sqrt{x-2} &= 4-x \\
 (-\sqrt{x-2})^2 &= (4-x)^2 \\
 x-2 &= 16-8x+x^2 \\
 0 &= x^2-9x+18 \\
 0 &= (x-6)(x-3) \\
 x-6 &= 0 & \text{or} & & x-3 &= 0 \\
 x &= 6 & & & x &= 3
 \end{aligned}$$

3 does not check and must be rejected.

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

$$\begin{aligned}
 89. \quad 2x^3 + x^2 - 8x + 2 &= 6 \\
 2x^3 + x^2 - 8x - 4 &= 0 \\
 x^2(2x+1) - 4(2x+1) &= 0 \\
 (2x+1)(x^2-4) &= 0 \\
 (2x+1)(x+2)(x-2) &= 0 \\
 2x+1 &= 0 & \text{or} & & x+2 &= 0 & \text{or} & & x-2 &= 0 \\
 x &= -\frac{1}{2} & & & x &= -2 & & & x &= 2
 \end{aligned}$$

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

$$\begin{aligned}
 90. \quad x^3 + 4x^2 - x + 6 &= 10 \\
 x^3 + 4x^2 - x - 4 &= 0 \\
 x^2(x+4) - 1(x+4) &= 0 \\
 (x+4)(x^2-1) &= 0 \\
 (x+4)(x+1)(x-1) &= 0 \\
 x+4 &= 0 & \text{or} & & x+1 &= 0 & \text{or} & & x-1 &= 0 \\
 x &= -4 & & & x &= -1 & & & x &= 1
 \end{aligned}$$

The solution set is  $\{-4, -1, 1\}$ .

$$\begin{aligned}
 91. \quad (x+4)^{\frac{3}{2}} &= 8 \\
 \left((x+4)^{\frac{3}{2}}\right)^{\frac{2}{3}} &= (8)^{\frac{2}{3}} \\
 x+4 &= (\sqrt[3]{8})^2 \\
 x+4 &= (2)^2 \\
 x+4 &= 4 \\
 x &= 0
 \end{aligned}$$

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

92.  $(x-5)^{\frac{3}{2}} = 125$

$$\left((x-5)^{\frac{3}{2}}\right)^{\frac{2}{3}} = (125)^{\frac{2}{3}}$$

$$x-5 = (\sqrt[3]{125})^2$$

$$x-5 = (5)^2$$

$$x-5 = 25$$

$$x = 30$$

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

93.  $y_1 = y_2 + 3$

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

$$(x^2 - 1)^2 - 2(x^2 - 1) - 3 = 0$$

Let  $t = x^2 - 1$  and substitute.

$$t^2 - 2t - 3 = 0$$

$$(t+1)(t-3) = 0$$

$$t+1=0 \quad \text{or} \quad t-3=0$$

$$t = -1 \quad t = 3$$

Substitute  $x^2 - 1$  for  $t$ .

$$x^2 - 1 = -1 \quad \text{or} \quad x^2 - 1 = 3$$

$$x^2 = 0 \quad x^2 = 4$$

$$x = 0 \quad x = \pm 2$$

The solution set is  $\{-2, 0, 2\}$ .

94.  $y_1 = y_2 + 6$

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

$$6\left(\frac{2x}{x-3}\right)^2 - 5\left(\frac{2x}{x-3}\right) - 6 = 0$$

Let  $t = \frac{2x}{x-3}$  and substitute.

$$6t^2 - 5t - 6 = 0$$

$$(3t+2)(2t-3) = 0$$

$$3t+2=0 \quad \text{or} \quad 2t-3=0$$

$$t = -\frac{2}{3} \quad t = \frac{3}{2}$$

Substitute  $\frac{2x}{x-3}$  for  $t$ .

$$\frac{2x}{x-3} = -\frac{2}{3} \quad \text{or} \quad \frac{2x}{x-3} = \frac{3}{2}$$

First solve  $\frac{2x}{x-3} = -\frac{2}{3}$

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

$$2x(3) = -2(x-3)$$

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

$$8x = 6$$

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

Next solve  $\frac{2x}{x-3} = \frac{3}{2}$

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

$$2x(2) = 3(x-3)$$

$$4x = 3x - 9$$

$$x = -9$$

The solution set is  $\left\{-9, \frac{3}{4}\right\}$ .

95.  $|x^2 + 2x - 36| = 12$

$$x^2 + 2x - 36 = 12 \quad x^2 + 2x - 36 = -12$$

$$x^2 + 2x - 48 = 0 \quad \text{or} \quad x^2 + 2x - 24 = 0$$

$$(x+8)(x-6) = 0 \quad (x+6)(x-4) = 0$$

Setting each of the factors above equal to zero gives  $x = -8$ ,  $x = 6$ ,  $x = -6$ , and  $x = 4$ .

The solution set is  $\{-8, -6, 4, 6\}$ .

96.  $|x^2 + 6x + 1| = 8$

$$x^2 + 6x + 1 = 8 \quad \text{or} \quad x^2 + 6x + 1 = -8$$

$$x^2 + 6x - 7 = 0 \quad x^2 + 6x + 9 = 0$$

$$(x+7)(x-1) = 0 \quad (x+3)(x+3) = 0$$

Setting each of the factors above equal to zero gives  $x = -7$ ,  $x = -3$ , and  $x = 1$ .

The solution set is  $\{-7, -3, 1\}$ .

97.  $x(x+1)^3 - 42(x+1)^2 = 0$

$$(x+1)^2(x(x+1) - 42) = 0$$

$$(x+1)^2(x^2 + x - 42) = 0$$

$$(x+1)^2(x+7)(x-6) = 0$$

Setting each of the factors above equal to zero gives  $x = -7$ ,  $x = -1$ , and  $x = 6$ .

The solution set is  $\{-7, -1, 6\}$ .

98.  $x(x-2)^3 - 35(x-2)^2 = 0$

$$x(x-2)^3 - 35(x-2)^2 = 0$$

$$(x-2)^2(x(x-2) - 35) = 0$$

$$(x-2)^2(x^2 - 2x - 35) = 0$$

$$(x-2)^2(x+5)(x-7) = 0$$

Setting each of the factors above equal to zero gives  $x = -5$ ,  $x = 2$ , and  $x = 7$ .

The solution set is  $\{-5, 2, 7\}$ .

99. Let  $x =$  the number.

$$\sqrt{5x-4} = x-2$$

$$(\sqrt{5x-4})^2 = (x-2)^2$$

$$5x-4 = x^2 - 4x + 4$$

$$0 = x^2 - 9x + 8$$

$$0 = (x-8)(x-1)$$

$$x-8 = 0 \quad \text{or} \quad x-1 = 0$$

$$x = 8 \quad x = 1$$

Check  $x = 8$ :  $\sqrt{5(8)-4} = 8-2$

$$\sqrt{40-4} = 6$$

$$\sqrt{36} = 6$$

$$6 = 6$$

Check  $x = 1$ :  $\sqrt{5(1)-4} = 1-2$

$$\sqrt{5-4} = -1$$

$$\sqrt{-1} \neq -1$$

Discard  $x = 1$ . The number is 8.

100. Let  $x =$  the number.

$$\sqrt{x-3} = x-5$$

$$(\sqrt{x-3})^2 = (x-5)^2$$

$$x-3 = x^2 - 10x + 25$$

$$0 = x^2 - 11x + 28$$

$$0 = (x-7)(x-4)$$

$$x-7 = 0 \quad \text{or} \quad x-4 = 0$$

$$x = 7 \quad x = 4$$

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

$$\sqrt{4} = 2$$

$$2 = 2$$

Check  $x = 4$ :  $\sqrt{4-3} = 4-5$

$$\sqrt{1} = -1$$

$$1 \neq -1$$

Discard 4. The number is 7.

101.

$$r = \sqrt{\frac{3V}{\pi h}}$$

$$r^2 = \left(\sqrt{\frac{3V}{\pi h}}\right)^2$$

$$r^2 = \frac{3V}{\pi h}$$

$$\pi r^2 h = 3V$$

$$\frac{\pi r^2 h}{3} = V$$

$$V = \frac{\pi r^2 h}{3} \quad \text{or} \quad V = \frac{1}{3} \pi r^2 h$$

102.

$$r = \sqrt{\frac{A}{4\pi}}$$

$$r^2 = \left(\sqrt{\frac{A}{4\pi}}\right)^2$$

$$r^2 = \frac{A}{4\pi}$$

$$4\pi r^2 = A \quad \text{or} \quad A = 4\pi r^2$$

- 103.** Exclude any value that causes the denominator to equal zero.

$$|x+2|-14=0$$

$$|x+2|=14$$

$$x+2=14 \quad \text{or} \quad x+2=-14$$

$$x=12 \quad \text{or} \quad x=-16$$

-16 and 12 must be excluded from the domain.

- 104.** Exclude any value that causes the denominator to equal zero.

$$x^3 + 3x^2 - x - 3 = 0$$

$$x^2(x+3) - 1(x+3) = 0$$

$$(x+3)(x^2-1) = 0$$

$$(x+3)(x+1)(x-1) = 0$$

Setting each of the factors above equal to zero gives  $x = -3$ ,  $x = -1$ , and  $x = 1$ .

-3, -1, and 1 must be excluded from the domain.

- 105.** Let  $P = 192$ .

$$P = 28\sqrt{t} + 80$$

$$192 = 28\sqrt{t} + 80$$

$$112 = 28\sqrt{t}$$

$$\frac{112}{28} = \frac{28\sqrt{t}}{28}$$

$$4 = \sqrt{t}$$

$$(4)^2 = (\sqrt{t})^2$$

$$16 = t$$

192 million computers will be sold 16 years after 1996, or 2012.

- 106.** Let  $P = 143$ .

$$P = 28\sqrt{t} + 80$$

$$143 = 28\sqrt{t} + 80$$

$$63 = 28\sqrt{t}$$

$$\frac{63}{28} = \frac{28\sqrt{t}}{28}$$

$$2.25 = \sqrt{t}$$

$$(2.25)^2 = (\sqrt{t})^2$$

$$5 \approx t$$

143 million computers were sold 5 years after 1996, or 2001. This matches the data shown in the figure quite well.

- 107.** For the year 2100, we use  $x = 98$ .

$$H = 0.083(98) + 57.9$$

$$= 66.034$$

$$L = 0.36\sqrt{98} + 57.9$$

$$\approx 61.464$$

In the year 2100, the projected high end temperature is about  $66^\circ$  and the projected low end temperature is about  $61.5^\circ$ .

- 108.** For the year 2080, we use  $x = 78$ .

$$H = 0.083(78) + 57.9 \approx 64.4$$

$$L = 0.36\sqrt{78} + 57.9 \approx 61.1$$

In the year 2080, the projected high end temperature is about  $64.4^\circ$  and the projected low end temperature is about  $61.1^\circ$ .

- 109.** Using  $H$ :

$$0.083x + 57.9 = 57.9 + 1$$

$$0.083x = 1$$

$$x = \frac{1}{0.083}$$

$$x \approx 12$$

The projected global temperature will exceed the 2002 average by 1 degree in 2014 (12 years after 2002).

Using  $L$ :

$$0.36\sqrt{x} + 57.9 = 1 + 57.9$$

$$0.36\sqrt{x} = 1$$

$$\sqrt{x} = \frac{1}{0.36}$$

$$(\sqrt{x})^2 = \left(\frac{1}{0.36}\right)^2$$

$$x \approx 8$$

The projected global temperature will exceed the 2002 average by 1 degree in 2010 (8 years after 2002).

**110.** Using  $H$ :

$$0.083x + 57.9 = 57.9 + 2$$

$$0.083x = 2$$

$$x = \frac{2}{0.083}$$

$$x \approx 24$$

The projected global temperature will exceed the 2002 average by 2 degrees in 2026 (24 years after 2002).

Using  $L$ :

$$0.36\sqrt{x} + 57.9 = 57.9 + 2$$

$$0.36\sqrt{x} = 2$$

$$\sqrt{x} = \frac{2}{0.36}$$

$$(\sqrt{x})^2 = \left(\frac{2}{0.36}\right)^2$$

$$x \approx 31$$

The projected global temperature will exceed the 2002 average by 2 degrees in 2033 (31 years after 2002).

**111.**

$$y = 5000\sqrt{100 - x}$$

$$40000 = 5000\sqrt{100 - x}$$

$$\frac{40000}{5000} = \frac{5000\sqrt{100 - x}}{5000}$$

$$8 = \sqrt{100 - x}$$

$$8^2 = (\sqrt{100 - x})^2$$

$$64 = 100 - x$$

$$-36 = -x$$

$$36 = x$$

40,000 people in the group will survive to age 36. This is shown on the graph as the point (36, 40000).

**112.**

$$y = 5000\sqrt{100 - x}$$

$$35000 = 5000\sqrt{100 - x}$$

$$\frac{35000}{5000} = \frac{5000\sqrt{100 - x}}{5000}$$

$$7 = \sqrt{100 - x}$$

$$7^2 = (\sqrt{100 - x})^2$$

$$49 = 100 - x$$

$$-51 = -x$$

$$51 = x$$

35,000 people will survive to age 51. This corresponds to the point (51, 35000) on the graph.

**113.**

$$365 = 0.2x^{3/2}$$

$$\frac{365}{0.2} = \frac{0.2x^{3/2}}{0.2}$$

$$1825 = x^{3/2}$$

$$1825^2 = (x^{3/2})^2$$

$$3,330,625 = x^3$$

$$\sqrt[3]{3,330,625} = \sqrt[3]{x^3}$$

$$149.34 \approx x$$

The average distance of the Earth from the sun is approximately 149 million kilometers.

