Chapter 1 Equations and Inequalities

Section 1.1 Exercises

1. Determine whether 2 is a solution.

$$3(x-4)+5=2x-5$$
$$3(2-4)+5\stackrel{?}{=}2(2)-5$$
$$3(-2)+5\stackrel{?}{=}4-5$$
$$-6+5\stackrel{?}{=}-1$$
$$-1=-1$$

Yes, 2 is a solution.

2. Determine the number.

For the equation, $\frac{1}{5}x-15=\frac{3}{10}x$, the LCD is 10. So multiply each side of the equation by 10 (or a multiple of 10) to clear fractions.

3. State the difference.

A conditional equation is true for some values of the variable, but not true for other values of the variable. An identity has an infinite number of solutions.

4. Write the possible values of $x + 9$.

$$|x+9|=5$$
$$x+9=5 \quad \text{or} \quad x+9=-5$$

The possible values of $x + 9$ are 5 and –5.

5. Solve the equation.

$$2x+10=40$$
$$2x=40-10$$
$$2x=30$$
$$x=15$$

6. Solve the equation.

$$-3y+20=2$$
$$-3y=2-20$$
$$-3y=-18$$
$$y=6$$

7. Solve the equation.

$$5x+2=2x-10$$
$$5x-2x=-10-2$$
$$3x=-12$$
$$x=-4$$

8. Solve the equation.

$$4x-11=7x+20$$
$$4x-7x=20+11$$
$$-3x=31$$
$$x=-\frac{31}{3}$$

9. Solve the equation.

$$2(x-3)-5=4(x-5)$$
$$2x-6-5=4x-20$$
$$2x-11=4x-20$$
$$2x-4x=-20+11$$
$$-2x=-9$$
$$x=\frac{9}{2}$$

10. Solve the equation.

$$5(x-4)-7=-2(x-3)$$
$$5x-20-7=-2x+6$$
$$5x-27=-2x+6$$
$$5x+2x=6+27$$
$$7x=33$$
$$x=\frac{33}{7}$$

11. Solve the equation.

$$3x+5(1-2x)=4-3(x+1)$$
$$3x+5-10x=4-3x-3$$
$$-7x+5=1-3x$$
$$-4x=-4$$
$$x=1$$

12. Solve the equation.

$$6-2(4x+1)=3x-2(2x+5)$$
$$6-8x-2=3x-4x-10$$
$$4-8x=-x-10$$
$$-7x=-14$$
$$x=2$$

13. Solve the equation.

$$\begin{aligned} 4(2r-17)+5(3r-8) &= 0 \\ 8r-68+15r-40 &= 0 \\ 23r-108 &= 0 \\ 23r &= 108 \\ r &= \frac{108}{23} \end{aligned}$$

14. Solve the equation.

$$\begin{aligned} 6(5s-11)-12(2s+5) &= 0 \\ 30s-66-24s-60 &= 0 \\ 6s-126 &= 0 \\ 6s &= 126 \\ s &= \frac{126}{6} \\ s &= 21 \end{aligned}$$

15. Solve the equation.

$$\begin{aligned} \frac{3}{4}x+\frac{1}{2} &= \frac{2}{3} \\ 12\cdot\left(\frac{3}{4}x+\frac{1}{2}\right) &= 12\cdot\left(\frac{2}{3}\right) \\ 9x+6 &= 8 \\ 9x &= 8-6 \\ 9x &= 2 \\ x &= \frac{2}{9} \end{aligned}$$

16. Solve the equation.

$$\begin{aligned} \frac{x}{4}-5 &= \frac{1}{2} \\ 4\cdot\left(\frac{x}{4}-5\right) &= 4\left(\frac{1}{2}\right) \\ x-20 &= 2 \\ x &= 2+20 \\ x &= 22 \end{aligned}$$

17. Solve the equation.

$$\begin{aligned} \frac{2}{3}x-5 &= \frac{1}{2}x-3 \\ 6\cdot\left(\frac{2}{3}x-5\right) &= 6\cdot\left(\frac{1}{2}x-3\right) \\ 4x-30 &= 3x-18 \\ 4x-3x &= -18+30 \\ x &= 12 \end{aligned}$$

18. Solve the equation.

$$\begin{aligned} \frac{1}{2}x+7-\frac{1}{4}x &= \frac{19}{2} \\ 4\cdot\left(\frac{1}{2}x+7-\frac{1}{4}x\right) &= 4\cdot\left(\frac{19}{2}\right) \\ 2x+28-x &= 38 \\ x+28 &= 38 \\ x &= 38-28 \\ x &= 10 \end{aligned}$$

19. Solve the equation.

$$\begin{aligned} 0.2x+0.4 &= 3.6 \\ 0.2x &= 3.6-0.4 \\ 0.2x &= 3.2 \\ x &= 16 \end{aligned}$$

20. Solve the equation.

$$\begin{aligned} 0.04x-0.2 &= 0.07 \\ 0.04x &= 0.07+0.2 \\ 0.04x &= 0.27 \\ x &= 6.75 \end{aligned}$$

21. Solve the equation.

$$\begin{aligned} x+0.08(60) &= 0.20(60+x) \\ x+4.8 &= 12+0.20x \\ x-0.20x &= 12-4.8 \\ 0.80x &= 7.2 \\ x &= 9 \end{aligned}$$

22. Solve the equation.

$$\begin{aligned} 6(t+1.5) &= 12t \\ 6t+9 &= 12t \\ 6t-12t &= -9 \\ -6t &= -9 \\ t &= \frac{3}{2} \end{aligned}$$

23. Solve the equation.

$$\begin{aligned} 5[x-(4x-5)] &= 3-2x \\ 5(x-4x+5) &= 3-2x \\ 5(-3x+5) &= 3-2x \\ -15x+25 &= 3-2x \\ -15x+2x &= 3-25 \\ -13x &= -22 \\ x &= \frac{22}{13} \end{aligned}$$

24. Solve the equation.

$$\begin{aligned}6[3y-2(y-1)]-2+7y&=0\\ 6(3y-2y+2)-2+7y&=0\\ 18y-12y+12-2+7y&=0\\ 13y+10&=0\\ 13y&=-10\\ y&=-\frac{10}{13}\end{aligned}$$

25. Solve the equation.

$$\begin{aligned}\frac{40-3x}{5}&=\frac{6x+7}{8}\\ 40\cdot\left(\frac{40-3x}{5}\right)&=40\cdot\left(\frac{6x+7}{8}\right)\\ 8(40-3x)&=5(6x+7)\\ 320-24x&=30x+35\\ -24x-30x&=35-320\\ -54x&=-285\\ x&=\frac{95}{18}\end{aligned}$$

26. Solve the equation.

$$\begin{aligned}\frac{12+x}{-4}&=\frac{5x-7}{3}+2\\ 12\cdot\left(\frac{12+x}{-4}\right)&=12\cdot\left(\frac{5x-7}{3}+2\right)\\ -3(12+x)&=4(5x-7)+24\\ -36-3x&=20x-28+24\\ -36-3x&=20x-4\\ -3x-20x&=-4+36\\ -23x&=32\\ x&=-\frac{32}{23}\end{aligned}$$

27. Classify: contradiction, conditional equation, identity.

$$\begin{aligned}-3(x-5)&=-3x+15\\ -3x+15&=-3x+15\end{aligned}$$

Identity

28. Classify: contradiction, conditional equation, identity.

$$\begin{aligned}2x+\frac{1}{3}&=\frac{6x+1}{3}\\ 3\cdot\left(2x+\frac{1}{3}\right)&=3\cdot\left(\frac{6x+1}{3}\right)\\ 6x+1&=6x+1\end{aligned}$$

Identity

29. Classify: contradiction, conditional equation, identity.

$$\begin{aligned}2x+7&=3(x-1)\\ 2x+7&=3x-3\\ 2x-3x&=-3-7\\ -x&=-10\\ x&=10\end{aligned}$$

Conditional equation

30. Classify: contradiction, conditional equation, identity.

$$\begin{aligned}4[2x-5(x-3)]&=6\\ 4[2x-5x+15]&=6\\ 4[-3x+15]&=6\\ -12x+60&=6\\ -12x&=-54\\ x&=\frac{9}{2}\end{aligned}$$

