Section P.4 Solving Equations Algebraically and Graphically

Solutions to Even-Numbered Exercises

2. $\dfrac{x}{2} + \dfrac{6x}{7} = \dfrac{19}{14}$

(a) $x = -2$

$$\dfrac{-2}{2} + \dfrac{6(-2)}{7} \overset{?}{=} \dfrac{19}{14}$$

$$\dfrac{-14 - 12}{14} \overset{?}{=} \dfrac{19}{14}$$

$$\dfrac{-26}{14} \overset{?}{=} \dfrac{19}{14}$$

$x = -2$ is not a solution.

(b) $x = 1$

$$\dfrac{1}{2} + \dfrac{6(1)}{7} \overset{?}{=} \dfrac{19}{14}$$

$$\dfrac{19}{14} = \dfrac{19}{14}$$

$x = 1$ is a solution.

(c) $x = \dfrac{1}{2}$

$$\dfrac{112}{2} + \dfrac{6\left(\dfrac{1}{2}\right)}{7} \overset{?}{=} \dfrac{19}{14}$$

$$\dfrac{\dfrac{7}{2} + 6}{14} \overset{?}{=} \dfrac{19}{14}$$

$$\dfrac{19}{28} \neq \dfrac{19}{14}$$

$x = \dfrac{1}{2}$ is not a solution.

(d) $x = 7$

$$\dfrac{7}{2} + \dfrac{6(7)}{7} = \dfrac{19}{14}$$

$$\dfrac{7}{2} + 6 = \dfrac{19}{14}$$

$$\dfrac{19}{2} \overset{?}{=} \dfrac{19}{14}$$

$x = 7$ is not a solution.

4. $\dfrac{(x + 5)}{2(x - 3)} = 24$

(a) $x = -3$

$$\dfrac{(-3 + 5)(-3 - 3)}{2} \overset{?}{=} 24$$

$$\dfrac{-12}{2} \overset{?}{=} 24$$

$$-6 \neq 24$$

$x = -3$ is not a solution.

(b) $x = -2$

$$\dfrac{(-2 + 5)(-2 - 3)}{2} \overset{?}{=} 24$$

$$\dfrac{-15}{2} \neq 24$$

$x = -2$ is not a solution.

(c) $x = 7$

$$\dfrac{(7 + 5)(7 - 3)}{2} \overset{?}{=} 24$$

$$24 = 24$$

$x = 7$ is a solution.

(d) $x = 9$

$$\dfrac{(9 + 5)(9 - 3)}{2} \overset{?}{=} 24$$

$$42 \neq 24$$

$x = 9$ is not a solution.

6. $\dfrac{\sqrt[3]{x - 8}}{3} = -\dfrac{2}{3}$

(a) $x = -16$

$$\dfrac{\sqrt[3]{-16 - 8}}{3} \overset{?}{=} -\dfrac{2}{3}$$

$$\sqrt[3]{-24} \neq -2$$

$x = -16$ is not a solution.

(b) $x = 0$

$$\dfrac{\sqrt[3]{0 - 8}}{3} \overset{?}{=} -\dfrac{2}{3}$$

$$-2 = -2$$

$x = 0$ is a solution.

(c) $x = 9$

$$\dfrac{\sqrt[3]{9 - 8}}{3} \overset{?}{=} -\dfrac{2}{3}$$

$$1 \neq -2$$

$x = 9$ is not a solution.

(d) $x = 16$

$$\dfrac{\sqrt[3]{16 - 8}}{3} \overset{?}{=} -\dfrac{2}{3}$$

$$2 \neq -2$$

$x = 16$ is not a solution.

8. $-7(x - 3) + 4x = 3(7 - x)$ is an *identity* by simplification. It is true for all real values of x.
$-7(x - 3) + 4x = -7x + 21 + 4x = 21 - 3x = 3(7 - x)$

10. $x^2 + 2(3x - 2) = x^2 + 6x - 4$ is an *identity* by simplification. It is true for all real values of x.

12. $\dfrac{5}{x} + \dfrac{3}{x} = 24$ is *conditional*. There are real values of x for which the equation is not true (for example, $x = 1$).