**114.**

$$f(x) = 0.2x^{3/2}$$

$$88 = 0.2x^{3/2}$$

$$\frac{88}{0.2} = \frac{0.2x^{3/2}}{0.2}$$

$$440 = x^{3/2}$$

$$440^2 = (x^{3/2})^2$$

$$193,600 = x^3$$

$$\sqrt[3]{193,600} = \sqrt[3]{x^3}$$

$$58 \approx x$$

The average distance of Mercury from the sun is approximately 58 million kilometers.

$$115. \sqrt{6^2 + x^2} + \sqrt{8^2 + (10 - x)^2} = 18$$

$$\sqrt{36 + x^2} = 18 - \sqrt{64 + 100 - 20x + x^2}$$

$$36 + x^2 = 324 - 36\sqrt{x^2 - 20x + 164} + x^2 - 20x + 164$$

$$36\sqrt{x^2 - 20x + 164} = -20x + 452$$

$$9\sqrt{x^2 - 20x + 164} = -5x + 113$$

$$81(x^2 - 20x + 164) = 25x^2 - 1130x + 12769$$

$$81x^2 - 1620x + 13284 = 25x^2 - 1130x + 12769$$

$$56x^2 - 490x + 515 = 0$$

$$x = \frac{490 \pm \sqrt{(-490)^2 - 4(56)(515)}}{2(56)}$$

$$x = \frac{490 \pm 353.19}{112}$$

$$x \approx 1.2 \quad x \approx 7.5$$

The point should be located approximately either 1.2 feet or 7.5 feet from the base of the 6-foot pole.

$$116. \text{ a. Distance from point } A = \sqrt{6^2 + x^2} + \sqrt{3^2 + (12 - x)^2} \text{ or } A = \sqrt{x^2 + 36} + \sqrt{(12 - x)^2 + 9}.$$

b. Let the distance = 15.

$$\sqrt{6^2 + x^2} + \sqrt{3^2 + (12 - x)^2} = 15$$

$$\sqrt{36 + x^2} = 15 - \sqrt{9 + 144 - 24x + x^2}$$

$$36 + x^2 = 225 - 30\sqrt{153 - 24x + x^2} + x^2 - 24x + 153$$

$$30\sqrt{x^2 - 24x + 153} = -24x + 342$$

$$5\sqrt{x^2 - 24x + 153} = -4x + 157$$

$$25(x^2 - 24x + 153) = 16x^2 - 456x + 3249$$

$$25x^2 - 600x + 3825 = 16x^2 - 456x + 3249$$

$$9x^2 - 144x + 576 = 0$$

$$x^2 - 16x + 64 = 0$$

$$(x - 8)(x - 8) = 0$$

$$x = 8$$

The distance is 8 miles.

$$125. x^3 + 3x^2 - x - 3 = 0$$

The solution set is  $\{-3, -1, 1\}$ .

$$(-3)^3 + 3(-3)^2 - (-3) - 3 = 0$$

$$-27 + 27 + 3 - 3 = 0$$

$$(-1)^3 + 3(-1)^2 - (-1) - 3 = 0$$

$$-1 + 3 + 1 - 3 = 0$$

$$1^3 + 3(1)^2 - (1) - 3 = 0$$

$$1 + 3 - 1 - 3 = 0$$

$$126. -x^4 + 4x^3 - 4x^2 = 0$$

The solution set is  $\{0, 2\}$ .

$$-(0)^4 + 4(0)^3 - 4(0)^2 = 0$$

$$0 = 0$$

$$-(2)^4 + 4(2)^3 - 4(2)^2 = 0$$

$$-16 + 32 - 16 = 0$$

$$0 = 0$$

127.  $\sqrt{2x+13} - x - 5 = 0$

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

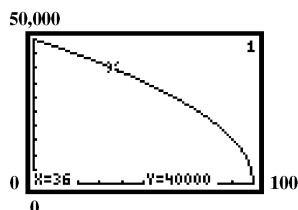
$$\sqrt{2(-2)+13} - (-2) - 5 = 0$$

$$\sqrt{-4+13} + 2 - 5 = 0$$

$$\sqrt{9} - 3 = 0$$

$$3 - 3 = 0$$

128. Tracing along the curve shows the point  $(36, 40000)$ .



129. a. False;  $(\sqrt{y+4} + \sqrt{y-1})^2 \neq y+4+y-1$
- b. False; if  $t = (x^2 - 2x)^3$ , the original equation can be written as  $t^3 - 5t + 6 = 0$ , not a quadratic form.
- c. False; the other value may be a solution.
- d. True
- (d) is true

130.  $\sqrt{6x-2} = \sqrt{2x+3} - \sqrt{4x-1}$

$$6x-2 = 2x+3 - 2\sqrt{(2x+3)(4x-1)} + 4x-1$$

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

$$2 = \sqrt{8x^2+10x-3}$$

$$4 = 8x^2+10x-3$$

$$8x^2+10x-7 = 0$$

$$x = \frac{-10 \pm \sqrt{10^2 - 4(8)(-7)}}{2(8)}$$

$$x = \frac{-10 \pm \sqrt{100 + 224}}{16}$$

$$x = \frac{-10 \pm \sqrt{324}}{16}$$

$$x = \frac{-10 \pm 18}{16}$$

$$x = \frac{-28}{16}, \frac{8}{16}$$

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

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

131.  $5 - \frac{2}{x} = \sqrt{5 - \frac{2}{x}}$

or

$$5 - \frac{2}{x} = 0 \quad 5 - \frac{2}{x} = 1$$

$$5 = \frac{2}{x} \quad -\frac{2}{x} = -4$$

$$5x = 2 \quad -4x = -2$$

$$x = \frac{2}{5} \quad x = \frac{1}{2}$$

The solution set is  $\left\{\frac{2}{5}, \frac{1}{2}\right\}$ .

132.  $\sqrt[3]{x\sqrt{x}} = 9$

$$\sqrt[3]{x\sqrt{x}} = 9$$

$$\sqrt[3]{x^1 x^{\frac{1}{2}}} = 9$$

$$\left(x^1 x^{\frac{1}{2}}\right)^{\frac{1}{3}} = 9$$

$$\left(x^{\frac{3}{2}}\right)^{\frac{1}{3}} = 9$$

$$x^{\frac{1}{2}} = 9$$

$$\left(x^{\frac{1}{2}}\right)^2 = (9)^2$$

$$x = 81$$

The solution set is  $\{81\}$ .

133.  $x^{5/6} + x^{2/3} - 2x^{1/2} = 0$

$$x^{1/2}(x^{2/6} + x^{1/6} - 2) = 0 \text{ let } t = x^{1/6}$$

$$x^{1/2}(t^2 + t - 2) = 0$$

$$x^{1/2} = 0 \quad t^2 + t - 2 = 0$$

$$(t-1)(t+2) = 0$$

$$t-1 = 0 \quad t+2 = 0$$

$$t = 1 \quad t = -2$$

$$x^{1/6} = 1 \quad x^{1/6} = -2$$

$$x = 1^6 \quad x = (-2)^6$$

$$x = 0 \quad x = 1 \quad x = 64$$

64 does not check and must be rejected.

The solution set is  $\{0, 1\}$ .

## Section 2.6

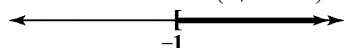
### Check Point Exercises

1.  $2 - 3x \leq 5$

$$-3x \leq 3$$

$$x \geq -1$$

The solution set is  $\{x | x \geq -1\}$  or  $[-1, \infty)$ .



2.  $3x + 1 > 7x - 15$

$$-4x > -16$$

$$\frac{-4x}{-4} < \frac{-16}{-4}$$

$$x < 4$$

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



3. a.  $3(x+1) > 3x+2$

$$3x+3 > 3x+2$$

$$3 > 2$$

$3 > 2$  is true for all values of  $x$ .

The solution set is  $\{x | x \text{ is a real number}\}$ .

b.  $x+1 \leq x-1$

$$1 \leq -1$$

$1 \leq -1$  is false for all values of  $x$ .

The solution set is  $\emptyset$ .

4.  $1 \leq 2x+3 < 11$

$$-2 \leq 2x < 8$$

$$-1 \leq x < 4$$

The solution set is  $\{x | -1 \leq x < 4\}$  or  $[-1, 4)$ .



5.  $|x-2| < 5$

$$-5 < x-2 < 5$$

$$-3 < x < 7$$

The solution set is  $\{x | -3 < x < 7\}$  or  $(-3, 7)$ .



6.  $-3|5x-2|+20 \geq -19$

$$-3|5x-2| \geq -39$$

$$\frac{-3|5x-2|}{-3} \leq \frac{-39}{-3}$$

$$|5x-2| \leq 13$$

$$-13 \leq 5x-2 \leq 13$$

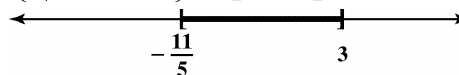
$$-11 \leq 5x \leq 15$$

$$\frac{-11}{5} \leq \frac{5x}{5} \leq \frac{15}{5}$$

$$-\frac{11}{5} \leq x \leq 3$$

The solution set is

$\{x | -\frac{11}{5} \leq x \leq 3\}$  or  $[-\frac{11}{5}, 3]$ .



7.  $18 < |6-3x|$

$$6-3x < -18$$

$$-3x < -24$$

$$\frac{-3x}{-3} > \frac{-24}{-3}$$

$$x > 8$$

$$6-3x > 18$$

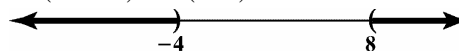
$$-3x > 12$$

$$\frac{-3x}{-3} < \frac{12}{-3}$$

$$x < -4$$

The solution set is  $\{x | x < -4 \text{ or } x > 8\}$

or  $(-\infty, -4) \cup (8, \infty)$ .

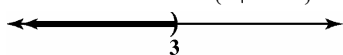


8. Let  $x$  = the number of miles driven in a week.  
 $260 < 80 + 0.25x$   
 $180 < 0.25x$   
 $720 < x$   
 Driving more than 720 miles in a week makes Basic the better deal.

**Exercise Set 2.6**

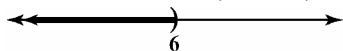
1.  $5x + 11 < 26$   
 $5x < 15$   
 $x < 3$

The solution set is  $\{x \mid x < 3\}$ , or  $(-\infty, 3)$ .



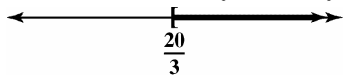
2.  $2x + 5 < 17$   
 $2x < 12$   
 $x < 6$

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



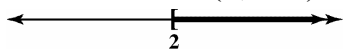
3.  $3x - 7 \geq 13$   
 $3x \geq 20$   
 $x \geq \frac{20}{3}$

The solution set is  $\{x \mid x \geq \frac{20}{3}\}$ , or  $[\frac{20}{3}, \infty)$ .



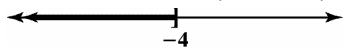
4.  $8x - 2 \geq 14$   
 $8x \geq 16$   
 $x \geq 2$

The solution set is  $\{x \mid x \geq 2\}$  or  $[2, \infty)$ .



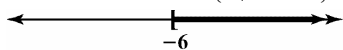
5.  $-9x \geq 36$   
 $x \leq -4$

The solution set is  $\{x \mid x \leq -4\}$ , or  $(-\infty, -4]$ .



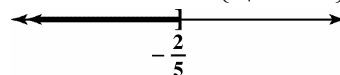
6.  $-5x \leq 30$   
 $x \geq -6$

The solution set is  $\{x \mid x \geq -6\}$  or  $[-6, \infty)$ .



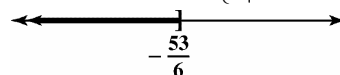
7.  $8x - 11 \leq 3x - 13$   
 $8x - 3x \leq -13 + 11$   
 $5x \leq -2$   
 $x \leq -\frac{2}{5}$

The solution set is  $\{x \mid x \leq -\frac{2}{5}\}$ , or  $(-\infty, -\frac{2}{5}]$ .



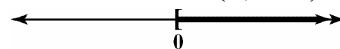
8.  $18x + 45 \leq 12x - 8$   
 $18x - 12x \leq -8 - 45$   
 $6x \leq -53$   
 $x \leq -\frac{53}{6}$

The solution set is  $\{x \mid x \leq -\frac{53}{6}\}$  or  $(-\infty, -\frac{53}{6}]$ .



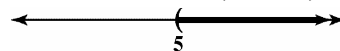
9.  $4(x + 1) + 2 \geq 3x + 6$   
 $4x + 4 + 2 \geq 3x + 6$   
 $4x + 6 \geq 3x + 6$   
 $4x - 3x \geq 6 - 6$   
 $x \geq 0$

The solution set is  $\{x \mid x \geq 0\}$ , or  $[0, \infty)$ .



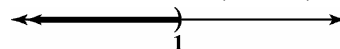
10.  $8x + 3 > 3(2x + 1) + x + 5$   
 $8x + 3 > 6x + 3 + x + 5$   
 $8x + 3 > 7x + 8$   
 $8x - 7x > 8 - 3$   
 $x > 5$

The solution set is  $\{x \mid x > 5\}$  or  $(5, \infty)$ .



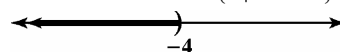
11.  $2x - 11 < -3(x + 2)$   
 $2x - 11 < -3x - 6$   
 $5x < 5$   
 $x < 1$

The solution set is  $\{x \mid x < 1\}$ , or  $(-\infty, 1)$ .



12.  $-4(x + 2) > 3x + 20$   
 $-4x - 8 > 3x + 20$   
 $-7x > 28$   
 $x < -4$

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

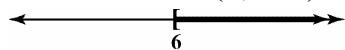


13.  $1 - (x + 3) \geq 4 - 2x$

$1 - x - 3 \geq 4 - 2x$

$-x - 2 \geq 4 - 2x$

$x \geq 6$

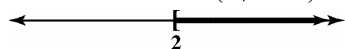
The solution set is  $\{x \mid x \geq 6\}$ , or  $[6, \infty)$ .

14.  $5(3 - x) \leq 3x - 1$

$15 - 5x \leq 3x - 1$

$-8x \leq -16$

$x \geq 2$

The solution set is  $\{x \mid x \geq 2\}$ , or  $[2, \infty)$ .

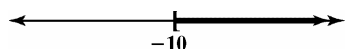
15.  $\frac{x}{4} - \frac{3}{2} \leq \frac{x}{2} + 1$

$\frac{4x}{4} - \frac{4 \cdot 3}{2} \leq \frac{4 \cdot x}{2} + 4 \cdot 1$

$x - 6 \leq 2x + 4$

$-x \leq 10$

$x \geq -10$

The solution set is  $\{x \mid x \geq -10\}$ , or  $[-10, \infty)$ .

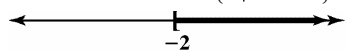
16.  $\frac{3x}{10} + 1 \geq \frac{1}{5} - \frac{x}{10}$

$10\left(\frac{3x}{10} + 1\right) \geq 10\left(\frac{1}{5} - \frac{x}{10}\right)$

$3x + 10 \geq 2 - x$

$4x \geq -8$

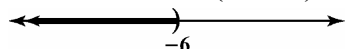
$x \geq -2$

The solution set is  $\{x \mid x \geq -2\}$ , or  $[-2, \infty)$ .

17.  $1 - \frac{x}{2} > 4$

$-\frac{x}{2} > 3$

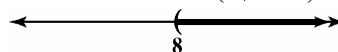
$x < -6$

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

18.  $7 - \frac{4}{5}x < \frac{3}{5}$

$-\frac{4}{5}x < -\frac{32}{5}$

$x > 8$

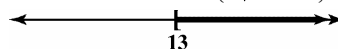
The solution set is  $\{x \mid x > 8\}$ , or  $(8, \infty)$ .