Conditional equation

31. Classify: contradiction, conditional equation, identity.

$$\begin{aligned}\frac{4x+8}{4}&=x+8\\ 4x+8&=4(x+8)\\ 4x+8&=4x+32\\ 8&=32\end{aligned}$$

Contradiction

32. Classify: contradiction, conditional equation, identity.

$$\begin{aligned}3[x-(4x-1)]&=-3(2x-5)\\ 3[x-4x+1]&=-6x+15\\ 3[-3x+1]&=-6x+15\\ -9x+3&=-6x+15\\ -3x&=12\\ x&=-4\end{aligned}$$

Conditional equation

33. Classify: contradiction, conditional equation, identity.

$$\begin{aligned}3[x-2(x-5)]-1&=-3x+29\\ 3[x-2x+10]-1&=-3x+29\\ 3[-x+10]-1&=-3x+29\\ -3x+30-1&=-3x+29\\ -3x+29&=-3x+29\end{aligned}$$

Identity

34. Classify: contradiction, conditional equation, identity.

$$\begin{aligned} 4[3(x-5)+7] &= 12x-32 \\ 4[3x-15+7] &= 12x-32 \\ 4[3x-8] &= 12x-32 \\ 12x-32 &= 12x-32 \end{aligned}$$

Identity

35. Classify: contradiction, conditional equation, identity.

$$\begin{aligned} 2x-8 &= -x+9 \\ 3x &= 17 \\ x &= \frac{17}{3} \end{aligned}$$

Conditional equation

36. Classify: contradiction, conditional equation, identity.

$$\begin{aligned} |3(x-4)+7| &= |3x-5| \\ |3x-12+7| &= |3x-5| \\ |3x-5| &= |3x-5| \end{aligned}$$

Identity

37. Solve for x.

$$|x| = 4$$

$x = 4$ or $x = -4$

38. Solve for x.

$$|x| = 7$$

$x = 7$ or $x = -7$

39. Solve for x.

$$|x-5| = 2$$

$$\begin{aligned} x-5 &= 2 \quad \text{or} \quad x-5 = -2 \\ x &= 7 \qquad\qquad x = 3 \end{aligned}$$

40. Solve for x.

$$|x-8| = 3$$

$$\begin{aligned} x-8 &= 3 \quad \text{or} \quad x-8 = -3 \\ x &= 11 \qquad\qquad x = 5 \end{aligned}$$

41. Solve for x.

$$|2x-5| = 11$$

$$\begin{aligned} 2x-5 &= 11 \quad \text{or} \quad 2x-5 = -11 \\ 2x &= 16 \qquad\qquad 2x = -6 \\ x &= 8 \qquad\qquad x = -3 \end{aligned}$$

42. Solve for x.

$$|2x-3| = 21$$

$$\begin{aligned} 2x-3 &= 21 \quad \text{or} \quad 2x-3 = -21 \\ 2x &= 24 \qquad\qquad 2x = -18 \\ x &= 12 \qquad\qquad x = -9 \end{aligned}$$

43. Solve for x.

$$|2x+6| = 10$$

$$\begin{aligned} 2x+6 &= 10 \quad \text{or} \quad 2x+6 = -10 \\ 2x &= 4 \qquad\qquad 2x = -16 \\ x &= 2 \qquad\qquad x = -8 \end{aligned}$$

44. Solve for x.

$$|2x+14| = 60$$

$$\begin{aligned} 2x+14 &= 60 \quad \text{or} \quad 2x+14 = -60 \\ 2x &= 46 \qquad\qquad 2x = -74 \\ x &= 23 \qquad\qquad x = -37 \end{aligned}$$

45. Solve for x.

$$\left|\frac{x-4}{2}\right| = 8$$

$$\begin{aligned} \frac{x-4}{2} &= 8 \quad \text{or} \quad \frac{x-4}{2} = -8 \\ x-4 &= 8(2) \qquad\qquad x-4 = -8(2) \\ x-4 &= 16 \qquad\qquad x-4 = -16 \\ x &= 20 \qquad\qquad x = -12 \end{aligned}$$

46. Solve for x.

$$\left|\frac{x+3}{4}\right| = 6$$

$$\begin{aligned} \frac{x+3}{4} &= 6 \quad \text{or} \quad \frac{x+3}{4} = -6 \\ x+3 &= 6(4) \qquad\qquad x+3 = -6(4) \\ x+3 &= 24 \qquad\qquad x+3 = -24 \\ x &= 21 \qquad\qquad x = -27 \end{aligned}$$

47. Solve for x.

$$|2x+5| = -8$$

$$|2x+5| \geq 0$$

$$-8 \geq 0$$

Contradiction. There is no solution.

48. Solve for x.

$$|4x-1| = -17$$
$$|4x-1| \geq 0$$
$$-17 \geq 0$$

Contradiction. There is no solution.

49. Solve for x.

$$2|x+3|+4 = 34$$
$$2|x+3| = 30$$
$$|x+3| = 15$$
$$x+3 = 15 \quad \text{or} \quad x+3 = -15$$
$$x = 12 \qquad\qquad x = -18$$

50. Solve for x.

$$3|x-5|-16 = 2$$
$$3|x-5| = 18$$
$$|x-5| = 6$$
$$x-5 = 6 \quad \text{or} \quad x-5 = -6$$
$$x = 11 \qquad\qquad x = -1$$

51. Solve for x.

$$3|2x-5|+2 = 11$$
$$3|2x-5| = 9$$
$$|2x-5| = 3$$
$$2x-5 = 3 \quad \text{or} \quad 2x-5 = -3$$
$$2x = 8 \quad \text{or} \quad 2x = 2$$
$$x = 4 \quad \text{or} \quad x = 1$$

52. Solve for x.

$$5-4|2-5x| = -7$$
$$-4|2-5x| = -12$$
$$|2-5x| = 3$$
$$2-5x = 3 \quad \text{or} \quad 2-5x = -3$$
$$-5x = 1 \quad \text{or} \quad -5x = -5$$
$$x = -\frac{1}{5} \quad \text{or} \quad x = 1$$

53. Estimate the volume of the pouch.

$$F = -5.5V + 5400$$
$$550 = -5.5V + 5400$$
$$-4850 = -5.5V$$
$$881.81\overline{81} = V$$
$$V \approx 882 \text{ cm}^3$$

54. Find the weight.

$$LBM = 0.3281W + 0.3393H - 29.5336$$
$$55 = 0.3281W + 0.3393(175) - 29.5336$$
$$25.1561 = 0.3281W$$
$$76.6720512 = W$$
$$W \approx 77 \text{ kg}$$

55. Find the time.

$$d = |210 - 50t|$$
$$60 = 210 - 50t \quad \text{or} \quad -60 = 210 - 50t$$
$$-150 = -50t \qquad\qquad -270 = -50t$$
$$t = 3 \qquad\qquad t = 5.4$$

5.4 hours = 5 hours 24 minutes

Ruben will be exactly 60 miles from Barstow after 3 hours and after 5 hours and 24 minutes.

56. Find the constant speed.

$$m = -\frac{1}{2}|s-55|+25$$
$$22 = -\frac{1}{2}|s-55|+25$$
$$-3 = -\frac{1}{2}|s-55|$$
$$6 = |s-55|$$
$$6 = s-55 \quad \text{or} \quad -6 = s-55$$
$$61 = s \qquad\qquad 49 = s$$

Kate can drive at 49 mph or 61 mph to obtain gas mileage of exactly 22 miles per gallon.

57. Find the number of minutes.

$$g = 18 - \frac{1}{36}t$$
$$0 = 18 - \frac{1}{36}t$$
$$\frac{1}{36}t = 18$$
$$t = 648$$

The engine will run out of gas in 648 min.

58. Find the depth. Round to the nearest tenth of a foot.

$$p = 0.445d + 14.7$$
$$24 = 0.445d + 14.7$$
$$9.3 = 0.445d$$
$$20.9 = d$$

The depth is approximately 20.9 ft.