14. Method 1:

$$\frac{37}{8} - \frac{z}{10} = 6$$

$$z\left(\frac{3}{8} - \frac{1}{10}\right) = 6$$

$$z\left(\frac{22}{80}\right) = 6$$

$$z = \frac{6(80)}{22} = \frac{240}{11} \approx 21.8182$$

Method 2: Graph $y_1 = \dfrac{3z}{8} - \dfrac{z}{10}$ and $y_2 = 6$ in

the same viewing rectangle. The lines intersect

at $z \approx 21.8182 \approx \dfrac{240}{11}$.

16. $\dfrac{x}{5} - \dfrac{x}{2} = 3$

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

$$x\left(\frac{-3}{10}\right) = 3$$

$$x = \left(\frac{10}{-3}\right)3$$

$$x = -10$$

18. $\dfrac{3x}{2} + \dfrac{1}{4}(x - 2) = 10$

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

$$6x + (x - 2) = 40$$

$$7x - 2 = 40$$

$$7x = 42$$

$$x = 6$$

20. $\dfrac{17 + y}{y} + \dfrac{32 + y}{y} = 100$

$$(y)\frac{17 + y}{y} + (y)\frac{32 + y}{y} = 100(y)$$

$$17 + y + 32 + y = 100y$$

$$49 + 2y = 100y$$

$$49 = 98y$$

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

22. $\dfrac{15}{x} - 4 = \dfrac{6}{x} + 3$

$$\frac{15}{x} - \frac{6}{x} = 7$$

$$\frac{9}{x} = 7$$

$$9 = 7x$$

$$\frac{9}{7} = x$$

24.

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

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

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

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

$$4x - 3 = 4$$

$$4x = 7$$

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

26.
$$\frac{4}{u-1} + \frac{6}{3u+1} = \frac{15}{3u+1}$$

$$(u-1)(3u+1)\frac{4}{u-1} + (u-1)(3u+1)\frac{6}{3u+1} = (u-1)(3u+1)\frac{15}{3u+1}$$

$$4(3u+1) + 6(u-1) = 15(u-1)$$

$$12u + 4 + 6u - 6 = 15u - 15$$

$$18u - 2 = 15u - 15$$

$$3u = -13$$

$$u = -\frac{13}{3}$$

28.
$$\frac{6}{x} - \frac{2}{x+3} = \frac{3(x+5)}{x(x+3)}$$

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

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

$$6x + 18 - 2x = 3x + 15$$

$$4x + 18 = 3x + 15$$

$$x = -3$$

Check: $\dfrac{6}{-3} - \dfrac{2}{-3+3} = \dfrac{3(-3+5)}{-3(-3+3)}$

$$-2 - \frac{2}{0} = \frac{-6}{-3(0)}$$

Division by zero is undefined. Thus, $x = -3$ is not a solution, and the original equation has no solution.

30.
$$3 = 2 + \frac{2}{z+2}$$

$$1 = \frac{2}{z+2}$$

$$z + 2 = 2$$

$$z = 0$$

32. $y = -\frac{3}{4}x - 3$

Let $y = 0$: $0 = -\frac{3}{4}x - 3 \Rightarrow \frac{3}{4}x = -3 \Rightarrow x = -4 \Rightarrow (-4, 0)$ x-intercepts

Let $x = 0$: $y = -\frac{3}{4}(0) - 3 = -3 \Rightarrow (0, -3)$ y-intercept

34. $y = 4 - x^2$

Let $y = 0$: $0 = 4 - x^2 \Rightarrow x = 2, -2 \Rightarrow (2, 0), (-2, 0)$ x-intercepts

Let $x = 0$: $y = 4 - 0^2 = 4 \Rightarrow (0, 4)$ y-intercept

36. $y = -\frac{1}{2}x\sqrt{x+3} + 1$

Let $y = 0$: $0 = -\frac{1}{2}x\sqrt{x+3} + 1 \Rightarrow \frac{1}{2}x\sqrt{x+3} = 1 \Rightarrow x\sqrt{x+3} = 2$

$$\Rightarrow x^2(x+3) = 4 \Rightarrow x^3 + 3x^2 - 4 = 0$$

$$\Rightarrow (x-1)(x^2 + 4x + 4) = 0 \Rightarrow (x-1)(x+2)^2 = 0$$

$$\Rightarrow x = 1 \Rightarrow (1, 0) \quad (x = -2 \text{ is impossible})$$

Let $x = 0 \Rightarrow y = 1 \Rightarrow (0, 1)$ y-intercept

38. $y = 3 - \frac{1}{2}|x + 1|$

   Let $y = 0$: $0 = 3 - \frac{1}{2}|x + 1| \Rightarrow \frac{1}{2}|x + 1| = 3 \Rightarrow |x + 1| = 6$