19.  $\frac{x-4}{6} \geq \frac{x-2}{9} + \frac{5}{18}$

$3(x-4) \geq 2(x-2) + 5$

$3x - 12 \geq 2x - 4 + 5$

$x \geq 13$

The solution set is  $\{x \mid x \geq 13\}$ , or  $[13, \infty)$ .

20.

$\frac{4x-3}{6} + 2 \geq \frac{2x-1}{12}$

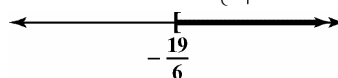
$2(4x-3) + 24 \geq 2x-1$

$8x - 6 + 24 \geq 2x - 1$

$6x + 18 \geq -1$

$6x \geq -19$

$x \geq -\frac{19}{6}$

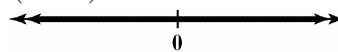
The solution set is  $\left\{x \mid x \geq -\frac{19}{6}\right\}$ , or  $\left[-\frac{19}{6}, \infty\right)$ .

21.  $4(3x-2) - 3x < 3(1+3x) - 7$

$12x - 8 - 3x < 3 + 9x - 7$

$9x - 8 < -4 + 9x$

$-8 < -4$

True for all  $x$ The solution set is  $\{x \mid x \text{ is any real number}\}$ , or $(-\infty, \infty)$ .

22.  $3(x-8) - 2(10-x) > 5(x-1)$

$3x - 24 - 20 + 2x > 5x - 5$

$5x - 44 > 5x - 5$

$-44 > -5$

Not true for any  $x$ .The solution set is the empty set,  $\emptyset$ .

23.  $5(x-2) - 3(x+4) \geq 2x - 20$

$$5x - 10 - 3x - 12 \geq 2x - 20$$

$$2x - 22 \geq 2x - 20$$

$$-22 \geq -20$$

Not true for any  $x$ .

The solution set is the empty set,  $\emptyset$ .



24.  $6(x-1) - (4-x) \geq 7x - 8$

$$6x - 6 - 4 + x \geq 7x - 8$$

$$7x - 10 \geq 7x - 8$$

$$-10 \geq -8$$

Not true for any  $x$ .

The solution set is the empty set,  $\emptyset$ .



25.  $6 < x + 3 < 8$

$$6 - 3 < x + 3 - 3 < 8 - 3$$

$$3 < x < 5$$

The solution set is  $\{x \mid 3 < x < 5\}$ , or  $(3, 5)$ .

26.  $7 < x + 5 < 11$

$$7 - 5 < x + 5 - 5 < 11 - 5$$

$$2 < x < 6$$

The solution set is  $\{x \mid 2 < x < 6\}$  or  $(2, 6)$ .

27.  $-3 \leq x - 2 < 1$

$$-1 \leq x < 3$$

The solution set is  $\{x \mid -1 \leq x < 3\}$ , or  $[-1, 3)$ .

28.  $-6 < x - 4 \leq 1$

$$-2 < x \leq 5$$

The solution set is  $\{x \mid -2 < x \leq 5\}$  or  $(-2, 5]$ .

29.  $-11 < 2x - 1 \leq -5$

$$-10 < 2x \leq -4$$

$$-5 < x \leq -2$$

The solution set is  $\{x \mid -5 < x \leq -2\}$ , or  $(-5, -2]$ .

30.  $3 \leq 4x - 3 < 19$

$$6 \leq 4x < 22$$

$$\frac{6}{4} \leq x < \frac{22}{4}$$

$$\frac{3}{2} \leq x < \frac{11}{2}$$

The solution set is  $\left\{x \mid \frac{3}{2} \leq x < \frac{11}{2}\right\}$  or  $\left[\frac{3}{2}, \frac{11}{2}\right)$ .

31.  $-3 \leq \frac{2}{3}x - 5 < -1$

$$2 \leq \frac{2}{3}x < 4$$

$$3 \leq x < 6$$

The solution set is  $\{x \mid 3 \leq x < 6\}$ , or  $[3, 6)$ .

32.  $-6 \leq \frac{1}{2}x - 4 < -3$

$$-2 \leq \frac{1}{2}x < 1$$

$$-4 \leq x < 2$$

The solution set is  $\{x \mid -4 \leq x < 2\}$  or  $[-4, 2)$ .

33.  $|x| < 3$

$$-3 < x < 3$$

The solution set is  $\{x \mid -3 < x < 3\}$ , or  $(-3, 3)$ .

34.  $|x| < 5$

$$-5 < x < 5$$

The solution set is  $\{x \mid -5 < x < 5\}$  or  $(-5, 5)$ .

35.  $|x - 1| \leq 2$

$$-2 \leq x - 1 \leq 2$$

$$-1 \leq x \leq 3$$

The solution set is  $\{x \mid -1 \leq x \leq 3\}$ , or  $[-1, 3]$ .

36.  $|x + 3| \leq 4$

$$-4 \leq x + 3 \leq 4$$

$$-7 \leq x \leq 1$$

The solution set is  $\{x \mid -7 \leq x \leq 1\}$  or  $[-7, 1]$ .

37.  $|2x - 6| < 8$

$$-8 < 2x - 6 < 8$$

$$-2 < 2x < 14$$

$$-1 < x < 7$$

The solution set is  $\{x \mid -1 < x < 7\}$ , or  $(-1, 7)$ .

38.  $|3x + 5| < 17$

$$-17 < 3x + 5 < 17$$

$$-22 < 3x < 12$$

The solution set is  $\left\{x \mid -\frac{22}{3} < x < 4\right\}$  or

$$\left(-\frac{22}{3}, 4\right).$$

$$\begin{aligned}
 39. \quad & |2(x-1)+4| \leq 8 \\
 & -8 \leq 2(x-1)+4 \leq 8 \\
 & -8 \leq 2x-2+4 \leq 8 \\
 & -8 \leq 2x+2 \leq 8 \\
 & -10 \leq 2x \leq 6 \\
 & -5 \leq x \leq 3
 \end{aligned}$$

The solution set is  $\{x \mid -5 \leq x \leq 3\}$ , or  $[-5, 3]$ .

$$\begin{aligned}
 40. \quad & |3(x-1)+2| \leq 20 \\
 & -20 \leq 3(x-1)+2 \leq 20 \\
 & -20 \leq 3x-1 \leq 20 \\
 & -19 \leq 3x \leq 21 \\
 & -\frac{19}{3} \leq x \leq 7
 \end{aligned}$$

The solution set is

$$\left\{x \mid -\frac{19}{3} \leq x \leq 7\right\} \text{ or } \left[-\frac{19}{3}, 7\right].$$

$$\begin{aligned}
 41. \quad & \left|\frac{2y+6}{3}\right| < 2 \\
 & -2 < \frac{2y+6}{3} < 2 \\
 & -6 < 2y+6 < 6 \\
 & -12 < 2y < 0 \\
 & -6 < y < 0
 \end{aligned}$$

The solution set is  $\{x \mid -6 < y < 0\}$ , or  $(-6, 0)$ .

$$\begin{aligned}
 42. \quad & \left|\frac{3(x-1)}{4}\right| < 6 \\
 & -6 < \frac{3(x-1)}{4} < 6 \\
 & -24 < 3x-3 < 24 \\
 & -21 < 3x < 27 \\
 & -7 < x < 9
 \end{aligned}$$

The solution set is  $\{x \mid -7 < x < 9\}$  or  $(-7, 9)$ .

$$\begin{aligned}
 43. \quad & |x| > 3 \\
 & x > 3 \text{ or } x < -3 \\
 & \text{The solution set is } \{x \mid x > 3 \text{ or } x < -3\}, \text{ that is,} \\
 & (-\infty, -3) \text{ or } (3, \infty).
 \end{aligned}$$

$$\begin{aligned}
 44. \quad & |x| > 5 \\
 & x > 5 \text{ or } x < -5 \\
 & \text{The solution set is } \{x \mid x < -5 \text{ or } x > 5\}, \text{ that is,} \\
 & \text{all } x \text{ in } (-\infty, -5) \text{ or } (5, \infty).
 \end{aligned}$$

$$\begin{aligned}
 45. \quad & |x-1| \geq 2 \\
 & x-1 \geq 2 \quad \text{or} \quad x-1 \leq -2 \\
 & x \geq 3 \quad \quad \quad x \leq -1
 \end{aligned}$$

The solution set is  $\{x \mid x \leq -1 \text{ or } x \geq 3\}$ , that is,  $(-\infty, -1] \text{ or } [3, \infty)$ .

$$\begin{aligned}
 46. \quad & |x+3| \geq 4 \\
 & x+3 \geq 4 \quad \text{or} \quad x+3 \leq -4 \\
 & x \geq 1 \quad \quad \quad x \leq -7
 \end{aligned}$$

The solution set is  $\{x \mid x \leq -7 \text{ or } x \geq 1\}$ , that is, all  $x$  in  $(-\infty, -7) \text{ or } (1, \infty)$ .

$$\begin{aligned}
 47. \quad & |3x-8| > 7 \\
 & 3x-8 > 7 \quad \text{or} \quad 3x-8 < -7 \\
 & 3x > 15 \quad \quad \quad 3x < 1 \\
 & x > 5 \quad \quad \quad x < \frac{1}{3}
 \end{aligned}$$

The solution set is  $\left\{x \mid x < \frac{1}{3} \text{ or } x > 5\right\}$ , that is,  $\left(-\infty, \frac{1}{3}\right) \text{ or } (5, \infty)$ .

$$\begin{aligned}
 48. \quad & |5x-2| > 13 \\
 & 5x-2 > 13 \quad \text{or} \quad 5x-2 < -13 \\
 & 5x > 15 \quad \quad \quad 5x < -11 \\
 & x > 3 \quad \quad \quad x < -\frac{11}{5}
 \end{aligned}$$

The solution set is  $\left\{x \mid x < -\frac{11}{5} \text{ or } x > 3\right\}$ , that is, all  $x$  in  $\left(-\infty, -\frac{11}{5}\right) \text{ or } (3, \infty)$ .

$$\begin{aligned}
 49. \quad & \left|\frac{2x+2}{4}\right| \geq 2 \\
 & \frac{2x+2}{4} \geq 2 \quad \text{or} \quad \frac{2x+2}{4} \leq -2 \\
 & 2x+2 \geq 8 \quad \quad \quad 2x+2 \leq -8 \\
 & 2x \geq 6 \quad \quad \quad 2x \leq -10 \\
 & x \geq 3 \quad \quad \quad x \leq -5
 \end{aligned}$$

The solution set is  $\{x \mid x \leq -5 \text{ or } x \geq 3\}$ , that is,  $(-\infty, -5] \text{ or } [3, \infty)$ .

$$50. \left| \frac{3x-3}{9} \right| \geq 1$$

$$\frac{3x-3}{9} \geq 1 \quad \text{or} \quad \frac{3x-3}{9} \leq -1$$

$$3x-3 \geq 9 \quad 3x-3 \leq -9$$

$$3x \geq 12 \quad 3x \leq -6$$

$$x \geq 4 \quad x \leq -2$$

The solution set is  $\{x \mid x \leq -2 \text{ or } x \geq 4\}$ ,

or  $(-\infty, -2]$  or  $[4, \infty)$ .

$$51. \left| 3 - \frac{2}{3}x \right| > 5$$

$$3 - \frac{2}{3}x > 5 \quad \text{or} \quad 3 - \frac{2}{3}x < -5$$

$$-\frac{2}{3}x > 2 \quad -\frac{2}{3}x < -8$$

$$x < -3 \quad x > 12$$

The solution set is  $\{x \mid x < -3 \text{ or } x > 12\}$ , that is,

$(-\infty, -3)$  or  $(12, \infty)$ .

$$52. \left| 3 - \frac{3}{4}x \right| > 9$$

$$3 - \frac{3}{4}x > 9 \quad \text{or} \quad 3 - \frac{3}{4}x < -9$$

$$-\frac{3}{4}x > 6 \quad -\frac{3}{4}x < -12$$

$$x < -8 \quad x > 16$$

$\{x \mid x < -8 \text{ or } x > 16\}$ , that is all  $x$  in

$(-\infty, -8)$  or  $(16, \infty)$ .

$$53. 3|x-1| + 2 \geq 8$$

$$3|x-1| \geq 6$$

$$|x-1| \geq 2$$

$$x-1 \geq 2 \quad \text{or} \quad x-1 \leq -2$$

$$x \geq 3 \quad x \leq -1$$

The solution set is  $\{x \mid x \leq -1 \text{ or } x \geq 3\}$ , that is,

$(-\infty, -1]$  or  $[3, \infty)$ .

$$54. 5|2x+1| - 3 \geq 9$$

$$5|2x+1| \geq 12$$

$$|2x+1| \geq \frac{12}{5}$$

$$2x+1 \geq \frac{12}{5} \quad 2x+1 \leq -\frac{12}{5}$$

$$2x \geq \frac{7}{5} \quad \text{or} \quad 2x \leq -\frac{17}{5}$$

$$x \geq \frac{7}{10} \quad x \leq -\frac{17}{10}$$

The solution set is  $\left\{x \mid x \leq -\frac{17}{10} \text{ or } x \geq \frac{7}{10}\right\}$ .

$$55. -2|x-4| \geq -4$$

$$\frac{-2|x-4|}{-2} \leq \frac{-4}{-2}$$

$$|x-4| \leq 2$$

$$-2 \leq x-4 \leq 2$$

$$2 \leq x \leq 6$$

The solution set is  $\{x \mid 2 \leq x \leq 6\}$ .

$$56. -3|x+7| \geq -27$$

$$\frac{-3|x+7|}{-3} \leq \frac{-27}{-3}$$

$$|x+7| \leq 9$$

$$-9 \leq x+7 \leq 9$$

$$-16 \leq x \leq 2$$

The solution set is  $\{x \mid -16 \leq x \leq 2\}$ .

$$57. -4|1-x| < -16$$

$$\frac{-4|1-x|}{-4} > \frac{-16}{-4}$$

$$|1-x| > 4$$

$$1-x > 4 \quad 1-x < -4$$

$$-x > 3 \quad \text{or} \quad -x < -5$$

$$x < -3 \quad x > 5$$

The solution set is  $\{x \mid x < -3 \text{ or } x > 5\}$ .

$$58. -2|5-x| < -6$$

$$-2|5-x| < -6$$

$$\frac{-2|5-x|}{-2} > \frac{-6}{-2}$$

$$|5-x| > 3$$

$$5-x > 3 \quad 5-x < -3$$

$$-x > -2 \quad \text{or} \quad -x < -8$$

$$x < 2 \quad x > 8$$

The solution set is  $\{x \mid x < 2 \text{ or } x > 8\}$ .