59. Find the number of minutes. Round to the nearest tenth of a minute.

$$p = 100 - \frac{30}{N}t$$
$$25 = 100 - \frac{30}{110}t$$
$$\frac{30}{110}t = 75$$
$$t = 275 \text{ seconds}$$
$$275 \text{ sec} \cdot \left(\frac{1 \text{ min}}{60 \text{ sec}}\right) \approx 4.6 \text{ min}$$

60. Find the number of hours. Round to the nearest tenth of an hour.

$2650 - 475t =$ miles remaining
$2650 - 475t = 1000$
$-475t = -1650$
$t \approx 3.5$ to the nearest tenth

3.5 hours

61. Find the MHR for a male and female. Round to the nearest beat per minute.

$\text{male} = 202 - 0.55a$ $\quad$ $\text{female} = 216 - 1.09a$
$= 202 - 0.55(25)$ $\quad$ $= 216 - 1.09(25)$
$= 202 - 13.75$ $\quad$ $= 216 - 27.25$
$= 188.25$ $\quad$ $= 188.75$

The MHR for a male who is 25 years of age is about 188 beats per minute.

The MHR for a female who is 25 years of age is about 189 beats per minute.

62. Find the age. Round to the nearest year.

$\text{female} = 216 - 1.09a$
$150 = 216 - 1.09a$
$-66 = -1.09a$
$60.55 \approx a$

A woman should have a maximum exercise heart rate of 150 beats per minute at approximately age 61.

63. Solve.

$$\frac{\frac{1}{2}}{1+x} + \frac{1}{x} = \frac{x+3}{2}$$
$$\frac{1+x}{2} + \frac{1}{x} = \frac{x+3}{2} \quad \text{LCD} = 2x$$
$$x(1+x) + 2 = x(x+3)$$
$$x + x^2 + 2 = x^2 + 3x$$
$$2 = 2x$$
$$1 = x$$

64. Solve.

$$\frac{2x^2 - x + 2}{x} - 3 = 2(x-4)$$
$$2x^2 - x + 2 - 3x = 2x^2 - 8x$$
$$2x^2 - 4x + 2 = 2x^2 - 8x$$
$$2 = -4x$$
$$-\frac{1}{2} = x$$

65. Solve.

$|x| + |x-1| = 3$

For $x < 0$,

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

For $0 \le x \le 1$, (one is positive and one is negative)

$$x - (x-1) = 3$$
$$1 \ne 3 \text{ contradiction (no solution)}$$

For $x > 1$,

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

66. To remove the absolute value signs, we must know whether the quantities inside the absolute value are positive or negative. Both quantities are negative when $x < 0$; one is positive (or 0) and one is negative (or 0) when $0 \le x \le 1$; and both are positive when $x > 1$.

Prepare for Section 1.2

P1. Evaluate.

$32 - x$

$32 - 8\frac{1}{2} = 23\frac{1}{2}$

P2. Evaluate.

$\frac{1}{2}bh$

$\frac{1}{2} \cdot \frac{2}{3} \cdot \frac{4}{5} = \frac{4}{15}$

P3. Determine the property.

$2l + 2w = 2(l + w)$

Distributive property

P4. Determine the property.

$\left(\frac{1}{2}b\right)h = \frac{1}{2}bh$

Associative property of multiplication

P5. Add.

$\frac{2}{5}x + \frac{1}{3}x = \frac{6}{15}x + \frac{5}{15}x = \frac{11}{15}x$

P6. Simplify.

$$\frac{1}{\frac{1}{a}+\frac{1}{b}} = \frac{1}{\frac{1}{a}\cdot\frac{b}{b}+\frac{1}{b}\cdot\frac{a}{a}} = \frac{1}{\frac{b}{ab}+\frac{a}{ab}} = \frac{1}{\frac{b+a}{ab}} = \frac{ab}{a+b}$$

Section 1.2 Exercises

1. Write the first step to solve $A = P + Prt$ for r.

Subtract P from each side.

2. Evaluate.

$A = \frac{1}{2}h(b_1 + b_2)$

$A = \frac{1}{2}(6)(5+7) = 36$

3. Write the ratio.

For similar triangles, the ratio of two sides is equal to the ratio of the same two sides of the similar triangle.

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

4. Write the expressions.

The amount invested at 5% is $4000 - x$.

Interest earned in 3% account: $0.03x$

Interest earned in 5% account: $0.05(4000 - x)$

The total amount of interest earned in the accounts in one year is $0.03x + 0.05(4000 - x)$.

5. Write the expression representing the total value.

Value of almonds: $7x$

Value of walnuts: 9(10), or 90

Total value of nut mixture: $7x + 90$

6. Write the expression representing the amount of lawn Maya can mow in m minutes.

$\frac{m}{45}$

7. Solve the formula.

$$V = \frac{1}{3}\pi r^2 h$$
$$3V = \pi r^2 h$$
$$\frac{3V}{\pi r^2} = h$$

8. Solve the formula.

$$P = S - Sdt$$
$$Sdt = S - P$$
$$t = \frac{S-P}{Sd}$$

9. Solve the formula.

$$I = Prt$$
$$\frac{I}{Pr} = t$$

10. Solve the formula.

$$A = P + Prt$$
$$A = P(1+rt)$$
$$\frac{A}{1+rt} = P$$

11. Solve the formula.

$$F = \frac{Gm_1m_2}{d^2}$$
$$Fd^2 = Gm_1m_2$$
$$\frac{Fd^2}{Gm_2} = m_1$$

12. Solve the formula.

$$A = \frac{1}{2}h(b_1 + b_2)$$
$$2A = hb_1 + hb_2$$
$$2A - hb_2 = hb_1$$
$$\frac{2A - hb_2}{h} = b_1$$

13. Solve the formula.

$$a_n = a_1 + (n-1)d$$
$$a_n - a_1 = (n-1)d$$
$$\frac{a_n - a_1}{n-1} = d$$

14. Solve the formula.

$$y - y_1 = m(x - x_1)$$
$$y - y_1 = mx - mx_1$$
$$y - y_1 + mx_1 = mx$$
$$\frac{y - y_1 + mx_1}{m} = x$$

15. Solve the formula.

$$S = \frac{a_1}{1-r}$$
$$S(1-r) = a_1$$
$$S - Sr = a_1$$
$$S - a_1 = Sr$$
$$\frac{S - a_1}{S} = r$$

16. Solve the formula.

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$
$$P_1V_1T_2 = P_2V_2T_1$$
$$\frac{P_1V_1T_2}{P_2T_1} = V_2$$

17. Find Schaub's quarterback rating.

$$\text{QB rating} = \frac{100}{6}[0.05(C-30) + 0.25(Y-3) + 0.2T + (2.375 - 0.25I)]$$
$$= \frac{100}{6}[0.05(61.0-30) + 0.25(8.49-3) + 0.2(5.1) + (2.375 - 0.25 \cdot 2.05)]$$
$$= 96.75$$
$$\approx 96.8$$

18. Find Smith's quarterback rating. Round to the nearest tenth.

$$\text{QB rating} = \frac{100}{6}[0.05(C-30) + 0.25(Y-3) + 0.2T + (2.375 - 0.25I)]$$
$$= \frac{100}{6}[0.05(61.3-30) + 0.25(7.07-3) + 0.2(3.8) + (2.375 - 0.25 \cdot 1.1)]$$
$$\approx 90.7$$

19. Estimate the reading level. Round to the nearest tenth.

$$\text{SMOG} = \sqrt{42} + 3 \approx 6.5 + 3 = 9.5$$

20. Estimate the reading level. Round to the nearest tenth.

$$\text{SMOG} = \sqrt{105} + 3 \approx 10.2 + 3 = 13.2$$

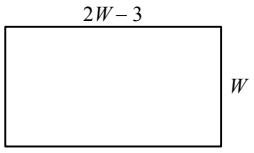
21. Estimate the reading level. Round to the nearest tenth.

$$\text{GFI} = 0.4(14.8 + 15.1) \approx 12.0$$

22. Estimate the reading level. Round to the nearest tenth.

$$\text{GFI} = 0.4(18.8 + 14.2) = 13.2$$

23. Find the width and length.

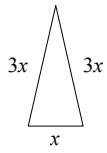


$$P = 2L + 2W$$
$$174 = 2(2W-3) + 2W$$
$$174 = 4W - 6 + 2W$$
$$180 = 6W$$
$$W = 30 \text{ ft}$$
$$L = 2W - 3 = 2(30) - 3 = 60 - 3 = 57 \text{ ft}$$

24. Find the dimensions.

$$P = 2L + 2W \qquad L = 2.25W, \ P = 1040$$
$$1040 = 2(2.25W) + 2W$$
$$1040 = 4.5W + 2W$$
$$1040 = 6.5W$$
$$W = 160 \text{ ft}$$
$$L = 2.25W$$
$$L = 2.25(160) = 360 \text{ ft}$$

25. Find the length of each side.

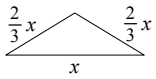


$$3x+3x+x=84$$
$$7x=84$$
$$x=12$$
$$3x=3(12)=36$$

The shortest side is 12 cm.