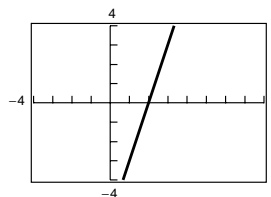 $\Rightarrow x = 5, -7 \Rightarrow (5, 0), (-7, 0)$ x-intercepts.

   Let $x = 0$, $y = 3 - \frac{1}{2} = 2.5$, $\left(0, \frac{5}{2}\right)$ y-intercept.
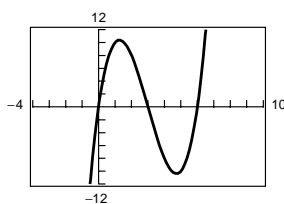
40. $x^2y - x^2 + 4y = 0$

   Let $y = 0$: $-x^2 = 0 \Rightarrow x = 0$

   $\Rightarrow (0, 0)$ x-intercept.

   Let $x = 0$: $4y = 0 \Rightarrow y = 0$

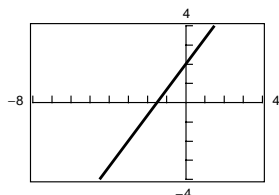 $\Rightarrow (0, 0)$ y-intercept.

42. $y = 3(x - 5) + 9$

44. $y = x^3 - 9x^2 + 18x$

46. $y = x - 3 - \dfrac{10}{x}$
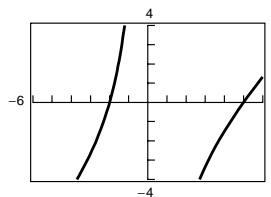
48.

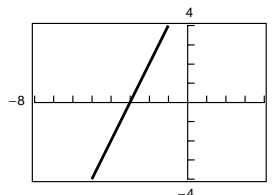$$0 = \frac{4}{3}x + 2$$

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

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

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

Intercept: $\left(-\frac{3}{2}, 0\right)$

The solution to $0 = \frac{4}{3}x + 2$ is the same as the x-intercept of $y = \frac{4}{3}x + 2$. They are both $x = -\frac{3}{2}$.

50.

$$0 = 10 + 2(x - 2)$$

$$0 = 10 + 2x - 4$$

$$0 = 6 + 2x$$

$$-2x = 6$$

$$x = -3$$

Intercept: $(-3, 0)$

The solution to $0 = 10 + 2(x - 2)$ is the same as the x-intercept of $0 = 10 + 2(x - 2)$ They are both $x = -3$.
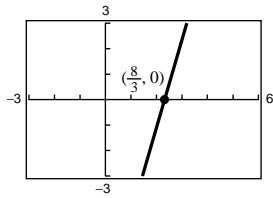
52. $3.5x - 8 = 0.5x$

$$3x = 8$$

$$x = \frac{8}{3}$$

$y = 3.5x - 8 - 0.05x = 0$

$x = 2.667$

54. $1200 = 300 + 2(x - 500)$
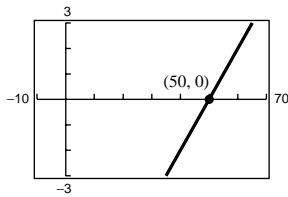
$$900 = 2x - 1000$$

$$1900 = 2x$$

$$x = 950$$

$y = 1200 - 300 - 2(x - 500)$

$\quad = 900 - 2(x - 500)$

56. $0.60x + 0.40(100 - x) = 50$

$$0.60x + 40 - 0.40x = 50$$

$$0.20x = 10$$

$$x = 50$$

$y = 0.60x + 0.40(100 - x) - 50 = 0$

$x = 50.0$

58. $\dfrac{x - 3}{25} = \dfrac{x - 5}{12}$

$$12(x - 3) = 25(x - 5)$$

$$12x - 36 = 25x - 125$$

$$13x = 89$$

$$x = \frac{89}{13} \approx 6.846$$

$y = \dfrac{x - 3}{25} - \dfrac{x - 5}{12}$

$x \approx 6.846$

60. $\dfrac{6}{x} + \dfrac{8}{x + 5} = 3$
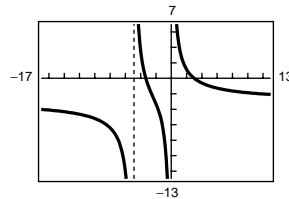
$$6(x + 5) + 8x = 3x(x + 5)$$