59.  $3 \leq |2x - 1|$

$$2x - 1 \geq 3 \quad 2x - 1 \leq -3$$

$$2x \geq 4 \quad \text{or} \quad 2x \leq -2$$

$$x \geq 2 \quad x \leq -1$$

The solution set is  $\{x \mid x \leq -1 \text{ or } x \geq 2\}$ .

60.  $9 \leq |4x + 7|$

$$4x + 7 \geq 9 \quad \text{or} \quad 4x + 7 \leq -9$$

$$4x \geq 2 \quad 4x \leq -16$$

$$x \geq \frac{2}{4} \quad x \leq -4$$

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

The solution set is  $\left\{x \mid x \leq -4 \text{ or } x \geq \frac{1}{2}\right\}$ .

61.  $5 > |4 - x|$  is equivalent to  $|4 - x| < 5$ .

$$-5 < 4 - x < 5$$

$$-9 < -x < 1$$

$$\frac{-9}{-1} > \frac{-x}{-1} > \frac{1}{-1}$$

$$9 > x > -1$$

$$-1 < x < 9$$

The solution set is  $\{x \mid -1 < x < 9\}$ .

62.  $2 > |11 - x|$  is equivalent to  $|11 - x| < 2$ .

$$-2 < 11 - x < 2$$

$$-13 < -x < -9$$

$$\frac{-13}{-1} > \frac{-x}{-1} > \frac{-9}{-1}$$

$$13 > x > 9$$

$$9 < x < 13$$

The solution set is  $\{x \mid 9 < x < 13\}$ .

63.  $1 < |2 - 3x|$  is equivalent to  $|2 - 3x| > 1$ .

$$2 - 3x > 1$$

$$2 - 3x < -1$$

$$-3x > -1 \quad -3x < -3$$

$$\frac{-3x}{-3} < \frac{-1}{-3} \quad \text{or} \quad \frac{-3x}{-3} > \frac{-3}{-3}$$

$$x < \frac{1}{3} \quad x > 1$$

The solution set is  $\left\{x \mid x < \frac{1}{3} \text{ or } x > 1\right\}$ .

64.  $4 < |2 - x|$  is equivalent to  $|2 - x| > 4$ .

$$2 - x > 4 \quad \text{or} \quad 2 - x < -4$$

$$-x > 2 \quad -x < -6$$

$$\frac{-x}{-1} < \frac{2}{-1} \quad \frac{-x}{-1} > \frac{-6}{-1}$$

$$x < -2 \quad x > 6$$

The solution set is  $\{x \mid x < -2 \text{ or } x > 6\}$ .

65.  $12 < \left| -2x + \frac{6}{7} \right| + \frac{3}{7}$

$$\frac{81}{7} < \left| -2x + \frac{6}{7} \right|$$

$$-2x + \frac{6}{7} > \frac{81}{7} \quad \text{or} \quad -2x + \frac{6}{7} < -\frac{81}{7}$$

$$-2x > \frac{75}{7} \quad -2x < -\frac{87}{7}$$

$$x < -\frac{75}{14} \quad x > \frac{87}{14}$$

The solution set is  $\left\{x \mid x < -\frac{75}{14} \text{ or } x > \frac{87}{14}\right\}$ ,

that is,  $\left(-\infty, -\frac{75}{14}\right) \text{ or } \left(\frac{87}{14}, \infty\right)$ .

66.  $1 < \left| x - \frac{11}{3} \right| + \frac{7}{3}$

$$-\frac{4}{3} < \left| x - \frac{11}{3} \right|$$

Since  $\left| x - \frac{11}{3} \right| > -\frac{4}{3}$  is true for all  $x$ ,

the solution set is  $\{x \mid x \text{ is any real number}\}$

or  $(-\infty, \infty)$ .

67.  $4 + \left| 3 - \frac{x}{3} \right| \geq 9$

$$\left| 3 - \frac{x}{3} \right| \geq 5$$

$$3 - \frac{x}{3} \geq 5 \quad \text{or} \quad 3 - \frac{x}{3} \leq -5$$

$$-\frac{x}{3} \geq 2 \quad -\frac{x}{3} \leq -8$$

$$x \leq -6 \quad x \geq 24$$

The solution set is  $\{x \mid x \leq -6 \text{ or } x \geq 24\}$ , that is,

$(-\infty, -6] \text{ or } [24, \infty)$ .

$$68. \left| 2 - \frac{x}{2} \right| - 1 \leq 1$$

$$\left| 2 - \frac{x}{2} \right| \leq 2$$

$$-2 \leq 2 - \frac{x}{2} \leq 2$$

$$-4 \leq -\frac{x}{2} \leq 0$$

$$8 \geq x \geq 0$$

The solution set is  $\{x \mid 0 \leq x \leq 8\}$  or  $[0, 8]$ .

$$69. y_1 \leq y_2$$

$$\frac{x}{2} + 3 \leq \frac{x}{3} + \frac{5}{2}$$

$$6\left(\frac{x}{2} + 3\right) \leq 6\left(\frac{x}{3} + \frac{5}{2}\right)$$

$$\frac{6x}{2} + 6(3) \leq \frac{6x}{3} + \frac{6(5)}{2}$$

$$3x + 18 \leq 2x + 15$$

$$x \leq -3$$

The solution set is  $(-\infty, -3]$ .

$$70. y_1 > y_2$$

$$\frac{2}{3}(6x - 9) + 4 > 5x + 1$$

$$3\left(\frac{2}{3}(6x - 9) + 4\right) > 3(5x + 1)$$

$$2(6x - 9) + 12 > 15x + 3$$

$$12x - 18 + 12 > 15x + 3$$

$$12x - 6 > 15x + 3$$

$$-3x > 9$$

$$\frac{-3x}{-3} < \frac{9}{-3}$$

$$x < -3$$

The solution set is  $(-\infty, -3)$ .

$$71. y \geq 4$$

$$1 - (x + 3) + 2x \geq 4$$

$$1 - x - 3 + 2x \geq 4$$

$$x - 2 \geq 4$$

$$x \geq 6$$

The solution set is  $[6, \infty)$ .

$$72. y \leq 0$$

$$2x - 11 + 3(x + 2) \leq 0$$

$$2x - 11 + 3x + 6 \leq 0$$

$$5x - 5 \leq 0$$

$$5x \leq 5$$

$$x \leq 1$$

The solution set is  $(-\infty, 1]$ .

$$73. y < 8$$

$$|3x - 4| + 2 < 8$$

$$|3x - 4| < 6$$

$$-6 < 3x - 4 < 6$$

$$-2 < 3x < 10$$

$$\frac{-2}{3} < \frac{3x}{3} < \frac{10}{3}$$

$$\frac{-2}{3} < x < \frac{10}{3}$$

The solution set is  $\left(\frac{-2}{3}, \frac{10}{3}\right)$ .

$$74. y > 9$$

$$|2x - 5| + 1 > 9$$

$$|2x - 5| > 8$$

$$2x - 5 > 8 \quad \text{or} \quad 2x - 5 < -8$$

$$2x > 13 \quad 2x < -3$$

$$x > \frac{13}{2} \quad x < \frac{-3}{2}$$

The solution set is  $\left(-\infty, -\frac{3}{2}\right) \cup \left(\frac{13}{2}, \infty\right)$ .

$$75. y \leq 4$$

$$7 - \left|\frac{x}{2} + 2\right| \leq 4$$

$$-\left|\frac{x}{2} + 2\right| \leq -3$$

$$\left|\frac{x}{2} + 2\right| \geq 3$$

$$\frac{x}{2} + 2 \geq 3 \quad \text{or} \quad \frac{x}{2} + 2 \leq -3$$

$$x + 4 \geq 6 \quad x + 4 \leq -6$$

$$x \geq 2 \quad x \leq -10$$

The solution set is  $(-\infty, -10] \cup [2, \infty)$ .

76.  $y \geq 6$

$$8 - |5x + 3| \geq 6$$

$$-|5x + 3| \geq -2$$

$$-(-|5x + 3|) \leq -(-2)$$

$$|5x + 3| \leq 2$$

$$-2 \leq 5x + 3 \leq 2$$

$$-5 \leq 5x \leq -1$$

$$\frac{-5}{5} \leq \frac{5x}{5} \leq \frac{-1}{5}$$

$$-1 \leq x \leq -\frac{1}{5}$$

The solution set is  $\left[-1, -\frac{1}{5}\right]$ .77. The graph's height is below 5 on the interval  $(-1, 9)$ .78. The graph's height is at or above 5 on the interval  $(-\infty, -1] \cup [9, \infty)$ .79. The solution set is  $\{x \mid -1 \leq x < 2\}$  or  $[-1, 2)$ .80. The solution set is  $\{x \mid 1 < x \leq 4\}$  or  $(1, 4]$ .81. Let  $x$  be the number.

$$|4 - 3x| \geq 5 \quad \text{or} \quad |3x - 4| \geq 5$$

$$3x - 4 \geq 5 \quad \quad 3x - 4 \leq -5$$

$$3x \geq 9 \quad \text{or} \quad 3x \leq -1$$

$$x \geq 3 \quad \quad x \leq -\frac{1}{3}$$

The solution set is  $\left\{x \mid x \leq -\frac{1}{3} \text{ or } x \geq 3\right\}$  or

$$\left(-\infty, -\frac{1}{3}\right] \cup [3, \infty).$$

82. Let  $x$  be the number.

$$|5 - 4x| \leq 13 \quad \text{or} \quad |4x - 5| \leq 13$$

$$-13 \leq 4x - 5 \leq 13$$

$$-8 \leq 4x \leq 18$$

$$-2 \leq x \leq \frac{9}{2}$$

The solution set is  $\left\{x \mid -2 \leq x \leq \frac{9}{2}\right\}$  or  $\left[-2, \frac{9}{2}\right]$ .

83.  $20 - 4x \geq 0$

$$-4x \geq -20$$

$$\frac{-4x}{-4} \leq \frac{-20}{-4}$$

$$x \leq 5$$

Domain:  $(-\infty, 5]$ 

84.  $15 - 3x \geq 0$

$$-3x \geq -15$$

$$\frac{-3x}{-3} \leq \frac{-15}{-3}$$

$$x \leq 5$$

Domain:  $(-\infty, 5]$ 

85.  $3(2x - 5) - 8x + 5 > 0$

$$6x - 15 - 8x + 5 > 0$$

$$-2x - 10 > 0$$

$$-2x > 10$$

$$\frac{-2x}{-2} < \frac{10}{-2}$$

$$x < -5$$

Domain:  $(-\infty, 5)$ 

86.  $5(2x + 7) + 4x + 7 > 0$

$$10x + 35 + 4x + 7 > 0$$

$$14x + 42 > 0$$

$$14x > -42$$

$$\frac{14x}{14} > \frac{-42}{14}$$

$$x > -3$$

Domain:  $(-3, \infty)$ 

87.  $2x - 8 \geq 0$  and  $4x - 4 \geq 0$

$$2x \geq 8$$

$$4x \geq 4$$

$$x \geq 4$$

$$x \geq 1$$

Domain:  $[4, \infty)$ 

88.  $-4x + 2 \geq 0$  and  $-2x - 8 \geq 0$

$$-4x \geq -2$$

$$-2x \geq 8$$

$$\frac{-4x}{-4} \leq \frac{-2}{-4}$$

$$\frac{-2x}{-2} \leq \frac{8}{-2}$$

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

$$x \leq -4$$

Domain:  $(-\infty, -4]$

89.  $(0, 4)$

90.  $[0, 5]$

91.  $\text{passion} \leq \text{intimacy}$  or  $\text{intimacy} \geq \text{passion}$

92.  $\text{commitment} \geq \text{intimacy}$  or  
 $\text{intimacy} \leq \text{commitment}$

93.  $\text{Passion} < \text{commitment}$  or  
 $\text{commitment} > \text{passion}$

94.  $\text{commitment} > \text{passion}$  or  
 $\text{passion} < \text{commitment}$

95. 9, after 3 years

96. After approximately  $5\frac{1}{2}$  years

97.  $3.1x + 25.8 > 63$

$3.1x > 37.2$

$x > 12$

Since  $x$  is the number of years after 1994, we calculate  $1994 + 12 = 2006$ . 63% of voters will use electronic systems after 2006.

98.  $-2.5x + 63.1 < 38.1$

$-2.5x < 25$

$x > 10$

$1994 + 10 = 2004$

In years after 2004, fewer than 38.1% of U.S. voters will use punch cards or lever machines.

99.  $28 \leq 20 + 0.40(x - 60) \leq 40$

$28 \leq 20 + 0.40x - 24 \leq 40$

$28 \leq 0.40x - 4 \leq 40$

$32 \leq 0.40x \leq 44$

$80 \leq x \leq 110$

Between 80 and 110 ten minutes, inclusive.

100.  $15 \leq \frac{5}{9}(F - 32) \leq 35$

$\frac{9}{5}(15) \leq \frac{9}{5}\left(\frac{5}{9}(F - 32)\right) \leq \frac{9}{5}(35)$

$9(3) \leq F - 32 \leq 9(7)$

$27 \leq F - 32 \leq 63$

$59 \leq F \leq 95$

The range for Fahrenheit temperatures is  $59^\circ\text{F}$  to  $95^\circ\text{F}$ , inclusive or  $[59^\circ\text{F}, 95^\circ\text{F}]$ .

101. a.  $m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{550 - 451}{32 - 0} \approx 3.1$

$y - y_1 = m(x - x_1)$

$y - 451 = 3.1(x - 0)$

$y = 3.1x + 451$

$M(x) = 3.1x + 451$

b.  $W(x) = 12.5x + 341$

c.  $W(x) > M(x)$

$12.5x + 341 > 3.1x + 451$

$9.4x > 110$

$x > 11.7$

Women were awarded more degrees than men starting about 11.7 years after 1970, or 1982. This describes the data shown in the graph very well.

102.  $\left|\frac{h-50}{5}\right| \geq 1.645$

$\frac{h-50}{5} \geq 1.645$  or  $\frac{h-50}{5} \leq -1.645$

$h - 50 \geq 8.225$   $h - 50 \leq -8.225$

$h \geq 58.225$   $h \leq 41.775$

The number of outcomes would be 59 or more, or 41 or less.

103.  $50 + 0.20x < 20 + 0.50x$

$30 < 0.3x$

$100 < x$

Basic Rental is a better deal when driving more than 100 miles per day.

104.  $15 + 0.08x < 3 + 0.12x$

$12 < 0.04x$

$300 < x$

Plan A is a better deal when driving more than 300 miles a month.

105.  $1800 + 0.03x < 200 + 0.08x$

$1600 < 0.05x$

$32000 < x$

A home assessment of greater than \$32,000 would make the first bill a better deal.

106.  $2 + 0.08x < 8 + 0.05x$

$0.03x < 6$

$x < 200$

The credit union is a better deal when writing less than 200 checks.