The longer sides are each 36 cm.

26. Find the length of each side.



$$\frac{2}{3}x+\frac{2}{3}x+x=161$$
$$2x+2x+3x=483$$
$$7x=483$$
$$x=69$$
$$\frac{2}{3}x=\frac{2}{3}(69)=46$$

The longest side is 69 miles.

The two shorter sides are each 46 miles.

27. Use similar triangles to find the height of the tree.

Let h = the height of the tree.

$$\frac{h}{10}=\frac{6}{4}$$
$$h=15 \text{ ft}$$

28. Find the height of the building.

Let h = the height of the building.

$$\frac{h}{50}=\frac{4(12)}{3}$$
$$h=800 \text{ ft}$$

29. Find the distance from the building.

Let x = the distance from the building.

$$\frac{20}{50}=\frac{20-x}{6}$$
$$300\left(\frac{20}{50}\right)=300\left(\frac{20-x}{6}\right)$$
$$120=1000-50x$$
$$50x=880$$
$$x=17.6 \text{ ft}$$

30. Find the length of the shadow. Round to the nearest tenth.

Let x = the length of the shadow.

$$\frac{x}{6}=\frac{x+10}{25}$$
$$150\left(\frac{x}{6}\right)=150\left(\frac{x+10}{25}\right)$$
$$25x=6x+60$$
$$19x=60$$
$$x=3.157894737$$
$$x\approx 3.2 \text{ ft}$$

31. Find the number of pairs of sunglasses.

Let x = the number of sunglasses.

Profit = Revenue – Cost

$$17{,}884=29.99x-8.95x$$
$$17{,}884=21.04x$$
$$x=850$$

The manufacturer must sell 850 pairs of sunglasses to make a profit of \$17,884.

32. Find the number of glasses of orange juice.

Let x = the number of glasses of orange juice.

Profit = Revenue – Cost

$$2058=1.75x-0.28x$$
$$2058=1.47x$$
$$1400=x$$

The owner must sell 1400 glasses of orange juice to make a profit of \$2058.

33. Find the price of the book and the bookmark.

Let x = price of book

$10.10 - x$ = price of bookmark.

$$x=10+(10.10-x)$$
$$2x=20.10$$
$$x=10.05$$
$$10.10-10.05=0.05$$

The price of the book is \$10.05.

The price of the bookmark is \$0.05.

34. Find the total cost of the yacht.

Let x = cost of yacht

$\frac{x}{3}=$ cost with 3 partners

$\frac{x}{4} =$ cost with 4 partners

$$\frac{x}{3} - \frac{x}{4} = 4000$$
$$12\left[\frac{x}{3} - \frac{x}{4}\right] = 12(4000)$$
$$4x - 3x = 48{,}000$$
$$x = 48{,}000$$

The total cost is \$48,000.

35. Find the cost of the computer last year.

Let x = cost last year.

$$x - 0.20x = 750$$
$$0.80x = 750$$
$$x = 937.50$$

The cost of a computer last year was \$937.50.

36. Find the cost of the magazine last year.

Let x = cost last year.

$$x + 0.04x = 26$$
$$1.04x = 26$$
$$x = 25$$

The cost of the subscription last year was \$25.

37. Find how much was invested in each account.

Let x = amount invested at 8%.

$(14{,}000 - x) =$ amount invested at 6.5%.

$$0.08x + 0.065(14{,}000 - x) = 1024$$
$$0.08x + 910 - 0.065x = 1024$$
$$0.015x = 114$$
$$x = 7600$$
$$14{,}000 - x = 6400$$

\$7600 was invested at 8%.

\$6400 was invested at 6.5%.

38. Find how much was invested in each account.

5%	x
7%	$7500 - x$

$$0.05x + 0.07(7500 - x) = 405$$
$$0.05x + 525 - 0.07x = 405$$
$$-0.02x = -120$$
$$x = 6000$$
$$7500 - x = 1500$$

\$6000 was invested at 5%.

\$1500 was invested at 7%.

39. Find the amount invested at 8%.

5.5%	2500
8%	x
7%	$2500 + x$

$$0.055(2500) + 0.08x = 0.07(2500 + x)$$
$$137.5 + 0.08x = 175 + 0.07x$$
$$0.01x = 37.5$$
$$x = 3750$$

\$3750 additional investment at 8%.

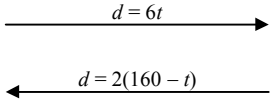
40. Find the amount invested at 9%.

6.8%	4600
9%	x
8%	$4600 + x$

$$0.068(4600) + 0.09x = 0.08(4600 + x)$$
$$312.8 + 0.09x = 368 + 0.08x$$
$$0.01x = 55.2$$
$$x = 5520$$

\$5520 additional investment at 9%.

41. Find the length of the track.

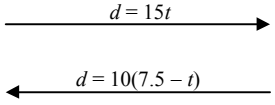


Let t = the time to run to the end of the track.

Let $160 - t$ = the time in seconds to jog back.

$$6t = 2(160 - t)$$
$$6t = 320 - 2t$$
$$8t = 320$$
$$t = 40$$
$$d = 6(40) = 240 \text{ meters}$$

42. Find the distance.



Let t = the time (in hours) to travel to the island.

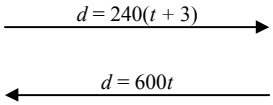
Let $7.5 - t$ = the time (in hours) to return.

$d = 15t$, and $d = 10(7.5 - t)$

Thus, $15t = 10(7.5 - t)$
$$15t = 75 - 10t$$
$$25t = 75$$
$$t = 3 \text{ hours}$$

$d = 15(3) = 45$ nautical miles

43. Find the time.



Let t = the time (in hours) of the second plane.

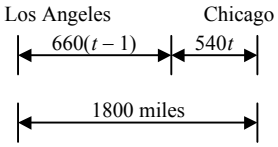
Let $t + 3$ = the time (in hours) of the first plane.

$$d = 240(t+3)$$
$$d = 600t$$
$$240(t+3) = 600t$$
$$240t + 720 = 600t$$
$$720 = 360t$$
$$2 = t$$
$$t = 2 \text{ hours}$$

44. Find the time and distance.

Let t = time (in hours) of the first plane.

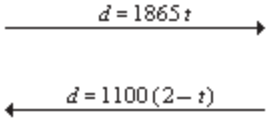
Let $t - 1$ = time (in hours) of the second plane.



$$660(t-1) + 540t = 1800$$
$$660t - 660 + 540t = 1800$$
$$1200t = 2460$$
$$t = 2.05 \text{ hours}$$

Thus, the planes pass each other 2.05 hours after the first plane leaves Chicago. The distance the first plane is from Chicago is 540(2.05) = 1107 miles.

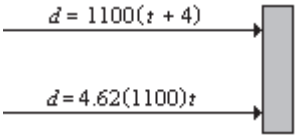
45. Find the distance.



$$1865t = 1100(2-t)$$
$$1865t = 2200 - 1100t$$
$$2965t = 2200$$
$$t \approx 0.741989$$
$$d = 1865t$$
$$d \approx 1383.81$$

The distance to the target is 1384 feet (to the nearest foot).