$$6x + 30 + 8x = 3x^2 + 15x$$

$$0 = 3x^2 + x - 30$$

$$= (x - 3)(3x + 10)$$

$x = 3, -\dfrac{10}{3}$

$y = \dfrac{6}{x} + \dfrac{8}{x + 5} - 3$

$x = 3, -3.333$

62. $(x + 1)^2 + 2(x - 2) = (x + 1)(x - 2)$

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

$$5x = 1$$

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

$y = (x + 1)^2 + 2(x - 2) - (x + 1)(x - 2) = 0$
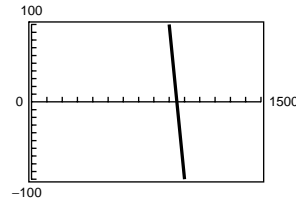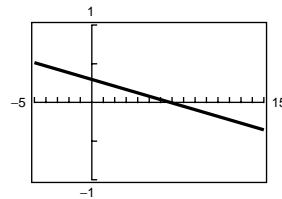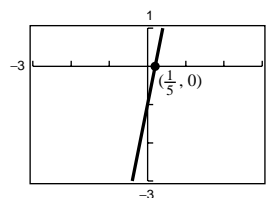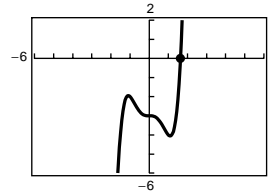
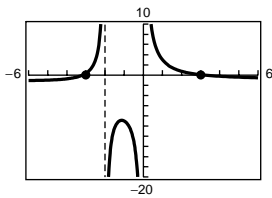$x = 0.20$

64. $4x^3 + 12x^2 - 26x - 24 = 0$

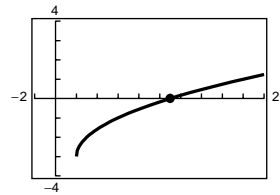$x = -4.206, -0.735, 1.941$
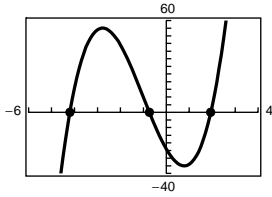
66. $x^5 = 3 + 2x^3$

$x^5 - 3 - 2x^3 = 0$

$x = 1.638$

68. $\dfrac{5}{x} = 1 + \dfrac{3}{x+2}$
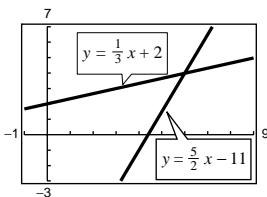
$\dfrac{5}{x} - 1 - \dfrac{3}{x+2} = 0$

$x = -3.162, 3.162$
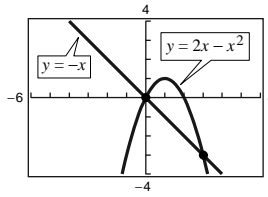

70. $\sqrt{x-2} = 3$

$x - 2 = 9$

$x = 11$

72. $2x + y = 6 \Longrightarrow y = 6 - 2x$

$-x + y = 0 \Longrightarrow y = x$

$6 - 2x = x$

$6 = 3x$

$x = 2, \ y = x = 2$

$(x, y) = (2, 2)$

74. $3x + y = 2 \quad \Longrightarrow \quad y = 2 - 3x$

$x^3 + y = 0 \quad \Longrightarrow \quad y = -x^3$

$2 - 3x = -x^3$

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

$(x - 1)(x^2 + x - 2) = 0$

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

$x = 1, -2$

$(x, y) = (1, -1), (-2, 8)$

76. $(x, y) = (6, 4)$

78. $(x, y) = (0, 0) \ (3, -3)$

80. $(x, y) = (1.670, 1.660)$
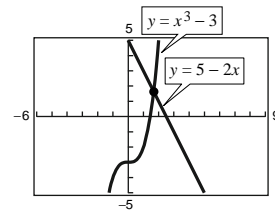
82. $9x^2 - 1 = 0$