107.  $2x > 10,000 + 0.40x$

$$1.6x > 10,000$$

$$\frac{1.6x}{1.6} > \frac{10,000}{1.6}$$

$$x > 6250$$

More than 6250 tapes need to be sold a week to make a profit.

108.  $3000 + 3x < 5.5x$

$$3000 < 2.5x$$

$$1200 < x$$

More than 1200 packets of stationary need to be sold each week to make a profit.

109.  $265 + 65x \leq 2800$

$$65x \leq 2535$$

$$x \leq 39$$

39 bags or fewer can be lifted safely.

110.  $245 + 95x \leq 3000$

$$95x \leq 2755$$

$$x \leq 29$$

29 bags or less can be lifted safely.

111. a.  $\frac{86 + 88 + x}{3} \geq 90$

$$\frac{174 + x}{3} \geq 90$$

$$174 + x \geq 270$$

$$x \geq 96$$

You must get at least a 96.

b.  $\frac{86 + 88 + x}{3} < 80$

$$\frac{174 + x}{3} < 80$$

$$174 + x < 240$$

$$x < 66$$

This will happen if you get a grade less than 66.

112. Let  $x$  = the grade on the final exam.

$$\frac{86 + 88 + 92 + 84 + x + x}{6} \geq 90$$

$$86 + 88 + 92 + 84 + x + x \geq 540$$

$$2x + 350 \geq 540$$

$$2x \geq 190$$

$$x \geq 95$$

You must receive at least a 95% to earn an A.

113. Let  $x$  = the number of times the bridge is crossed per three month period

The cost with the 3-month pass is

$$C_3 = 7.50 + 0.50x.$$

The cost with the 6-month pass is  $C_6 = 30$ .

Because we need to buy two 3-month passes per 6-month pass, we multiply the cost with the 3-month pass by 2.

$$2(7.50 + 0.50x) < 30$$

$$15 + x < 30$$

$$x < 15$$

We also must consider the cost without purchasing a pass. We need this cost to be less than the cost with a 3-month pass.

$$3x > 7.50 + 0.50x$$

$$2.50x > 7.50$$

$$x > 3$$

The 3-month pass is the best deal when making more than 3 but less than 15 crossings per three-month period.

114. Let  $x$  = the number of hours the mechanic works on the car.

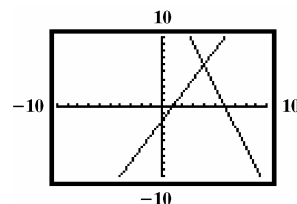
$$226 \leq 175 + 34x \leq 294$$

$$51 \leq 34x \leq 119$$

$$1.5 \leq x \leq 3.5$$

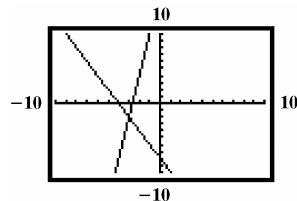
The man will be working on the job at least 1.5 and at most 3.5 hours.

123.



$$x < 4$$

124.



$$x < -3$$

125. Verify exercise 142.

| X | Y <sub>1</sub> | Y <sub>2</sub> |
|---|----------------|----------------|
| 2 | 12             | 2              |
| 3 | 13             | 4              |
| 4 | 14             | 6              |
| 5 | 15             | 8              |
| 6 | 16             | 10             |
| 7 | 17             | 12             |
| 8 | 18             | 14             |

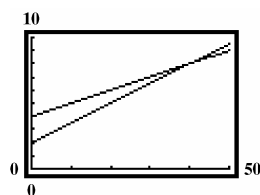
X=4

Verify exercise 143.

| X  | Y <sub>1</sub> | Y <sub>2</sub> |
|----|----------------|----------------|
| -5 | 2              | -14            |
| -4 | 0              | -8             |
| -3 | -2             | -2             |
| -2 | -4             | 4              |
| -1 | -6             | 10             |
| 0  | -8             | 16             |
| 1  | -10            | 22             |

X=-3

- 126 a. The cost of Plan A is  $4 + 0.10x$ ;  
The cost of Plan B is  $2 + 0.15x$ .



- c. 41 or more checks make Plan A better.
- d.  $4 + 0.10x < 2 + 0.15x$   
 $2 < 0.05x$   
 $x > 40$   
The solution set is  $\{x \mid x > 40\}$  or  $(40, \infty)$ .
127. a. False;  $|2x - 3| > -7$  is true for any  $x$  because the absolute value is 0 or positive.
- b. False;  $2x > 6$ ,  $x > 3$   
3.1 is a real number that satisfies the inequality.
- c. True;  $|x - 4| > 0$  is not satisfied only when  $x = 4$ . Since 4 is rational, all irrational numbers satisfy the inequality.
- d. False  
(c) is true.
128. Because  $x > y$ ,  $y - x$  represents a negative number. When both sides are multiplied by  $(y - x)$  the inequality must be reversed.

129. a.  $|x - 4| < 3$

b.  $|x - 4| \geq 3$

130. Model 1:

$|T - 57| < 7$

$-7 < T - 57 < 7$

$50 < T < 64$

Model 2:

$|T - 50| < 22$

$-22 < T - 50 < 22$

$28 < T < 72$

Model 1 describes a city with monthly temperature averages ranging from 50 degrees to 64 degrees Fahrenheit. Model 2 describes a city with monthly temperature averages ranging from 28 degrees to 72 degrees Fahrenheit.

Model 1 describes San Francisco and Model 2 describes Albany.

## Chapter 2 Review Exercises

1.  $2x - 5 = 7$   
 $2x = 12$   
 $x = 6$   
The solution set is  $\{6\}$ .  
This is a conditional equation.
2.  $5x + 20 = 3x$   
 $2x = -20$   
 $x = -10$   
The solution set is  $\{-10\}$ .  
This is a conditional equation.
3.  $7(x - 4) = x + 2$   
 $7x - 28 = x + 2$   
 $6x = 30$   
 $x = 5$   
The solution set is  $\{5\}$ .  
This is a conditional equation.
4.  $1 - 2(6 - x) = 3x + 2$   
 $1 - 12 + 2x = 3x + 2$   
 $-11 - x = 2$   
 $-x = 13$   
 $x = -13$   
The solution set is  $\{-13\}$ .  
This is a conditional equation.

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

$$2x-8+3x+15=2x-2$$

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

$$3x=-9$$

$$x=-3$$

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

This is a conditional equation.

6.  $2x-4(5x+1)=3x+17$

$$2x-20x-4=3x+17$$

$$-18x-4=3x+17$$

$$-21x=21$$

$$x=-1$$

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

This is a conditional equation.

7.  $7x+5=5(x+3)+2x$

$$7x+5=5x+15+2x$$

$$7x+5=7x+15$$

$$5=15$$

The solution set is  $\emptyset$ .

This is an inconsistent equation.

8.  $7x+13=2(2x-5)+3x+23$

$$7x+13=2(2x-5)+3x+23$$

$$7x+13=4x-10+3x+23$$

$$7x+13=7x+13$$

$$13=13$$

The solution set is all real numbers.

This is an identity.

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

$$2(2x)=x+6$$

$$4x=x+6$$

$$3x=6$$

$$x=2$$

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

This is a conditional equation.

10.  $\frac{x}{2}-\frac{1}{10}=\frac{x}{5}+\frac{1}{2}$

$$5x-1=2x+5$$

$$3x=6$$

$$x=2$$

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

This is a conditional equation.

11.  $\frac{2x}{3}=6-\frac{x}{4}$

$$4(2x)=12(6)-3x$$

$$8x=72-3x$$

$$11x=72$$

$$x=\frac{72}{11}$$

The solution set is  $\left\{\frac{72}{11}\right\}$ .

This is a conditional equation.

12.  $\frac{x}{4}=2-\frac{x-3}{3}$

$$\frac{12 \cdot x}{4}=12(2)-\frac{12(x-3)}{3}$$

$$3x=24-4x+12$$

$$7x=36$$

$$x=\frac{36}{7}$$

The solution set is  $\left\{\frac{36}{7}\right\}$ .

This is a conditional equation.

13.  $\frac{3x+1}{3}-\frac{13}{2}=\frac{1-x}{4}$

$$4(3x+1)-6(13)=3(1-x)$$

$$12x+4-78=3-3x$$

$$12x-74=3-3x$$

$$15x=77$$

$$x=\frac{77}{15}$$

The solution set is  $\left\{\frac{77}{15}\right\}$ .

This is a conditional equation.

14.  $\frac{9}{4}-\frac{1}{2x}=\frac{4}{x}$

$$9x-2=16$$

$$9x=18$$

$$x=2$$

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

This is a conditional equation.

$$15. \quad \frac{7}{x-5} + 2 = \frac{x+2}{x-5}$$

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

$$7 + 2x - 10 = x + 2$$

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

$$x = 5$$

5 does not check and must be rejected.

The solution set is the empty set,  $\emptyset$ .

This is an inconsistent equation.

$$16. \quad \frac{1}{x-1} - \frac{1}{x+1} = \frac{2}{x^2-1}$$

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

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

$$x+1 - x + 1 = 2$$

$$2 = 2$$

The solution set is all real numbers except  $-1$  and  $1$ . This is a conditional equation.

$$17. \quad \frac{5}{x+3} + \frac{1}{x-2} = \frac{8}{x^2+x-6}$$

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

$$\frac{5(x+3)(x-2)}{x+3} + \frac{(x+3)(x-2)}{x-2} = \frac{8(x+3)(x-2)}{(x+3)(x-2)}$$

$$5(x-2) + 1(x+3) = 8$$

$$5x - 10 + x + 3 = 8$$

$$6x - 7 = 8$$

$$6x = 15$$

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

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

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

This is a conditional equation.

$$18. \quad \frac{1}{x+5} = 0$$

$$(x+5) \frac{1}{x+5} = (x+5)(0)$$

$$1 = 0$$

The solution set is the empty set,  $\emptyset$ .

This is an inconsistent equation.

$$19. \quad \frac{4}{x+2} + \frac{3}{x} = \frac{10}{x^2+2x}$$

$$\frac{4}{x+2} + \frac{3}{x} = \frac{10}{x(x+2)}$$

$$\frac{4 \cdot x(x+2)}{x+2} + \frac{3 \cdot x(x+2)}{x} = \frac{10 \cdot x(x+2)}{x(x+2)}$$

$$4x + 3(x+2) = 10$$

$$4x + 3x + 6 = 10$$

$$7x + 6 = 10$$

$$7x = 4$$

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

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

This is a conditional equation.

$$20. \quad 3 - 5(2x+1) - 2(x-4) = 0$$

$$3 - 5(2x+1) - 2(x-4) = 0$$

$$3 - 10x - 5 - 2x + 8 = 0$$

$$-12x + 6 = 0$$

$$-12x = -6$$

$$x = \frac{-6}{-12}$$

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

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

This is a conditional equation.

$$21. \quad \frac{x+2}{x+3} + \frac{1}{x^2+2x-3} - 1 = 0$$

$$\frac{x+2}{x+3} + \frac{1}{(x+3)(x-1)} - 1 = 0$$

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

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

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

$$x^2 + x - 2 + 1 = x^2 + 2x - 3$$

$$x - 1 = 2x - 3$$

$$-x = -2$$

$$x = 2$$

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

This is a conditional equation.

22. Let  $x$  = the number of calories in Burger King's Chicken Caesar.  
 $x + 125$  = the number of calories in Taco Bell's Express Taco Salad.  
 $x + 95$  = the number of calories in Wendy's Mandarin Chicken Salad.

$$x + (x + 125) + (x + 95) = 1705$$

$$3x + 220 = 1705$$

$$3x = 1485$$

$$x = 495$$

$$x + 125 = 495 + 125 = 620$$

$$x + 95 = 495 + 95 = 590$$

There are 495 calories in the Chicken Caesar, 620 calories in the Express Taco Salad, and 590 calories in the Mandarin Chicken Salad.

23. Let  $x$  = the number of years after 1970.

$$P = -0.5x + 37.4$$

$$18.4 = -0.5x + 37.4$$

$$-19 = -0.5x$$

$$\frac{-19}{-0.5} = \frac{-0.5x}{-0.5}$$

$$38 = x$$

If the trend continues only 18.4% of U.S. adults will smoke cigarettes 38 years after 1970, or 2008.

24.  $15 + .05x = 5 + .07x$

$$10 = .02x$$

$$500 = x$$

Both plans cost the same at 500 minutes.

25. Let  $x$  = the original price of the phone

$$48 = x - 0.20x$$

$$48 = 0.80x$$

$$60 = x$$

The original price is \$60.

26. Let  $x$  = the amount sold to earn \$800 in one week

$$800 = 300 + 0.05x$$

$$500 = 0.05x$$

$$10,000 = x$$

Sales must be \$10,000 in one week to earn \$800.

27. Let  $x$  = the amount invested at 4%

Let  $y$  = the amount invested at 7%

$$x + y = 9000$$

$$0.04x + 0.07y = 555$$

Multiply the first equation by  $-0.04$  and add.

$$-0.04x - 0.04y = -360$$

$$\frac{0.04x + 0.07y = 555}{0.03y = 195}$$

$$0.03y = 195$$

$$y = 6500$$

Back-substitute 6500 for  $y$  in one of the original equations to find  $x$ .

$$x + y = 9000$$

$$x + 6500 = 9000$$

$$x = 2500$$

There was \$2500 invested at 4% and \$6500 invested at 7%.

28. Let  $x$  = the amount invested at 2%

Let  $8000 - x$  = the amount invested at 5%.

$$0.05(8000 - x) = 0.02x + 85$$

$$400 - 0.05x = 0.02x + 85$$

$$-0.05x - 0.02x = 85 - 400$$

$$-0.07x = -315$$

$$\frac{-0.07x}{-0.07} = \frac{-315}{-0.07}$$

$$x = 4500$$

$$8000 - x = 3500$$

\$4500 was invested at 2% and \$3500 was invested at 5%.

29. Let  $w$  = the width of the playing field,

Let  $3w - 6$  = the length of the playing field

$$P = 2(\text{length}) + 2(\text{width})$$

$$340 = 2(3w - 6) + 2w$$

$$340 = 6w - 12 + 2w$$

$$340 = 8w - 12$$

$$352 = 8w$$

$$44 = w$$

The dimensions are 44 yards by 126 yards.

30. a. Let  $x$  = the number of years (after 2007).