46. Find the distance.



$$(t+4)(1100) = 4.62(1100)t$$
$$1100t + 4400 = 5082t$$
$$4400 = 3982t$$
$$1.104972376 \approx t$$
$$d = 5082t$$
$$d \approx 5615 \text{ ft}$$

47. Find the speed of the second car.

30 seconds = 0.5 minutes $= \frac{0.5}{60}$ hour $= \frac{1}{120}$ hour.

500 meters = $\frac{1}{2}$ km.

	rate	time
Faster car	x	$\frac{1}{120}$
Slower car	80	$\frac{1}{120}$

$$x\left(\frac{1}{120}\right) - 80\left(\frac{1}{120}\right) = \frac{1}{2}$$
$$120\left[x\left(\frac{1}{120}\right) - 80\left(\frac{1}{120}\right)\right] = 120\left(\frac{1}{2}\right)$$
$$x - 80 = 60$$
$$x = 140$$

140 km/h

48. Find all the possible values of r.

Each plane travels at the same speed: r

There are 2 cases: greater than 2 hr, and less than 4 hr

Greater than or equal to 2 hours,

$$1500 = 2r + 2r$$
$$1500 = 4r$$
$$375 = r$$

Less than or equal to 4 hours,

$$1500 = 4r + 4r$$
$$1500 = 8r$$
$$187.5 = r$$

After travelling between 2 and 4 hours, the possible values of r are $187.5 \text{ mph} \le r \le 375 \text{ mph}$.

49. Find the number of grams of pure silver.

1.00	x
0.45	$200-x$
0.50	200

$$x+0.45(200-x)=0.50(200)$$
$$x+90-0.45x=100$$
$$0.55x=10$$
$$x=18\frac{2}{11} \text{ g pure silver}$$

50. Find the number of liters of 40% sulfuric acid.

0.40	x
0.24	4
0.30	$4+x$

$$0.40x+0.24(4)=0.30(4+x)$$
$$0.40x+0.96=1.2+0.30x$$
$$0.10x=0.24$$
$$x=2.4$$

2.4 liters of 40% sulfuric acid

51. Find the number of liters of water.

0	x
0.12	160
0.20	$160-x$

$$0.12(160)-0=0.20(160-x)$$
$$19.2=32-0.20x$$
$$0.20x=12.8$$
$$x=64$$

64 liters of water

52. Find the number of liters to be drained and replaced.

0.25	6
0.25	x
1.00	x
0.33	6

$$0.25(6)-0.25x+x=0.33(6)$$
$$1.5+0.75x=1.98$$
$$0.75x=0.48$$
$$x=0.64$$

0.64 liter of water should be replaced.

53. Find the number of grams of pure gold.

1.00	x
$\frac{14}{24}$ or $\frac{7}{12}$	15
$\frac{18}{24}$ or $\frac{3}{4}$	$15+x$

$$x+\frac{7}{12}(15)=\frac{3}{4}(15+x)$$
$$12\cdot\left[x+\frac{7}{12}(15)\right]=12\cdot\left[\frac{3}{4}(15+x)\right]$$
$$12x+7(15)=9(15+x)$$
$$12x+105=135+9x$$
$$3x=30$$
$$x=10$$

10 g of pure gold

54. Find the number of ounces of 14-karat gold.

1.00	4
$\frac{14}{24}$ or $\frac{7}{12}$	x
$\frac{18}{24}$ or $\frac{3}{4}$	$4+x$

$$4+\frac{7}{12}x=\frac{3}{4}(4+x)$$
$$12\cdot\left[4+\frac{7}{12}x\right]=12\cdot\left[\frac{3}{4}(4+x)\right]$$
$$48+7x=9(4+x)$$
$$48+7x=36+9x$$
$$-2x=-12$$
$$x=6$$

6 oz of 14 karat gold

55. Find the amount of each grade of tea.

\$6.50	x
\$4.25	$20-x$
\$5.60	20

$$6.50x+4.25(20-x)=5.60(20)$$
$$6.50x+85-4.25x=112$$
$$2.25x+85=112$$
$$2.25x=27$$
$$x=12 \text{ lbs of \$6.50 grade}$$
$$20-x=8 \text{ lbs of \$4.25 grade}$$

56. Find the number of ounces of pure gold.

\$850	x
\$500	25
\$725	$x+25$

$$850x+500(25)=725(x+25)$$
$$850x+12{,}500=725x+18{,}125$$
$$125x=5625$$
$$x=45 \text{ oz of pure gold}$$

57. Find the number of pounds of each.

\$6	x
\$3	$25-x$
\$3.84	25

$$6x+3(25-x)=3.84(25)$$
$$6x+75-3x=96$$
$$3x=21$$
$$x=7 \text{ lbs of cranberries}$$
$$25-x=18 \text{ lb of granola}$$

58. Find the amount for each coffee.

\$12	x
\$9	$20-x$
\$10	20

$$12x+9(20-x)=10(20)$$
$$12x+180-9x=200$$
$$3x=20$$
$$x=6\frac{2}{3}$$

$6\frac{2}{3}$ lb of \$12 coffee

$20-6\frac{2}{3}=13\frac{1}{3}$ lb of \$9 coffee

59. Find the number of pounds of each kind of coffee.

\$8	x
\$4	$50-x$
\$5.50	50

$$8x+4(50-x)=5.50(50)$$
$$8x+200-4x=275$$
$$4x=75$$
$$x=18.75 \text{ lb of \$8 coffee}$$
$$50-x=31.25 \text{ lb of \$4 coffee}$$

60. Find the number of pounds of each kind of silver alloy.

\$6.50	x
\$8.00	$20-x$
\$7.40	20

$$6.50x+8.00(20-x)=7.40(20)$$
$$6.5x+160-8x=148$$
$$-1.5x=-12$$
$$x=8 \text{ oz of \$6.50 silver alloy}$$
$$20-x=12 \text{ oz of \$8.00 silver alloy}$$

61. Find the time working together.

Let t = the time it takes both electricians working together to wire the house.

The first electrician does $\frac{1}{14}$ of the job every hour.

The second electrician does $\frac{1}{18}$ of the job every hour.

$$\frac{1}{14}t+\frac{1}{18}t=1$$
$$126\left[\frac{1}{14}t+\frac{1}{18}t\right]=126\cdot 1$$
$$9t+7t=126$$
$$16t=126$$
$$t=7\frac{7}{8} \text{ hours}$$

62. Find the time working together.

Let t = the time it takes them working together to print the report.

Printer A does $\frac{1}{3}$ of the job every hour.

Printer B does $\frac{1}{4}$ of the job every hour.

$$\frac{1}{3}t+\frac{1}{4}t=1$$
$$12\left[\frac{1}{3}t+\frac{1}{4}t\right]=12\cdot 1$$
$$4t+3t=12$$
$$7t=12$$
$$t=1\frac{5}{7} \text{ hours}$$

63. Find the time working together.

Let t = the time it takes both painters working together to paint the kitchen.

The painter can paint $\frac{1}{10}$ of the kitchen every hour.

The apprentice can paint $\frac{1}{15}$ of the kitchen every hour.

$$\frac{1}{10}t+\frac{1}{15}t=1$$
$$30\left[\frac{1}{10}t+\frac{1}{15}t\right]=30\cdot 1$$
$$3t+2t=30$$
$$5t=30$$
$$t=6 \text{ hours}$$

64. Find the time.

Let t = the time it takes to deposit enough snow to open the beginning trail.

The snow making machine does $\frac{1}{16}$ of the job every hr.

The natural snow fall does $\frac{1}{24}$ of the job every hour.

$$\frac{1}{16}t+\frac{1}{24}t=1$$
$$48\left[\frac{1}{16}t+\frac{1}{24}t\right]=48\cdot 1$$
$$3t+2t=48$$
$$5t=48$$
$$t=9\frac{3}{5}\text{hours}$$

65. Find the time for the older machine.

Let t = time it takes the older machine to finish the job.

The new machine does $\frac{1}{12}$ of the job every hour.

The old machine does $\frac{1}{16}$ of the job every hour.

The new machine works for 4 hours: $4\left(\frac{1}{12}\right)=\frac{1}{3}$.