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

$3x + 1 = 0 \Longrightarrow x = -\frac{1}{3}$

$3x + 1 = 0 \Longrightarrow x = \frac{1}{3}$

84. $x^2 - 10x + 9 = 0$

$(x - 9)(x - 1) = 0$

$x - 9 = 0 \Longrightarrow x = 9$

$x - 1 = 0 \Longrightarrow x = 1$

86. $2x^2 = 19x + 33$

$2x^2 - 19x - 33 = 0$

$(2x + 3)(x - 11) = 0$

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

$x - 11 = 0 \Longrightarrow x = 11$

88. $-x^2 + 8x = 12$

$x^2 - 8x + 12 = 0$

$(x - 2)(x - 6) = 0$

$x = 2, 6$

90. $9x^2 = 25$

$x^2 = \frac{25}{9}$

$x = \pm\sqrt{\frac{25}{9}} = \pm\frac{5}{3} = \pm 1.67$

92. $(x - 5)^2 = 20$

$x - 5 = \pm\sqrt{20}$

$x = 5 \pm 2\sqrt{5} = 9.47, 0.53$

94. $(4x + 7)^2 = 44$

$4x + 7 = \pm\sqrt{44} = \pm 2\sqrt{11}$

$4x = -7 \pm 2\sqrt{11}$

$x = -\frac{7}{4} \pm \frac{1}{2}\sqrt{11}$

$x \approx -3.41, -0.09$

96.