College A's enrollment:  $14,100 + 1500x$

College B's enrollment:  $41,700 - 800x$

$$14,100 + 1500x = 41,700 - 800x$$

- b. Check some points to determine that

$$y_1 = 14,100 + 1500x \text{ and}$$

$$y_2 = 41,700 - 800x. \text{ Since}$$

$$y_1 = y_2 = 32,100 \text{ when } x = 12, \text{ the two}$$

colleges will have the same enrollment in the year  $2007 + 12 = 2019$ . That year the enrollments will be 32,100 students.

$$31. (8-3i)-(17-7i) = 8-3i-17+7i \\ = -9+4i$$

$$32. 4i(3i-2) = (4i)(3i) + (4i)(-2) \\ = 12i^2 - 8i \\ = -12 - 8i$$

$$33. (7-i)(2+3i) \\ = 7 \cdot 2 + 7(3i) + (-i)(2) + (-i)(3i) \\ = 14 + 21i - 2i + 3 \\ = 17 + 19i$$

$$34. (3-4i)^2 = 3^2 + 2 \cdot 3(-4i) + (-4i)^2 \\ = 9 - 24i - 16 \\ = -7 - 24i$$

$$35. (7+8i)(7-8i) = 7^2 + 8^2 = 49 + 64 = 113$$

$$36. \frac{6}{5+i} = \frac{6}{5+i} \cdot \frac{5-i}{5-i} \\ = \frac{30-6i}{25+1} \\ = \frac{30-6i}{26} \\ = \frac{15-3i}{13} \\ = \frac{15}{13} - \frac{3}{13}i$$

$$37. \frac{3+4i}{4-2i} = \frac{3+4i}{4-2i} \cdot \frac{4+2i}{4+2i} \\ = \frac{12+6i+16i+8i^2}{16-4i^2} \\ = \frac{12+22i-8}{16+4} \\ = \frac{4+22i}{20} \\ = \frac{1}{5} + \frac{11}{10}i$$

$$38. \sqrt{-32} - \sqrt{-18} = i\sqrt{32} - i\sqrt{18} \\ = i\sqrt{16 \cdot 2} - i\sqrt{9 \cdot 2} \\ = 4i\sqrt{2} - 3i\sqrt{2} \\ = (4i-3i)\sqrt{2} \\ = i\sqrt{2}$$

$$39. (-2+\sqrt{-100})^2 = (-2+i\sqrt{100})^2 \\ = (-2+10i)^2 \\ = 4 - 40i + (10i)^2 \\ = 4 - 40i - 100 \\ = -96 - 40i$$

$$40. \frac{4+\sqrt{-8}}{2} = \frac{4+i\sqrt{8}}{2} = \frac{4+2i\sqrt{2}}{2} = 2+i\sqrt{2}$$

$$41. 2x^2 + 15x = 8 \\ 2x^2 + 15x - 8 = 0 \\ (2x-1)(x+8) = 0 \\ 2x-1 = 0 \quad x+8 = 0 \\ x = \frac{1}{2} \quad \text{or} \quad x = -8$$

The solution set is  $\left\{\frac{1}{2}, -8\right\}$ .

$$42. 5x^2 + 20x = 0 \\ 5x(x+4) = 0 \\ 5x = 0 \quad x+4 = 0 \\ x = 0 \quad \text{or} \quad x = -4 \\ \text{The solution set is } \{0, -4\}.$$

$$43. 2x^2 - 3 = 125 \\ 2x^2 = 128 \\ x^2 = 64 \\ x = \pm 8 \\ \text{The solution set is } \{8, -8\}.$$

$$44. \frac{x^2}{2} + 5 = -3 \\ \frac{x^2}{2} = -8 \\ x^2 = -16 \\ \sqrt{x^2} = \pm\sqrt{-16} \\ x = \pm 4i$$

$$45. (x+3)^2 = -10 \\ \sqrt{(x+3)^2} = \pm\sqrt{-10} \\ x+3 = \pm i\sqrt{10} \\ x = -3 \pm i\sqrt{10}$$

46.  $(3x-4)^2 = 18$

$$\sqrt{(3x-4)^2} = \pm\sqrt{18}$$

$$3x-4 = \pm 3\sqrt{2}$$

$$3x = 4 \pm 3\sqrt{2}$$

$$\frac{3x}{3} = \frac{4 \pm 3\sqrt{2}}{3}$$

$$x = \frac{4 \pm 3\sqrt{2}}{3}$$

47.  $x^2 - 12x + 27 = 0$

$$x^2 - 12x = -27$$

$$x^2 - 12x + 36 = -27 + 36$$

$$(x-6)^2 = 9$$

$$x-6 = \pm 3$$

$$x = 6 \pm 3$$

$$x = 9, 3$$

The solution set is  $\{9, 3\}$ .

48.  $3x^2 - 12x + 11 = 0$

$$3x^2 - 12x = -11$$

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

$$x^2 - 4x + 4 = -\frac{11}{3} + 4$$

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

$$x-2 = \pm\sqrt{\frac{1}{3}}$$

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

The solution set is  $\left\{2 + \frac{\sqrt{3}}{3}, 2 - \frac{\sqrt{3}}{3}\right\}$ .

49.  $x^2 = 2x + 4$

$$x^2 - 2x - 4 = 0$$

$$x = \frac{2 \pm \sqrt{(-2)^2 - 4(1)(-4)}}{2(1)}$$

$$x = \frac{2 \pm \sqrt{4+16}}{2}$$

$$x = \frac{2 \pm \sqrt{20}}{2}$$

$$x = \frac{2 \pm 2\sqrt{5}}{2}$$

$$x = 1 \pm \sqrt{5}$$

The solution set is  $\{1 + \sqrt{5}, 1 - \sqrt{5}\}$ .

50.  $x^2 - 2x + 19 = 0$

$$x = \frac{2 \pm \sqrt{(-2)^2 - 4(1)(19)}}{2(1)}$$

$$x = \frac{2 \pm \sqrt{4-76}}{2}$$

$$x = \frac{2 \pm \sqrt{-72}}{2}$$

$$x = \frac{2 \pm 6i\sqrt{2}}{2}$$

$$x = 1 \pm 3i\sqrt{2}$$

The solution set is  $\{1 + 3i\sqrt{2}, 1 - 3i\sqrt{2}\}$ .

51.  $2x^2 = 3 - 4x$

$$2x^2 + 4x - 3 = 0$$

$$x = \frac{-4 \pm \sqrt{4^2 - 4(2)(-3)}}{2(2)}$$

$$x = \frac{-4 \pm \sqrt{16+24}}{4}$$

$$x = \frac{-4 \pm \sqrt{40}}{4}$$

$$x = \frac{-4 \pm 2\sqrt{10}}{4}$$

$$x = \frac{-2 \pm \sqrt{10}}{2}$$

The solution set is  $\left\{\frac{-2 + \sqrt{10}}{2}, \frac{-2 - \sqrt{10}}{2}\right\}$ .

52.  $x^2 - 4x + 13 = 0$

$$(-4)^2 - 4(1)(13)$$

$$= 16 - 52$$

$$= -36; 2 \text{ complex imaginary solutions}$$

53.  $9x^2 = 2 - 3x$

$$9x^2 + 3x - 2 = 0$$

$$3^2 - 4(9)(-2)$$

$$= 9 + 72$$

$$= 81; 2 \text{ unequal real solutions}$$

54.  $2x^2 - 11x + 5 = 0$

$$(2x - 1)(x - 5) = 0$$

$$2x - 1 = 0 \quad x - 5 = 0$$

$$x = \frac{1}{2} \text{ or } x = 5$$

$$\text{The solution set is } \left\{5, \frac{1}{2}\right\}.$$

55.  $(3x + 5)(x - 3) = 5$

$$3x^2 + 5x - 9x - 15 = 5$$

$$3x^2 - 4x - 20 = 0$$

$$x = \frac{4 \pm \sqrt{(-4)^2 - 4(3)(-20)}}{2(3)}$$

$$x = \frac{4 \pm \sqrt{16 + 240}}{6}$$

$$x = \frac{4 \pm \sqrt{256}}{6}$$

$$x = \frac{4 \pm 16}{6}$$

$$x = \frac{20}{6}, \frac{-12}{6}$$

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

$$\text{The solution set is } \left\{-2, \frac{10}{3}\right\}.$$

56.  $3x^2 - 7x + 1 = 0$

$$x = \frac{7 \pm \sqrt{(-7)^2 - 4(3)(1)}}{2(3)}$$

$$x = \frac{7 \pm \sqrt{49 - 12}}{6}$$

$$x = \frac{7 \pm \sqrt{37}}{6}$$

$$\text{The solution set is } \left\{\frac{7 + \sqrt{37}}{6}, \frac{7 - \sqrt{37}}{6}\right\}.$$

57.  $x^2 - 9 = 0$

$$x^2 = 9$$

$$x = \pm 3$$

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

58.  $(x - 3)^2 - 25 = 0$

$$(x - 3)^2 = 25$$

$$x - 3 = \pm 5$$

$$x = 3 \pm 5$$

$$x = 8, -2$$

$$\text{The solution set is } \{8, -2\}.$$

59.  $3x^2 - x + 2 = 0$

$$x = \frac{1 \pm \sqrt{(-1)^2 - 4(3)(2)}}{2(3)}$$

$$x = \frac{1 \pm \sqrt{1 - 24}}{6}$$

$$x = \frac{1 \pm \sqrt{-23}}{6}$$

$$x = \frac{1 \pm i\sqrt{23}}{6}$$

$$\text{The solution set is } \left\{\frac{1 + i\sqrt{23}}{6}, \frac{1 - i\sqrt{23}}{6}\right\}.$$

60.  $3x^2 - 10x = 8$

$$3x^2 - 10x - 8 = 0$$

$$(3x + 2)(x - 4) = 0$$

$$3x + 2 = 0 \quad \text{or} \quad x - 4 = 0$$

$$3x = -2 \quad \text{or} \quad x = 4$$

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

$$\text{The solution set is } \left\{-\frac{2}{3}, 4\right\}.$$

61.  $(x + 2)^2 + 4 = 0$

$$(x + 2)^2 = -4$$

$$\sqrt{(x + 2)^2} = \pm \sqrt{-4}$$

$$x + 2 = \pm 2i$$

$$x = -2 \pm 2i$$

$$\text{The solution set is } \{-2 + 2i, -2 - 2i\}.$$

$$62. \quad \frac{5}{x+1} + \frac{x-1}{4} = 2$$

$$\frac{5 \cdot 4(x+1)}{x+1} + \frac{(x-1) \cdot 4(x+1)}{4} = 2 \cdot 4(x+1)$$

$$20 + (x-1)(x+1) = 8(x+1)$$

$$20 + x^2 - 1 = 8x + 8$$

$$x^2 - 8x - 11 = 0$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$x = \frac{-(-8) \pm \sqrt{(-8)^2 - 4(1)(-11)}}{2(1)}$$

$$x = \frac{8 \pm \sqrt{20}}{2}$$

$$x = \frac{8 \pm 2\sqrt{5}}{2}$$

$$x = 4 \pm \sqrt{5}$$

The solution set is  $\{4 + \sqrt{5}, 4 - \sqrt{5}\}$ .

$$63. \quad W(t) = 3t^2$$

$$588 = 3t^2$$

$$196 = t^2$$

Apply the square root property.

$$t^2 = 196$$

$$t = \pm\sqrt{196}$$

$$t = \pm 14$$

The solutions are  $-14$  and  $14$ . We disregard  $-14$ , because we cannot have a negative time measurement. The fetus will weigh 588 grams after 14 weeks.

$$64. \quad P = -0.035x^2 + 0.65x + 7.6$$

$$0 = -0.035x^2 + 0.65x + 7.6$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$x = \frac{-(0.65) \pm \sqrt{(0.65)^2 - 4(-0.035)(7.6)}}{2(-0.035)}$$

$$x \approx 27 \quad x \approx -8 \text{ (rejected)}$$

If this trend continues, corporations will pay no taxes 27 years after 1985, or 2012.

$$65. \quad A = lw$$

$$15 = l(2l - 7)$$

$$15 = 2l^2 - 7l$$

$$0 = 2l^2 - 7l - 15$$

$$0 = (2l + 3)(l - 5)$$

$$l = 5$$

$$2l - 7 = 3$$

The length is 5 yards, the width is 3 yards.

$$66. \quad \text{Let } x = \text{height of building}$$

$$2x = \text{shadow height}$$

$$x^2 + (2x)^2 = 300^2$$

$$x^2 + 4x^2 = 90,000$$

$$5x^2 = 90,000$$

$$x^2 = 18,000$$

$$x \approx \pm 134.164$$

Discard negative height.

The building is approximately 134 meters high.

$$67. \quad 2x^4 = 50x^2$$

$$2x^4 - 50x^2 = 0$$

$$2x^2(x^2 - 25) = 0$$

$$x = 0$$

$$x = \pm 5$$

The solution set is  $\{-5, 0, 5\}$ .

$$68. \quad 2x^3 - x^2 - 18x + 9 = 0$$

$$x^2(2x - 1) - 9(2x - 1) = 0$$

$$(x^2 - 9)(2x - 1) = 0$$

$$x = \pm 3, \quad x = \frac{1}{2}$$

The solution set is  $\left\{-3, \frac{1}{2}, 3\right\}$ .

69.  $\sqrt{2x-3} + x = 3$

$$\sqrt{2x-3} = 3-x$$

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

$$x^2 - 8x + 12 = 0$$

$$x^2 - 8x = -12$$

$$x^2 - 8x + 16 = -12 + 16$$

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

$$x-4 = \pm 2$$

$$x = 4 + 2$$

$$x = 6, 2$$

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

70.  $\sqrt{x-4} + \sqrt{x+1} = 5$

$$\sqrt{x-4} = 5 - \sqrt{x+1}$$

$$x-4 = 25 - 10\sqrt{x+1} + (x+1)$$

$$x-4 = 26 + x - 10\sqrt{x+1}$$

$$-30 = -10\sqrt{x+1}$$

$$3 = \sqrt{x+1}$$

$$9 = x+1$$

$$x = 8$$

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

71.  $3x^{\frac{3}{4}} - 24 = 0$

$$3x^{\frac{3}{4}} = 24$$

$$x^{\frac{3}{4}} = 8$$

$$\left(x^{\frac{3}{4}}\right)^{\frac{4}{3}} = (8)^{\frac{4}{3}}$$

$$x = 16$$

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

72.  $(x-7)^{\frac{2}{3}} = 25$

$$\left[(x-7)^{\frac{2}{3}}\right]^{\frac{3}{2}} = 25^{\frac{3}{2}}$$

$$x-7 = (5^2)^{\frac{3}{2}}$$

$$x-7 = 5^3$$

$$x-7 = 125$$

$$x = 132$$

The solution set is  $\{132\}$ .