The old machine completes the job.

$$\frac{1}{3}+\frac{1}{16}t=1$$
$$\frac{1}{16}t=\frac{2}{3}$$
$$t=10\frac{2}{3} \text{ hours}$$

66. Find the time for the apprentice.

Let t = the time it takes the apprentice to finish the job.

The mason does $\frac{1}{12}$ of the job every hour.

The apprentice does $\frac{1}{16}$ of the job every hour.

The two people work together for 4 hours:

$$4\left(\frac{1}{12}+\frac{1}{16}\right)=\frac{7}{12}$$
$$\frac{7}{12}+\frac{1}{16}t=1$$
$$\frac{1}{16}t=\frac{5}{12}$$
$$t=6\frac{2}{3} \text{ hours}$$

67. Find the percent salt concentration.

8 kg of 30% salt has a weight of $8(0.30)=2.4$ kg

$8(0.30)=2.4$ kg salt

$8(0.70)=5.6$ kg water

After 2 kg of water evaporates, the solution has 2.4 kg salt and 3.6 kg water, for a total weight of 6 kg.

New solution: $\frac{2.4}{6}=40\%$ salt and $\frac{3.6}{6}=60\%$ water.

Finally, 2 kg of 30% salt solution is added to 6 kg.

$2(0.30)=0.6$ kg salt

The solution has a total weight of 8 kg. The weight of salt is 2.4 kg + 0.6 kg = 3 kg. The percent salt concentration is $\frac{3}{8}=37.5\%$.

68. Find the weight of the solution.

The 10 lb solution is 99% water, so the water weighs

$10(0.99)=9.9$ lb

The 10 lb solution is 1% sugar, so the sugar weighs

$10(0.01)=0.1$ lb

After some water evaporates, the solution is 98% water and 2% sugar. The weight of sugar has not changed. The weight of the new solution is

$$\frac{0.1 \text{ lb}}{0.02}=5 \text{ lb}.$$

69. Find the distance.

To Jon's house	rate	time	distance
Up	4	$\frac{d_2}{4}$	d_2
Level	6	$\frac{d_1}{6}$	d_1
Down	12	$\frac{d_2}{12}$	d_2

$$\frac{d_2}{4}+\frac{d_1}{6}+\frac{d_1}{6}+\frac{d_2}{12}=1$$
$$12\left(\frac{d_2}{4}+\frac{d_1}{6}+\frac{d_1}{6}+\frac{d_2}{12}\right)=12(1)$$
$$3d_2+2d_1+2d_1+d_2=12$$
$$4d_1+4d_2=12$$
$$4(d_1+d_2)=12$$
$$d_1+d_2=3$$

The distance is 3 mi.

Prepare for Section 1.3

P1. Factor.

$$x^2-x-42=(x+6)(x-7)$$

P2. Factor.

$$6x^2-x-15=(2x+3)(3x-5)$$

P3. Write in $a + bi$ form.

$$3+\sqrt{-16}=3+4i$$

P4. Evaluate.

$$\frac{-(-2)-\sqrt{(-2)^2-4(-3)(5)}}{2(-3)}=\frac{2-\sqrt{64}}{-6}=1$$

P5. Evaluate.

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

P6. Evaluate.

$$(3-i)^2-6(3-i)+10=9-6i+i^2-18+6i+10$$
$$=0$$

Section 1.3 Exercises

1. From the equation $(x-8)(x+5)=0$, the zero product property says either $x - 8 = 0$ or $x + 5 = 0$.

2. Simplify.

$$\sqrt{(x-3)^2}=|x-3|$$

3. Complete the square.

a. $\left(\frac{1}{2}\cdot 12\right)^2=36$

b. $\left(\frac{1}{2}\cdot 9\right)^2=\frac{81}{4}$

4. State the first step to solve $4x^2+6x-1=0$ by completing the square.

Divide each side by 4.

5. State the quadratic formula. Identify the discriminant.

$x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$; b^2-4ac is the discriminant.

6. State each solution and approximate.

$-5-\sqrt{2}\approx -6.4$

$-5+\sqrt{2}\approx -3.6$

7. Solve: factor and apply the zero product principle.

$$x^2-2x-15=0$$
$$(x+3)(x-5)=0$$
$$x+3=0 \quad \text{or} \quad x-5=0$$
$$x=-3 \qquad\qquad x=5$$

8. Solve: factor and apply the zero product principle.

$$x^2+3x-10=0$$
$$(x+5)(x-2)=0$$
$$x+5=0 \quad \text{or} \quad x-2=0$$
$$x=-5 \qquad\qquad x=2$$

9. Solve: factor and apply the zero product principle.

$$2x^2-x=1$$
$$2x^2-x-1=0$$
$$(2x+1)(x-1)=0$$
$$2x+1=0 \quad \text{or} \quad x-1=0$$
$$2x=-1 \qquad\qquad x=1$$
$$x=-\frac{1}{2}$$

10. Solve: factor and apply the zero product principle.

$$2x^2+5x=3$$
$$2x^2+5x-3=0$$
$$(2x-1)(x+3)=0$$
$$2x-1=0 \quad \text{or} \quad x+3=0$$
$$2x=1 \qquad\qquad x=-3$$
$$x=\frac{1}{2}$$

11. Solve: factor and apply the zero product principle.

$$8x^2+189x-72=0$$
$$(8x-3)(x+24)=0$$
$$8x-3=0 \quad \text{or} \quad x+2=0$$
$$8x=3 \qquad\qquad x=-24$$
$$x=\frac{3}{8}$$

12. Solve: factor and apply the zero product principle.

$$12x^2-41x+24=0$$
$$(4x-3)(3x-8)=0$$
$$4x-3=0 \quad \text{or} \quad 3x-8=0$$
$$4x=3 \qquad\qquad 3x=8$$
$$x=\frac{3}{4} \qquad\qquad x=\frac{8}{3}$$

13. Solve: factor and apply the zero product principle.

$$(x-3)(x+4)=8$$
$$x^2+x-12=8$$
$$x^2+x-20=0$$
$$(x+5)(x-4)=0$$
$$x+5=0 \quad \text{or} \quad x-4=0$$
$$x=-5 \qquad\qquad x=4$$

14. Solve: factor and apply the zero product principle.

$$(2x+1)(x-3)=9$$
$$2x^2-5x-3=9$$
$$2x^2-5x-12=0$$
$$(2x+3)(x-4)=0$$
$$2x+3=0 \quad \text{or} \quad x-4=0$$
$$2x=-3 \qquad\qquad x=4$$
$$x=-\frac{3}{2}$$

15. Solve: factor and apply the zero product principle.

$$3x^2+x-1=(2x+9)(x-1)$$
$$3x^2+x-1=2x^2+7x-9$$
$$x^2-6x+8=0$$
$$(x-2)(x-4)=0$$
$$x-2=0 \quad \text{or} \quad x-4=0$$
$$x=2 \qquad\qquad x=4$$

16. Solve: factor and apply the zero product principle.

$$(2x-5)(x+4)=(x+4)(x-2)$$
$$2x^2+3x-20=x^2+2x-8$$
$$x^2+x-12=0$$
$$(x+4)(x-3)=0$$
$$x+4=0 \quad \text{or} \quad x-3=0$$
$$x=-4 \qquad\qquad x=3$$

17. Solve by the square root procedure.

$$y^2=24$$
$$y=\pm\sqrt{24}$$
$$y=\pm 2\sqrt{6}$$

18. Solve by the square root procedure.

$$y^2=48$$
$$y=\pm\sqrt{48}$$
$$y=\pm 4\sqrt{3}$$

19. Solve by the square root procedure.

$$z^2=-16$$
$$z=\pm\sqrt{-16}$$
$$z=\pm 4i$$

20. Solve by the square root procedure.

$$z^2=-100$$
$$z=\pm\sqrt{-100}$$
$$z=\pm 10i$$

21. Solve by the square root procedure.

$$(x-5)^2 = 36$$
$$x-5 = \pm\sqrt{36}$$
$$x-5 = \pm 6$$
$$x = 5 \pm 6$$
$$x = 5+6 \quad \text{or} \quad x = 5-6$$
$$x = 11 \qquad\qquad x = -1$$