$(x + 5)^2 = (x + 4)^2$

$(x + 5)^2 - (x + 4)^2 = 0$

$[(x + 5) - (x + 4)][(x + 5) + (x + 4)] = 0$

$2x + 9 = 0$

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

$= -4.5$

98. $x^2 - 2x - 3 = 0$

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

$(x - 1)^2 = 4$

$x - 1 = \pm 2$

$x = 1 \pm 2$

$x = 3, -1$

100. $x^2 + 8x + 14 = 0$

$x^2 + 8x = -14$

$x^2 + 8x + 4^2 = -14 + 16$

$(x + 4)^2 = 2$

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

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

102. $9x^2 - 12x = 14$

$x^2 - \frac{4}{3}x = \frac{14}{9}$

$x^2 - \frac{4}{3}x + \left(\frac{2}{3}\right)^2 = \frac{14}{9} + \frac{4}{9}$

$\left(x - \frac{2}{3}\right)^2 = \frac{18}{9}$

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

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

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

104. $x^2 - 10x + 22 = 0$

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

$= \dfrac{-(-10) \pm \sqrt{(-10)^2 - 4(1)(22)}}{2(1)}$

$= \dfrac{10 \pm \sqrt{100 - 88}}{2}$

$= \dfrac{10 \pm 2\sqrt{3}}{2} = 5 \pm \sqrt{3}$

106. $4x^2 - 4x - 4 = 0$

$x^2 - x - 1 = 0$

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

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

$= \dfrac{1 \pm \sqrt{1 + 4}}{2}$

$= \dfrac{1}{2} \pm \dfrac{\sqrt{5}}{2}$

108. $9x^2 - 6x - 35 = 0$

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

$$= \frac{6 \pm \sqrt{(-6)^2 - 4(9)(-35)}}{2(9)}$$

$$= \frac{6 \pm 36}{18}$$

$$= \frac{7}{3}, -\frac{5}{3}$$

110. $11x^2 + 33x = 0$

$$11(x^2 + 3x) = 0$$

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

$$x = 0$$

$$x + 3 = 0 \Rightarrow x = -3$$

112. $x^2 - 14x + 49 = 0$

$$(x - 7)^2 = 0$$

$$x = 7$$

114. $x^2 + 3x - \frac{3}{4} = 0$

$$x^2 + 3x + \left(\frac{3}{2}\right)^2 = \frac{3}{4} + \frac{9}{4}$$

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

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

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

116. $20x^3 - 125x = 0$

$$5x(4x^2 - 25) = 0$$

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

$$5x = 0 \Rightarrow x = 0$$

$$2x + 5 = 0 \Rightarrow x = -\frac{5}{2}$$

$$2x - 5 = 0 \Rightarrow x = \frac{5}{2}$$

118. $x^6 - 64 = 0$

$$(x^3 - 8)(x^3 + 8) = 0$$

$$(x - 2)(x^2 + 2x + 4)(x + 2)(x^2 - 2x + 4) = 0$$

$$x - 2 = 0 \Rightarrow x = 2$$

$$x^2 + 2x + 4 = 0 \text{ No real solution.}$$

$$x + 2 = 0 \Rightarrow x = -2$$

$$x^2 - 2x + 4 = 0 \text{ No real solution.}$$

120. $9x^4 - 24x^3 + 16x^2 = 0$

$$x^2(9x^2 - 24x + 16) = 0$$

$$x^2(3x - 4)^2 = 0$$

$$x^2 = 0 \Rightarrow x = 0$$

$$3x - 4 = 0 \Rightarrow x = \frac{4}{3}$$

122. $x^4 + 2x^3 - 8x - 16 = 0$

$$x^3(x + 2) - 8(x + 2) = 0$$

$$(x^3 - 8)(x + 2) = 0$$

$$(x - 2)(x^2 + 2x + 4)(x + 2) = 0$$

$$x - 2 = 0 \Rightarrow x = 2$$

$$x^2 + 2x + 4 = 0 \text{ No real solution.}$$

$$x + 2 = 0 \Rightarrow x = -2$$

124. $x^4 + 5x^2 - 36 = 0$

$$(x^2 + 9)(x^2 - 4) = 0$$

$$(x^2 + 9)(x + 2)(x - 2) = 0$$

$$x^2 + 9 = 0 \text{ No real solution.}$$

$$x + 2 = 0 \Rightarrow x = -2$$

$$x - 2 = 0 \Rightarrow x = 2$$

126. $$36t^4 + 29t^2 - 7 = 0$$
$$(36t^2 - 7)(t^2 + 1) = 0$$
$$\left(6t + \sqrt{7}\right)\left(6t - \sqrt{7}\right)(t^2 + 1) = 0$$

$$6t + \sqrt{7} = 0 \Longrightarrow t = -\frac{\sqrt{7}}{6}$$

$$6t - \sqrt{7} = 0 \Longrightarrow t = \frac{\sqrt{7}}{6}$$

$$t^2 + 1 = 0 \text{ No real solution.}$$

128. $6\left(\dfrac{s}{s+1}\right)^2 + 5\left(\dfrac{s}{s+1}\right) - 6 = 0$

Let $u = s/(s+1)$.

$$6u^2 + 5u - 6 = 0$$
$$(3u - 2)(2u + 3) = 0$$

$$3u - 2 = 0 \Longrightarrow u = \frac{2}{3}$$

$$2u + 3 = 0 \Longrightarrow u = -\frac{3}{2}$$

$$\frac{s}{s+1} = \frac{2}{3} \Longrightarrow s = 2$$

$$\frac{s}{s+1} = -\frac{3}{2} \Longrightarrow s = -\frac{3}{5}$$

130. $$3x^{1/3} + 2x^{2/3} = 5$$
$$2x^{2/3} + 3x^{1/3} - 5 = 0$$
$$(2x^{1/3} + 5)(x^{1/3} - 1) = 0$$

$$x^{1/3} = -\frac{5}{2} \Longrightarrow x = \frac{-125}{8}$$

$$x^{1/3} = 1 \Longrightarrow x = 1$$

132. $\sqrt[3]{2x + 5} + 3 = 0$

$$\sqrt[3]{2x + 5} = -3$$
$$2x + 5 = -27$$
$$2x = -32$$
$$x = -16$$

134. $\sqrt{x + 5} = \sqrt{x - 5}$

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

No solution

136. $\sqrt{x} + \sqrt{x - 20} = 10$

$$\sqrt{x} = 10 - \sqrt{x - 20}$$
$$\left(\sqrt{x}\right)^2 = \left(10 - \sqrt{x - 20}\right)^2$$
$$x = 100 - 20\sqrt{x - 20} + x - 20$$
$$-80 = -20\sqrt{x - 20}$$
$$4 = \sqrt{x - 20}$$
$$16 = x - 20$$
$$36 = x$$