73.  $x^4 - 5x^2 + 4 = 0$

$$\text{Let } t = x^2$$

$$t^2 - 5t + 4 = 0$$

$$t = 4 \quad \text{or} \quad t = 1$$

$$x^2 = 4 \quad x^2 = 1$$

$$x = \pm 2 \quad x = \pm 1$$

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

74.  $x^{1/2} + 3x^{1/4} - 10 = 0$

$$\text{Let } t = x^{1/4}$$

$$t^2 + 3t - 10 = 0$$

$$(t+5)(t-2) = 0$$

$$t = -5$$

$$\text{or} \quad t = 2$$

$$x^{\frac{1}{4}} = -5$$

$$x^{\frac{1}{4}} = 2$$

$$\left(x^{\frac{1}{4}}\right)^4 = (-5)^4 \quad \left(x^{\frac{1}{4}}\right)^4 = (2)^4$$

$$x = 625$$

$$x = 16$$

625 does not check and must be rejected.

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

75.  $|2x+1| = 7$

$$2x+1 = 7 \quad \text{or} \quad 2x+1 = -7$$

$$2x = 6 \quad 2x = -8$$

$$x = 3 \quad x = -8$$

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

76.  $2|x-3| - 6 = 10$

$$2|x-3| = 16$$

$$|x-3| = 8$$

$$x-3 = 8 \quad \text{or} \quad x-3 = -8$$

$$x = 11 \quad x = -5$$

The solution set is  $\{-5, 11\}$ .

77.  $3x^{4/3} - 5x^{2/3} + 2 = 0$

Let  $t = x^{2/3}$ .

$$3t^2 - 5t + 2 = 0$$

$$(3t-2)(t-1) = 0$$

$$3t-2=0$$

$$3t=2$$

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

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

$$\left(x^{2/3}\right)^{3/2} = \pm \left(\frac{2}{3}\right)^{3/2}$$

$$x = \pm \sqrt[2]{\left(\frac{2}{3}\right)^3}$$

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

$$x = \pm \frac{2}{3} \cdot \frac{\sqrt{2}}{\sqrt{3}} \cdot \frac{\sqrt{3}}{\sqrt{3}}$$

$$x = \pm \frac{2\sqrt{6}}{9}$$

The solution set is  $\left\{-\frac{2\sqrt{6}}{9}, \frac{2\sqrt{6}}{9}, -1, 1\right\}$ .

78.  $2\sqrt{x-1} = x$

$$4(x-1) = x^2$$

$$4x-4 = x^2$$

$$x^2 - 4x + 4 = 0$$

$$(x-2)^2 = 0$$

$$x = 2$$

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

79.  $|2x-5|-3=0$

$$2x-5=3 \quad \text{or} \quad 2x-5=-3$$

$$2x=8$$

$$2x=2$$

$$x=4$$

$$x=1$$

The solution set is  $\{4, 1\}$ .

80.  $x^3 + 2x^2 - 9x - 18 = 0$

$$x^2(x+2) - 9(x+2) = 0$$

$$(x+2)(x^2-9) = 0$$

$$(x+2)(x+3)(x-3) = 0$$

The solution set is  $\{-3, -2, 3\}$ .

81.  $\sqrt{8-2x} - x = 0$

$$\sqrt{8-2x} = x$$

$$(\sqrt{8-2x})^2 = (x)^2$$

$$8-2x = x^2$$

$$0 = x^2 + 2x - 8$$

$$0 = (x+4)(x-2)$$

$$x+4=0 \quad \text{or} \quad x-2=0$$

$$x=-4$$

$$x=2$$

$-4$  does not check.

The zero is 2.

82.  $f(x) = 4x^{4/3} - 13x^{2/3} + 9$

$$0 = 4x^{4/3} - 13x^{2/3} + 9$$

$$0 = \left(x^{2/3} - 1\right)\left(4x^{2/3} - 9\right)$$

$$x^{2/3} - 1 = 0 \quad \text{or} \quad 4x^{2/3} - 9 = 0$$

$$x^{2/3} = 1$$

$$x = \pm \left(\frac{9}{4}\right)^{3/2}$$

$$x = \pm 1^{3/2}$$

$$x = \pm 1$$

$$x = \pm \frac{27}{8}$$

The zeros are 1,  $-1$ ,  $\frac{27}{8}$ , and  $\frac{27}{8}$ .

83.  $x^3 + 3x^2 - 2x - 6 = 0$

$$x^2(x+3) - 2(x+3) = 0$$

$$(x+3)(x^2-2) = 0$$

$$x+3=0 \quad \text{or} \quad x^2-2=0$$

$$x=-3$$

$$x^2=2$$

$$x = \pm\sqrt{2}$$

The solution set is  $\{-3, -\sqrt{2}, \sqrt{2}\}$ .

84.  $-4|x+1|+12=0$

$$-4|x+1| = -12$$

$$|x+1| = 3$$

$$x+1=3 \quad \text{or} \quad x+1=-3$$

$$x=2$$

$$x=-4$$

The solution set is  $\{-4, 2\}$ .

85. We need to solve
- $4.3 = 0.3\sqrt{x} + 3.4$
- for
- $x$
- .

$$4.3 = 0.3\sqrt{x} + 3.4$$

$$0.9 = 0.3\sqrt{x}$$

$$3 = \sqrt{x}$$

$$3^2 = (\sqrt{x})^2$$

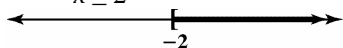
$$9 = x$$

The model indicates that the number of HIV infections in India will reach 4.3 million in 2007 ( $x = 9$  years after 1998).

- 86.
- $-6x + 3 \leq 15$

$$-6x \leq 12$$

$$x \geq 2$$

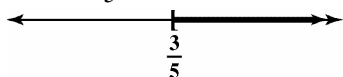


The solution set is  $[-2, \infty)$ .

- 87.
- $6x - 9 \geq -4x - 3$

$$10x \geq 6$$

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



The solution set is  $[\frac{3}{5}, \infty)$ .

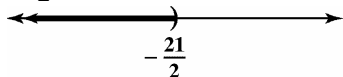
- 88.
- $\frac{x}{3} - \frac{3}{4} - 1 > \frac{x}{2}$

$$12\left(\frac{x}{3} - \frac{3}{4} - 1\right) > 12\left(\frac{x}{2}\right)$$

$$4x - 9 - 12 > 6x$$

$$-21 > 2x$$

$$-\frac{21}{2} > x$$



The solution set is  $(-\infty, -\frac{21}{2})$ .

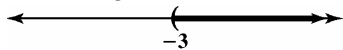
- 89.
- $6x + 5 > -2(x - 3) - 25$

$$6x + 5 > -2x + 6 - 25$$

$$8x + 5 > -19$$

$$8x > -24$$

$$x > -3$$



The solution set is  $(-3, \infty)$ .

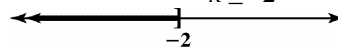
- 90.
- $3(2x - 1) - 2(x - 4) \geq 7 + 2(3 + 4x)$

$$6x - 3 - 2x + 8 \geq 7 + 6 + 8x$$

$$4x + 5 \geq 8x + 13$$

$$-4x \geq 8$$

$$x \leq -2$$



The solution set is  $[-\infty, -2)$ .

- 91.
- $5(x - 2) - 3(x + 4) \geq 2x - 20$

$$5x - 10 - 3x - 12 \geq 2x - 20$$

$$2x - 22 \geq 2x - 20$$

$$-22 \geq -20$$

The solution set is  $\emptyset$ .

- 92.
- $7 < 2x + 3 \leq 9$

$$4 < 2x \leq 6$$

$$2 < x \leq 3$$

$$(2, 3]$$



The solution set is  $(2, 3)$ .

- 93.
- $|2x + 3| \leq 15$

$$-15 \leq 2x + 3 \leq 15$$

$$-18 \leq 2x \leq 12$$

$$-9 \leq x \leq 6$$



The solution set is  $[-9, 6]$ .

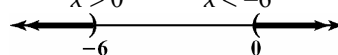
- 94.
- $\left|\frac{2x+6}{3}\right| > 2$

$$\frac{2x+6}{3} > 2 \quad \frac{2x+6}{3} < -2$$

$$2x+6 > 6 \quad 2x+6 < -6$$

$$2x > 0 \quad 2x < -12$$

$$x > 0 \quad x < -6$$



The solution set is  $(-\infty, -6)$  or  $(0, \infty)$ .

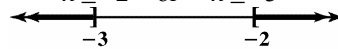
- 95.
- $|2x + 5| - 7 \geq -6$

$$|2x + 5| \geq 1$$

$$2x + 5 \geq 1 \text{ or } 2x + 5 \leq -1$$

$$2x \geq -4 \quad 2x \leq -6$$

$$x \geq -2 \text{ or } x \leq -3$$



The solution set is  $(-\infty, -3]$  or  $[-2, \infty)$ .

96.  $-4|x+2|+5 \leq -7$

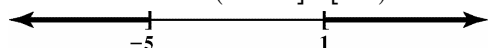
$$-4|x+2| \leq -12$$

$$|x+2| \geq 3$$

$$x+2 \geq 3 \quad \text{or} \quad x+2 \leq -3$$

$$x \geq 1 \quad \text{or} \quad x \leq -5$$

The solution set is  $(-\infty, -5] \cup [1, \infty)$ .



97.  $y_1 > y_2$

$$-10 - 3(2x+1) > 8x+1$$

$$-10 - 6x - 3 > 8x+1$$

$$-6x - 13 > 8x+1$$

$$-14x > 14$$

$$\frac{-14x}{-14} < \frac{14}{-14}$$

$$x < -1$$

The solution set is  $(-\infty, -1)$ .

98.  $3 - |2x-5| \geq -6$

$$-|2x-5| \geq -9$$

$$\frac{-|2x-5|}{-1} \leq \frac{-9}{-1}$$

$$|2x-5| \leq 9$$

$$-9 \leq 2x-5 \leq 9$$

$$-4 \leq 2x \leq 14$$

$$-2 \leq x \leq 7$$

The solution set is  $[-2, 7]$ .

99.  $0.20x + 24 \leq 40$

$$0.20x \leq 16$$

$$\frac{0.20x}{0.20} \leq \frac{16}{0.20}$$

$$x \leq 80$$

A customer can drive no more than 80 miles.

100.  $80 \leq \frac{95+79+91+86+x}{5} < 90$

$$400 \leq 95+79+91+86+x < 450$$

$$400 \leq 351+x < 450$$

$$49 \leq x < 99$$

A grade of at least 49% but less than 99% will result in a B.

101.  $0.075x \geq 9000$

$$\frac{0.075x}{0.075} \geq \frac{9000}{0.075}$$

$$x \geq 120,000$$

The investment must be at least \$120,000.

### Chapter 2 Test

1.  $7(x-2) = 4(x+1) - 21$

$$7x - 14 = 4x + 4 - 21$$

$$7x - 14 = 4x - 17$$

$$3x = -3$$

$$x = -1$$

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

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

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

$$2x-3 = 2x-8-x-1$$

$$2x-3 = x-9$$

$$x = -6$$

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

3.  $\frac{2}{x-3} - \frac{4}{x+3} = \frac{8}{(x-3)(x+3)}$

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

$$2x+6-4x+12=8$$

$$-2x+18=8$$

$$-2x=-10$$

$$x=5$$

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

4.  $2x^2 - 3x - 2 = 0$

$$(2x+1)(x-2) = 0$$

$$2x+1=0 \quad \text{or} \quad x-2=0$$

$$x = -\frac{1}{2} \quad \text{or} \quad x = 2$$

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

5.  $(3x-1)^2 = 75$

$$3x-1 = \pm\sqrt{75}$$

$$3x = 1 \pm 5\sqrt{3}$$

$$x = \frac{1 \pm 5\sqrt{3}}{3}$$

The solution set is  $\left\{\frac{1-5\sqrt{3}}{3}, \frac{1+5\sqrt{3}}{3}\right\}$ .

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

$$x^2 - 2x - 4 = 0$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$x = \frac{2 \pm \sqrt{(-2)^2 - 4(1)(-4)}}{2}$$

$$x = \frac{2 \pm 2\sqrt{5}}{2}$$

$$x = 1 \pm \sqrt{5}$$

The solution set is  $\{1 - \sqrt{5}, 1 + \sqrt{5}\}$ .

7.  $4x^2 = 8x - 5$

$$4x^2 - 8x + 5 = 0$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$x = \frac{8 \pm \sqrt{(-8)^2 - 4(4)(5)}}{2(4)}$$

$$x = \frac{8 \pm \sqrt{-16}}{8}$$

$$x = \frac{8 \pm 4i}{8}$$

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

The solution set is  $\left\{1 + \frac{1}{2}i, 1 - \frac{1}{2}i\right\}$ .

8.  $x^3 - 4x^2 - x + 4 = 0$

$$x^2(x-4) - 1(x-4) = 0$$

$$(x^2 - 1)(x-4) = 0$$

$$(x-1)(x+1)(x-4) = 0$$

$$x=1 \text{ or } x=-1 \text{ or } x=4$$

The solution set is  $\{-1, 1, 4\}$ .

9.  $\sqrt{x-3} + 5 = x$

$$\sqrt{x-3} = x-5$$

$$x-3 = x^2 - 10x + 25$$

$$x^2 - 11x + 28 = 0$$

$$x = \frac{11 \pm \sqrt{11^2 - 4(1)(28)}}{2(1)}$$

$$x = \frac{11 \pm \sqrt{121 - 112}}{2}$$

$$x = \frac{11 \pm \sqrt{9}}{2}$$

$$x = \frac{11 \pm 3}{2}$$

$$x = 7 \text{ or } x = 4$$

4 does not check and must be rejected.

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

10.  $\sqrt{x+4} + \sqrt{x-1} = 5$

$$\sqrt{x+4} = 5 - \sqrt{x-1}$$

$$x+4 = 25 - 10\sqrt{x-1} + (x-1)$$

$$x+4 = 25 - 10\sqrt{x-1} + x-1$$

$$-20 = -10\sqrt{x-1}$$

$$2 = \sqrt{x-1}$$

$$4 = x-1$$

$$x = 5$$

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

11.  $5x^{3/2} - 10 = 0$

$$5x^{3/2} = 10$$

$$x^{3/2} = 2$$

$$x = 2^{2/3}$$

$$x = \sqrt[3]{4}$$

The solution set is  $\{\sqrt[3]{4}\}$ .

12.  $x^{2/3} - 9x^{1/3} + 8 = 0$  let  $t = x^{1/3}$

$$t^2 - 9t + 8 = 0$$

$$(t-1)(t-8) = 0$$

$$t = 1 \quad t = 8$$

$$x^{1/3} = 1 \quad x^{1/3} = 8$$

$$x = 1 \quad x = 512$$

The solution set is  $\{1, 512\}$ .

$$13. \left| \frac{2}{3}x - 6 \right| = 2$$

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

$$\frac{2}{3}x = 8 \quad \frac{2}{3}x = 4$$

$$x = 12 \quad x = 6$$

The solution set is  $\{6, 12\}$ .