22. Solve by the square root procedure.

$$(x+4)^2 = 121$$
$$x+4 = \pm\sqrt{121}$$
$$x+4 = \pm 11$$
$$x = -4 \pm 11$$
$$x = -4+11 \quad \text{or} \quad x = -4-11$$
$$x = 7 \qquad\qquad x = -15$$

23. Solve by the square root procedure.

$$(x+2)^2 = 27$$
$$x+2 = \pm\sqrt{27}$$
$$x+2 = \pm 3\sqrt{3}$$
$$x = -2 \pm 3\sqrt{3}$$
$$x = -2+3\sqrt{3} \quad \text{or} \quad x = -2-3\sqrt{3}$$

24. Solve by the square root procedure.

$$(x-3)^2 = 8$$
$$x-3 = \pm\sqrt{8}$$
$$x-3 = \pm 2\sqrt{2}$$
$$x = 3 \pm 2\sqrt{2}$$
$$x = 3+2\sqrt{2} \quad \text{or} \quad x = 3-2\sqrt{2}$$

25. Solve by the square root procedure.

$$(z-4)^2 + 25 = 0$$
$$(z-4)^2 = -25$$
$$z-4 = \pm\sqrt{-25}$$
$$z-4 = \pm 5i$$
$$z = 4 \pm 5i$$
$$z = 4+5i \quad \text{or} \quad z = 4-5i$$

26. Solve by the square root procedure.

$$(z+1)^2 + 64 = 0$$
$$(z+1)^2 = -64$$
$$z+1 = \pm\sqrt{-64}$$
$$z+1 = \pm 8i$$
$$z = -1 \pm 8i$$
$$z = -1+8i \quad \text{or} \quad z = -1-8i$$

27. Solve by the square root procedure.

$$(y-6)^2 - 4 = 14$$
$$(y-6)^2 = 18$$
$$y-6 = \pm\sqrt{18}$$
$$y-6 = \pm 3\sqrt{2}$$
$$y = 6 \pm 3\sqrt{2}$$
$$y = 6+3\sqrt{2} \quad \text{or} \quad y = 6-3\sqrt{2}$$

28. Solve by the square root procedure.

$$(y+2)^2 + 5 = 15$$
$$(y+2)^2 = 10$$
$$y+2 = \pm\sqrt{10}$$
$$y = -2 \pm \sqrt{10}$$
$$y = -2+\sqrt{10} \quad \text{or} \quad y = -2-\sqrt{10}$$

29. Solve by the square root procedure.

$$5(x+6)^2 + 60 = 0$$
$$5(x+6)^2 = -60$$
$$(x+6)^2 = -12$$
$$x+6 = \pm\sqrt{-12}$$
$$x+6 = \pm 2i\sqrt{3}$$
$$x = -6 \pm 2i\sqrt{3}$$
$$x = -6+2i\sqrt{3} \quad \text{or} \quad x = -6-2i\sqrt{3}$$

30. Solve by the square root procedure.

$$(x+2)^2+28=0$$
$$(x+2)^2=-28$$
$$x+2=\pm\sqrt{-28}$$
$$x+2=\pm 2i\sqrt{7}$$
$$x=-2\pm 2i\sqrt{7}$$

$x=-2+2i\sqrt{7}$ or $x=-2-2i\sqrt{7}$

31. Solve by the square root procedure.

$$2(x+4)^2=9$$
$$(x+4)^2=\frac{9}{2}$$
$$x+4=\pm\sqrt{\frac{9}{2}}$$
$$x+4=\pm\frac{\sqrt{9}}{\sqrt{2}}\cdot\frac{\sqrt{2}}{\sqrt{2}}$$
$$x+4=\pm\frac{3\sqrt{2}}{2}$$
$$x=-4\pm\frac{3\sqrt{2}}{2}=\frac{-8\pm 3\sqrt{2}}{2}$$

$x=\dfrac{-8+3\sqrt{2}}{2}$ or $x=\dfrac{-8-3\sqrt{2}}{2}$

32. Solve by the square root procedure.

$$3(x-2)^2=20$$
$$(x-2)^2=\frac{20}{3}$$
$$x-2=\pm\sqrt{\frac{20}{3}}$$
$$x-2=\pm\frac{2\sqrt{5}}{\sqrt{3}}\cdot\frac{\sqrt{3}}{\sqrt{3}}$$
$$x-2=\pm\frac{2\sqrt{15}}{3}$$
$$x=2\pm\frac{2\sqrt{15}}{3}=\frac{6\pm 2\sqrt{15}}{3}$$

$x=\dfrac{6+2\sqrt{15}}{3}$ or $x=\dfrac{6-2\sqrt{15}}{3}$

33. Solve by the square root procedure.

$$4(x-2)^2+15=0$$
$$4(x-2)^2=-15$$
$$(x-2)^2=-\frac{15}{4}$$
$$x-2=\pm\sqrt{-\frac{15}{4}}$$
$$x-2=\pm\frac{i\sqrt{15}}{2}$$
$$x=2\pm\frac{i\sqrt{15}}{2}=\frac{4\pm i\sqrt{15}}{2}$$

$x=\dfrac{4+i\sqrt{15}}{2}$ or $x=\dfrac{4-i\sqrt{15}}{2}$

34. Solve by the square root procedure.

$$6(x+5)^2+21=0$$
$$6(x+5)^2=-21$$
$$(x+5)^2=-\frac{7}{2}$$
$$x+5=\pm\sqrt{-\frac{7}{2}}$$
$$x+5=\pm\frac{i\sqrt{7}}{\sqrt{2}}\cdot\frac{\sqrt{2}}{\sqrt{2}}$$
$$x+5=\pm\frac{i\sqrt{14}}{2}$$
$$x=-5\pm\frac{i\sqrt{14}}{2}=\frac{-10\pm i\sqrt{14}}{2}$$

$x=\dfrac{-10+i\sqrt{14}}{2}$ or $x=\dfrac{-10-i\sqrt{14}}{2}$

35. Solve by completing the square.

$$x^2-2x-15=0$$
$$x^2-2x+1=15+1$$
$$(x-1)^2=16$$
$$x-1=\pm\sqrt{16}$$
$$x=1\pm 4$$

$x=1+4$ or $x=1-4$

$x=5$ $\qquad$ $x=-3$

36. Solve by completing the square.

$$x^2+2x-8=0$$
$$x^2+2x+1=8+1$$
$$(x+1)^2=9$$
$$x+1=\pm\sqrt{9}$$
$$x=-1\pm 3$$
$$x=-1+3 \quad \text{or} \quad x=-1-3$$
$$x=2 \qquad\qquad x=-4$$

37. Solve by completing the square.

$$2x^2-5x-12=0$$
$$2x^2-5x=12$$
$$x^2-\frac{5}{2}x=6$$
$$x^2-\frac{5}{2}x+\frac{25}{16}=6+\frac{25}{16}$$
$$\left(x-\frac{5}{4}\right)^2=\frac{121}{16}$$
$$x-\frac{5}{4}=\pm\sqrt{\frac{121}{16}}$$
$$x=\frac{5}{4}\pm\frac{11}{4}$$
$$x=\frac{5}{4}+\frac{11}{4} \quad \text{or} \quad x=\frac{5}{4}-\frac{11}{4}$$
$$x=4 \qquad\qquad x=-\frac{3}{2}$$

38. Solve by completing the square.

$$3x^2-5x-2=0$$
$$3x^2-5x=2$$
$$x^2-\frac{5}{3}x=\frac{2}{3}$$
$$x^2-\frac{5}{3}x+\frac{25}{36}=\frac{2}{3}+\frac{25}{36}$$
$$\left(x-\frac{5}{6}\right)^2=\frac{49}{36}$$
$$x-\frac{5}{6}=\pm\sqrt{\frac{49}{36}}$$
$$x=\frac{5}{6}\pm\frac{7}{6}$$
$$x=\frac{5}{6}+\frac{7}{6} \quad \text{or} \quad x=\frac{5}{6}-\frac{7}{6}$$
$$x=2 \qquad\qquad x=-\frac{1}{3}$$