138. $(x^2 - x - 22)^{4/3} = 16$

$$x^2 - x - 22 = \pm16$$
$$x^2 - x - 22 = \pm8$$
$$x^2 - x - 30 = 0 \Longrightarrow x = -5, 6$$
$$x^2 - x - 14 = 0 \Longrightarrow x = \frac{1 \pm \sqrt{57}}{2}$$

140. $4x^2(x - 1)^{1/3} + 6x(x - 1)^{4/3} = 0$

$$2x[2x(x - 1)^{1/3} + 3(x - 1)^{4/3}] = 0$$
$$2x(x - 1)^{1/3}[2x + 3(x - 1)] = 0$$
$$2x(x - 1)^{1/3}(5x - 3) = 0$$

$$2x = 0 \Longrightarrow x = 0$$
$$x - 1 = 0 \Longrightarrow x = 1$$
$$5x - 3 = 0 \Longrightarrow x = \tfrac{3}{5}$$

142. $$\frac{4}{x} - \frac{5}{3} = \frac{x}{6}$$

$$(6x)\frac{4}{x} - (6x)\frac{5}{3} = (6x)\frac{x}{6}$$
$$24 - 10x = x^2$$
$$x^2 + 10x - 24 = 0$$
$$(x + 12)(x - 2) = 0$$

$$x + 12 = 0 \Longrightarrow x = -12$$
$$x - 2 = 0 \Longrightarrow x = 2$$

144.
$$\frac{x}{x^2 - 4} + \frac{1}{x + 2} = 3$$

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

$$x + x - 2 = 3x^2 - 12$$

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

$$a = 3, \ b = -2, \ c = -10$$

$$x = \frac{-(-2) \pm \sqrt{(-2)^2 - 4(3)(-10)}}{2(3)} = \frac{2 \pm \sqrt{124}}{6} = \frac{2 \pm 2\sqrt{31}}{6} = \frac{1 \pm \sqrt{31}}{3}$$

146.
$$4x + 1 = \frac{3}{x}$$

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

$$4x^2 + x = 3$$

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

$$(4x - 3)(x + 1) = 0$$

$$4x - 3 = 0 \Longrightarrow x = \frac{3}{4}$$

$$x + 1 = 0 \Longrightarrow x = -1$$

148. $|3x + 2| = 7$

$$3x + 2 = 7 \Longrightarrow x = \frac{5}{3}$$

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

$$-3x - 2 = 7 \Longrightarrow x = -3$$

150. $|x - 10| = x^2 - 10x$

First equation:

$$x - 10 = x^2 - 10x$$

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

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

$$0 = x - 1 \Longrightarrow x = 1, \text{ not a solution}$$

$$0 = x - 10 \Longrightarrow x = 10$$

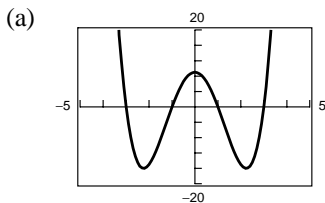*Second equation:*

$$-(x - 10) = x^2 - 10x$$

$$0 = x^2 - 9x - 10$$

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

$$0 = x - 10 \Longrightarrow x = 10$$

$$0 = x + 1 \Longrightarrow x = -1$$

152. $y = x^4 - 10x^2 + 9$

(a)

(b) x-intercepts: $(\pm 1, 0), \ (\pm 3, 0)$

(c) $\ 0 = x^4 - 10x^2 + 9$

$$0 = (x^2 - 1)(x^2 - 9)$$

$$0 = (x + 1)(x - 1)(x + 3)(x - 3)$$
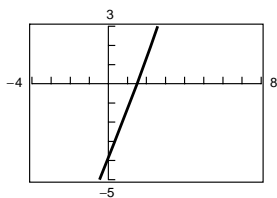
$$x + 1 = 0 \ \Longrightarrow \ x = -1$$

$$x - 1 = 0 \ \Longrightarrow \ x = 1$$

$$x + 3 = 0 \ \Longrightarrow \ x = -3$$

$$x - 3 = 0 \ \Longrightarrow \ x = 3$$

154. $y = 2x - \sqrt{15 - 4x}$

(a)