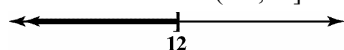
$$14. 3(x + 4) \geq 5x - 12$$

$$3x + 12 \geq 5x - 12$$

$$-2x \geq -24$$

$$x \leq 12$$

The solution set is  $(-\infty, 12]$ .



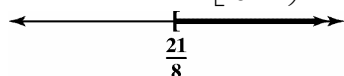
$$15. \frac{x}{6} + \frac{1}{8} \leq \frac{x}{2} - \frac{3}{4}$$

$$4x + 3 \leq 12x - 18$$

$$-8x \leq -21$$

$$x \geq \frac{21}{8}$$

The solution set is  $\left[ \frac{21}{8}, \infty \right)$ .



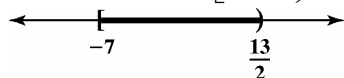
$$16. -3 \leq \frac{2x+5}{3} < 6$$

$$-9 \leq 2x + 5 < 18$$

$$-14 \leq 2x < 13$$

$$-7 \leq x < \frac{13}{2}$$

The solution set is  $\left[ -7, \frac{13}{2} \right)$ .



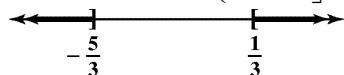
$$17. |3x + 2| \geq 3$$

$$3x + 2 \geq 3 \quad \text{or} \quad 3x + 2 \leq -3$$

$$3x \geq 1 \quad 3x \leq -5$$

$$x \geq \frac{1}{3} \quad x \leq -\frac{5}{3}$$

The solution set is  $\left( -\infty, -\frac{5}{3} \right] \cup \left[ \frac{1}{3}, \infty \right)$ .



$$18. 0 = \sqrt{8-2x} - x$$

$$x = \sqrt{8-2x}$$

$$x^2 = (\sqrt{8-2x})^2$$

$$x^2 = 8 - 2x$$

$$x^2 + 2x - 8 = 0$$

$$(x+4)(x-2) = 0$$

$$x = -4, 2$$

$-4$  does not check. The only zero is  $2$ .

$$19. 0 = -3|4x - 7| + 15$$

$$3|4x - 7| = 15$$

$$|4x - 7| = 5$$

$$4x - 7 = 5 \quad \text{or} \quad 4x - 7 = -5$$

$$4x = 12$$

$$4x = 2$$

$$x = 3$$

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

The zeros are  $\frac{1}{2}$  and  $3$ .

$$20. 0 = -10 - 3(2x + 1) - 8x - 1$$

$$0 = -10 - 6x - 3 - 8x - 1$$

$$0 = -14x - 14$$

$$14x = -14$$

$$x = -1$$

The zero is  $-1$ .

$$21. 0 = \frac{1}{x^2} - \frac{4}{x} + 1$$

$$(x^2)0 = x^2 \left( \frac{1}{x^2} - \frac{4}{x} + 1 \right)$$

$$0 = 1 - 4x + x^2$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$x = \frac{-(-4) \pm \sqrt{(-4)^2 - 4(1)(1)}}{2(1)}$$

$$x = \frac{4 \pm \sqrt{12}}{2}$$

$$x = \frac{4 \pm 2\sqrt{3}}{2}$$

$$x = 2 \pm \sqrt{3}$$

The zeros are  $2 - \sqrt{3}$  and  $2 + \sqrt{3}$ .

22.  $(x+3)^2 - 24 = 0$

$$(x+3)^2 = 24$$

$$\sqrt{(x+3)^2} = \pm\sqrt{24}$$

$$x+3 = \pm 2\sqrt{6}$$

$$x = -3 \pm 2\sqrt{6}$$

The zeros are  $-3 - 2\sqrt{6}$  and  $-3 + 2\sqrt{6}$ .

23. 
$$0 = \frac{2x}{x^2 + 6x + 8} - \frac{x}{x+4} + \frac{2}{x+2}$$

$$0(x+4)(x+2) = \left( \frac{2x}{(x+4)(x+2)} - \frac{x}{x+4} + \frac{2}{x+2} \right) (x+4)(x+2)$$

$$0 = 2x - x(x+2) + 2(x+4)$$

$$0 = 2x - x^2 - 2x + 2x + 8$$

$$0 = -x^2 + 2x + 8$$

$$0 = x^2 - 2x - 8$$

$$0 = (x+2)(x-4)$$

$$x = -2, 4$$

-2 does not check. The only zero is 4.

24.  $-3 \leq y \leq 7$   
 $-3 \leq 2x - 5 \leq 7$   
 $2 \leq 2x \leq 12$   
 $1 \leq x \leq 6$

The solution set is  $[1, 6]$ .

25.  $y \geq 1$

$$\left| \frac{2-x}{4} \right| \geq 1$$

$$\frac{2-x}{4} \geq 1 \quad \text{or} \quad \frac{2-x}{4} \leq -1$$

$$2-x \geq 4 \quad 2-x \leq -4$$

$$-x \geq 2 \quad -x \leq -6$$

$$x \leq -2 \quad x \geq 6$$

The solution set is  $(-\infty, -2] \cup [6, \infty)$ .

26.  $(6-7i)(2+5i) = 12 + 30i - 14i - 35i^2$   
 $= 12 + 16i + 35$   
 $= 47 + 16i$

27. 
$$\frac{5}{2-i} = \frac{5}{2-i} \cdot \frac{2+i}{2+i}$$

$$= \frac{5(2+i)}{4+1}$$

$$= \frac{5(2+i)}{5}$$

$$= 2+i$$

28.  $2\sqrt{-49} + 3\sqrt{-64} = 2(7i) + 3(8i)$   
 $= 14i + 24i$   
 $= 38i$

29.  $43x + 575 = 1177$   
 $43x = 602$   
 $x = 14$

The system's income will be \$1177 billion 14 years after 2004, or 2018.

30.  $B = 0.07x^2 + 47.4x + 500$   
 $1177 = 0.07x^2 + 47.4x + 500$   
 $0 = 0.07x^2 + 47.4x - 677$   
 $0 = 0.07x^2 + 47.4x - 677$   

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$x = \frac{-(47.4) \pm \sqrt{(47.4)^2 - 4(0.07)(-677)}}{2(0.07)}$$
 $x \approx 14, \quad x \approx -691 \text{ (rejected)}$   
 The system's income will be \$1177 billion 14 years after 2004, or 2018.

31. The formulas model the data quite well.

32. Let  $x$  = the number of books in 2002.  
 Let  $x + 62$  = the number of books in 2003.  
 Let  $x + 190$  = the number of books in 2004.  
 $(x) + (x + 62) + (x + 190) = 2598$   
 $x + x + 62 + x + 190 = 2598$   
 $3x + 252 = 2598$   
 $3x = 2346$   
 $x = 782$   
 $x + 62 = 844$   
 $x + 190 = 972$   
 The number of books in 2002, 2003, and 2004 were 782, 844, and 972 respectively.

33.  $29700 + 150x = 5000 + 1100x$   
 $24700 = 950x$   
 $26 = x$   
 In 26 years, the cost will be \$33,600.

34. Let  $x$  = amount invested at 8%  
 $10000 - x$  = amount invested at 10%  
 $.08x + .1(10000 - x) = 940$   
 $.08x + 1000 - .1x = 940$   
 $-.02x = -60$   
 $x = 3000$   
 $10000 - x = 7000$   
 \$3000 at 8%, \$7000 at 10%

35.  $l = 2w + 4$   
 $A = lw$   
 $48 = (2w + 4)w$   
 $48 = 2w^2 + 4w$   
 $0 = 2w^2 + 4w - 48$   
 $0 = w^2 + 2w - 24$   
 $0 = (w + 6)(w - 4)$   
 $w + 6 = 0 \quad w - 4 = 0$   
 $w = -6 \quad w = 4$   
 $2w + 4 = 2(4) + 4 = 12$   
 width is 4 feet, length is 12 feet

36.  $24^2 + x^2 = 26^2$   
 $576 + x^2 = 676$   
 $x^2 = 100$   
 $x = \pm 10$   
 The wire should be attached 10 feet up the pole.

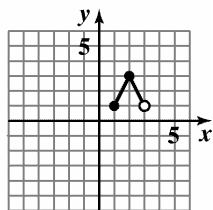
37. Let  $x$  = the original selling price  
 $20 = x - 0.60x$   
 $20 = 0.40x$   
 $50 = x$   
 The original price is \$50.

38. Let  $x$  = the number of local calls  
 The monthly cost using Plan A is  $C_A = 25$ .  
 The monthly cost using Plan B is  $C_B = 13 + 0.06x$ .  
 For Plan A to be better deal, it must cost less than Plan B.  
 $C_A < C_B$   
 $25 < 13 + 0.06x$   
 $12 < 0.06x$   
 $200 < x$   
 $x > 200$   
 Plan A is a better deal when more than 200 local calls are made per month.

### Cumulative Review Exercises (Chapters 1–2)

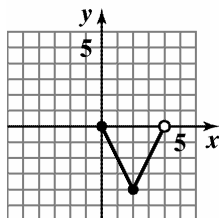
- Domain:  $[0, 2)$   
 Range:  $[0, 2]$
- $f(x) = 1$  at  $\frac{1}{2}$  and  $\frac{3}{2}$ .
- relative maximum: 2

4.



$$g(x) = f(x-1) + 1$$

5.



6.

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

$$x^2 - x - 12 = 8$$

$$x^2 - x - 20 = 0$$

$$(x+4)(x-5) = 0$$

$$x+4=0 \quad \text{or} \quad x-5=0$$

$$x=-4 \quad \text{or} \quad x=5$$

7.

$$3(4x-1) = 4-6(x-3)$$

$$12x-3 = 4-6x+18$$

$$18x = 25$$

$$x = \frac{25}{18}$$

8.

$$\sqrt{x} + 2 = x$$

$$\sqrt{x} = x - 2$$

$$(\sqrt{x})^2 = (x-2)^2$$

$$x = x^2 - 4x + 4$$

$$0 = x^2 - 5x + 4$$

$$0 = (x-1)(x-4)$$

$$x-1=0 \quad \text{or} \quad x-4=0$$

$$x=1 \quad \text{or} \quad x=4$$

A check of the solutions shows that  $x=1$  is an extraneous solution. The only solution is  $x=4$ .

9.

$$x^{2/3} - x^{1/3} - 6 = 0$$

$$\text{Let } u = x^{1/3}. \text{ Then } u^2 = x^{2/3}.$$

$$u^2 - u - 6 = 0$$

$$(u+2)(u-3) = 0$$

$$u=-2 \quad \text{or} \quad u=3$$

$$x^{1/3}=-2 \quad \text{or} \quad x^{1/3}=3$$

$$x=(-2)^3 \quad \text{or} \quad x=3^3$$

$$x=-8 \quad \text{or} \quad x=27$$

10.

$$\frac{x}{2} - 3 \leq \frac{x}{4} + 2$$

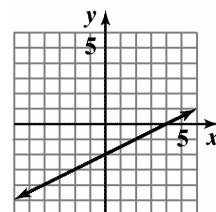
$$4\left(\frac{x}{2} - 3\right) \leq 4\left(\frac{x}{4} + 2\right)$$

$$2x - 12 \leq x + 8$$

$$x \leq 20$$

The solution set is  $(-\infty, 20]$ .

11.

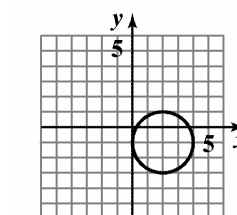


$$3(x) - 6y - 12 = 0$$

Domain:  $(-\infty, \infty)$

Range:  $(-\infty, \infty)$

12.

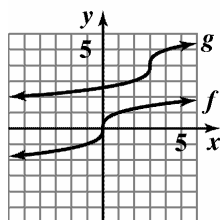


$$(x-2)^2 + (y+1)^2 = 4$$

Domain:  $[0, 4]$

Range:  $[-3, 1]$

13.



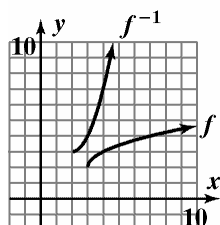
Domain of  $f$ :  $(-\infty, \infty)$

Range of  $f$ :  $(-\infty, \infty)$

Domain of  $g$ :  $(-\infty, \infty)$

Range of  $g$ :  $(-\infty, \infty)$

14.



Domain of  $f$ :  $[3, \infty)$

Range of  $f$ :  $[2, \infty)$

Domain of  $f^{-1}$ :  $[2, \infty)$

Range of  $f^{-1}$ :  $[3, \infty)$

$$\begin{aligned}
 15. \quad & \frac{f(x+h) - f(x)}{h} \\
 &= \frac{(4 - (x+h)^2) - (4 - x^2)}{h} \\
 &= \frac{4 - (x^2 + 2xh + h^2) - (4 - x^2)}{h} \\
 &= \frac{4 - x^2 - 2xh - h^2 - 4 + x^2}{h} \\
 &= \frac{-2xh - h^2}{h} \\
 &= \frac{h(-2x - h)}{h} \\
 &= -2x - h
 \end{aligned}$$

$$16. \quad (f \circ g)(x) = f(g(x))$$

$$(f \circ g)(x) = f(x+5)$$

$$0 = 4 - (x+5)^2$$

$$0 = 4 - (x^2 + 10x + 25)$$

$$0 = 4 - x^2 - 10x - 25$$

$$0 = -x^2 - 10x - 21$$

$$0 = x^2 + 10x + 21$$

$$0 = (x+7)(x+3)$$

The value of  $(f \circ g)(x)$  will be 0 when  $x = -3$  or  $x = -7$ .

$$17. \quad y = -\frac{1}{4}x + \frac{1}{3}, \text{ so } m = 4.$$

$$\text{point-slope form: } y - 5 = 4(x + 2)$$

$$\text{slope-intercept form: } y = 4x + 13$$

$$\text{general form: } 4x - y + 13 = 0$$

$$18. \quad 0.07x + 0.09(6000 - x) = 510$$

$$0.07x + 540 - 0.09x = 510$$

$$-0.02x = -30$$

$$x = 1500$$

$$6000 - x = 4500$$

\$1500 was invested at 7% and \$4500 was invested at 9%.

$$19. \quad 200 + 0.05x = .15x$$

$$200 = 0.10x$$

$$2000 = x$$

For \$2000 in sales, the earnings will be the same.

$$20. \quad \text{width} = w$$

$$\text{length} = 2w + 2$$

$$2(2w + 2) + 2w = 22$$

$$4w + 4 + 2w = 22$$

$$6w = 18$$

$$w = 3$$

$$2w + 2 = 8$$

The garden is 3 feet by 8 feet.