(b) x-intercept: $\left(\frac{3}{2}, 0\right)$

(c) $0 = 2x - \sqrt{15 - 4x}$

$\sqrt{15 - 4x} = 2x$

$15 - 4x = 4x^2$

$0 = 4x^2 + 4x - 15$

$0 = (2x + 5)(2x - 3)$
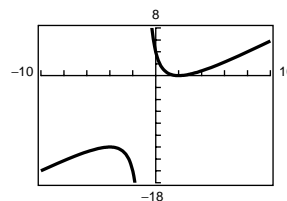
$0 = 2x + 5 \Longrightarrow x = -\frac{5}{2}$

$0 = 2x - 3 \Longrightarrow x = \frac{3}{2}$

$x = -\frac{5}{2}$ is extraneous. The x-intercept is $\left(\frac{3}{2}, 0\right)$.

(d) Same intercept

156. $y = x + \dfrac{9}{x + 1} - 5$

(a)

(b) x-intercept: $(2, 0)$

(c) $0 = x + \dfrac{9}{x + 1} - 5$

$0 = x(x + 1) + (x + 1)\dfrac{9}{x + 1} - 5(x + 1)$

$0 = x^2 + x + 9 - 5x - 5$

$0 = x^2 - 4x + 4$
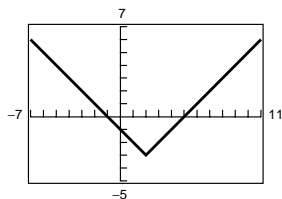
$0 = (x - 2)(x - 2)$

$0 = x - 2 \Longrightarrow x = 2$

x-intercept: $(2, 0)$

(d) Same intercept

158. $y = |x - 2| - 3$

(a)

(b) x-intercepts: $(5, 0), (-1, 0)$

(c) $0 = |x - 2| - 3$

$3 = |x - 2|$

First equation:

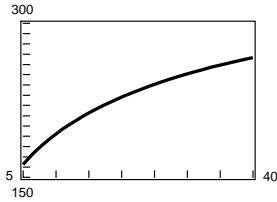$x - 2 = 3 \Longrightarrow x = 5$

Second equation:

$-(x - 2) = 3$

$-x + 2 = 3 \Longrightarrow x = -1$

x-intercepts: $(5, 0), (-1, 0)$

(d) Same intercepts

160. (a)

(b) $\qquad\qquad\qquad\qquad\qquad x = 14.696$

$75.82 - 2.11(14.696) + 43.51\sqrt{14.696} \approx 211.6°\,\text{F}$

(c) $240 = 75.82 - 2.11x + 43.51\sqrt{x}$

$\quad\;\; 0 = -164.18 - 2.11x + 43.51\sqrt{x}$

$\quad a = -2.11,\;\; b = 43.51,\;\; c = -164.18$

$$\sqrt{x} = \frac{-43.51 \pm \sqrt{(43.51)^2 - 4(-2.11)(-164.18)}}{2(-2.11)}$$

$$x = \left[\frac{-43.51 - \sqrt{507.4409}}{-4.22}\right]^2 \approx 244.874$$

$$x = \left[\frac{-43.51 + \sqrt{507.4409}}{-4.22}\right]^2 \approx 24.725$$

Because x is restricted to $5 \le x \le 40$, choose $x = 24.725$ pounds per square inch.

162. False. An equation can have any number of extraneous solutions.

164. (a) $\quad ax^2 + bx = 0$ $\qquad\qquad$ (b) $\quad ax^2 - ax = 0$

$\qquad\quad x(ax + b) = 0$ $\qquad\qquad\qquad\quad ax(x - 1) = 0$

$\qquad\qquad\qquad\quad x = 0$ $\qquad\qquad\qquad\qquad\qquad\quad x = 0$

$\qquad\qquad\qquad\; x = -b/a$ $\qquad\qquad\qquad\qquad\qquad\; x = 1$

Section P.5 Solving Inequalities Algebraically and Graphically

Solutions to Even-Numbered Exercises

2. $x \ge 5$ $\qquad\qquad\qquad\qquad\qquad\qquad\qquad$ **4.** $0 \le x \le \frac{9}{2}$

Matches (a). $\qquad\qquad\qquad\qquad\qquad\qquad\qquad\;\;$ Matches (b).