39. Solve by completing the square.

$$x^2+6x+1=0$$
$$x^2+6x+9=-1+9$$
$$(x+3)^2=8$$
$$x+3=\pm\sqrt{8}$$
$$x=-3\pm 2\sqrt{2}$$
$$x=-3+2\sqrt{2} \quad \text{or} \quad x=-3-2\sqrt{2}$$

40. Solve by completing the square.

$$x^2+8x-10=0$$
$$x^2+8x+16=10+16$$
$$(x+4)^2=26$$
$$x+4=\pm\sqrt{26}$$
$$x=-4\pm\sqrt{26}$$
$$x=-4+\sqrt{26} \quad \text{or} \quad x=-4-\sqrt{26}$$

41. Solve by completing the square.

$$x^2+3x-1=0$$
$$x^2+3x+\frac{9}{4}=1+\frac{9}{4}$$
$$\left(x+\frac{3}{2}\right)^2=\frac{13}{4}$$
$$x+\frac{3}{2}=\pm\sqrt{\frac{13}{4}}$$
$$x=-\frac{3}{2}\pm\frac{\sqrt{13}}{2}=\frac{-3\pm\sqrt{13}}{2}$$
$$x=\frac{-3+\sqrt{13}}{2} \quad \text{or} \quad x=\frac{-3-\sqrt{13}}{2}$$

42. Solve by completing the square.

$$x^2+7x-2=0$$
$$x^2+7x+\frac{49}{4}=2+\frac{49}{4}$$
$$\left(x+\frac{7}{2}\right)^2=\frac{57}{4}$$
$$x+\frac{7}{2}=\pm\sqrt{\frac{57}{4}}$$
$$x=-\frac{7}{2}\pm\frac{\sqrt{57}}{2}=\frac{-7\pm\sqrt{57}}{2}$$
$$x=\frac{-7+\sqrt{57}}{2} \quad \text{or} \quad x=\frac{-7-\sqrt{57}}{2}$$

43. Solve by completing the square.

$$3x^2-8x=-1$$
$$x^2-\frac{8}{3}x=-\frac{1}{3}$$
$$x^2-\frac{8}{3}x+\frac{16}{9}=-\frac{1}{3}+\frac{16}{9}$$
$$\left(x-\frac{4}{3}\right)^2=\frac{13}{9}$$
$$x-\frac{4}{3}=\pm\sqrt{\frac{13}{9}}$$
$$x=\frac{4}{3}\pm\frac{\sqrt{13}}{3}=\frac{4\pm\sqrt{13}}{3}$$

$x=\dfrac{4+\sqrt{13}}{3}$ or $x=\dfrac{4-\sqrt{13}}{3}$

44. Solve by completing the square.

$$2x^2+10x-3=0$$
$$2x^2+10x=3$$
$$x^2+5x=\frac{3}{2}$$
$$x^2+5x+\frac{25}{4}=\frac{3}{2}+\frac{25}{4}$$
$$\left(x+\frac{5}{2}\right)^2=\frac{31}{4}$$
$$x+\frac{5}{2}=\pm\sqrt{\frac{31}{4}}$$
$$x=-\frac{5}{2}\pm\frac{\sqrt{31}}{2}=\frac{-5\pm\sqrt{31}}{2}$$

$x=\dfrac{-5+\sqrt{31}}{2}$ or $x=\dfrac{-5-\sqrt{31}}{2}$

45. Solve by completing the square.

$$x^2+4x+5=0$$
$$x^2+4x+4=-5+4$$
$$(x+2)^2=-1$$
$$x+2=\pm\sqrt{-1}$$
$$x+2=\pm i$$
$$x=-2\pm i$$

$x=-2-i$ or $x=-2+i$

46. Solve by completing the square.

$$x^2-6x+10=0$$
$$x^2-6x+9=-10+9$$
$$(x-3)^2=-1$$
$$x-3=\pm\sqrt{-1}$$
$$x=3\pm i$$

$x=3+i$ or $x=3-i$

47. Solve by completing the square.

$$4x^2+4x+2=0$$
$$4x^2+4x=-2$$
$$x^2+x=-\frac{1}{2}$$
$$x^2+x+\frac{1}{4}=-\frac{1}{2}+\frac{1}{4}$$
$$\left(x+\frac{1}{2}\right)^2=-\frac{1}{4}$$
$$x+\frac{1}{2}=\pm\sqrt{-\frac{1}{4}}$$
$$x=-\frac{1}{2}\pm\frac{1}{2}i \text{ or } \frac{-1\pm i}{2}$$

$x=\dfrac{-1+i}{2}$ or $x=\dfrac{-1-i}{2}$

48. Solve by completing the square.

$$9x^2+12x+5=0$$
$$9x^2+12x=-5$$
$$x^2+\frac{4}{3}x=-\frac{5}{9}$$
$$x^2+\frac{4}{3}x+\frac{4}{9}=-\frac{5}{9}+\frac{4}{9}$$
$$\left(x+\frac{2}{3}\right)^2=-\frac{1}{9}$$
$$x+\frac{2}{3}=\pm\sqrt{-\frac{1}{9}}$$
$$x=-\frac{2}{3}\pm\frac{1}{3}i \text{ or } \frac{-2\pm i}{3}$$

$x=\dfrac{-2+i}{3}$ or $x=\dfrac{-2-i}{3}$

49. Solve by completing the square.

$$3x^2+2x+1=0$$
$$3x^2+2x=-1$$
$$x^2+\frac{2}{3}x=-\frac{1}{3}$$
$$x^2+\frac{2}{3}x+\frac{1}{9}=-\frac{1}{3}+\frac{1}{9}$$
$$\left(x+\frac{1}{3}\right)^2=-\frac{2}{9}$$
$$x+\frac{1}{3}=\pm\sqrt{-\frac{2}{9}}$$
$$x=-\frac{1}{3}\pm\frac{\sqrt{2}}{3}i \text{ or } \frac{-1\pm i\sqrt{2}}{3}$$

$x=\dfrac{-1+i\sqrt{2}}{3}$ or $x=\dfrac{-1-i\sqrt{2}}{3}$

50. Solve by completing the square.

$$4x^2-4x+15=0$$
$$4x^2-4x=-15$$
$$x^2-x=-\frac{15}{4}$$
$$x^2-x+\frac{1}{4}=-\frac{15}{4}+\frac{1}{4}$$
$$\left(x-\frac{1}{2}\right)^2=-\frac{14}{4}$$
$$x-\frac{1}{2}=\pm\sqrt{-\frac{14}{4}}$$
$$x=\frac{1}{2}\pm\frac{i\sqrt{14}}{2}$$

$$x=\frac{1}{2}+\frac{\sqrt{14}}{2}i \quad \text{or} \quad x=\frac{1}{2}-\frac{\sqrt{14}}{2}i$$

51. Solve by using the quadratic formula.

$$x^2-2x-15=0,\ a=1,\ b=-2,\ c=-15$$
$$x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$
$$x=\frac{-(-2)\pm\sqrt{(-2)^2-4(1)(-15)}}{2(1)}$$
$$x=\frac{2\pm\sqrt{4+60}}{2}=\frac{2\pm\sqrt{64}}{2}$$
$$x=\frac{2\pm8}{2}$$
$$x=\frac{2+8}{2}=\frac{10}{2}=5 \quad \text{or} \quad x=\frac{2-8}{2}=\frac{-6}{2}=-3$$
$$x=5 \text{ or } x=-3$$

52. Solve by using the quadratic formula.

$$x^2-5x-24=0$$
$$x=\frac{-(-5)\pm\sqrt{(-5)^2-4(1)(-24)}}{2(1)}$$
$$x=\frac{5\pm\sqrt{25+96}}{2}=\frac{5\pm\sqrt{121}}{2}$$
$$x=\frac{5\pm11}{2}$$
$$x=\frac{5+11}{2}=\frac{16}{2}=8 \quad \text{or} \quad x=\frac{5-11}{2}=\frac{-6}{2}=-3$$
$$x=8 \text{ or } x=-3$$

53. Solve by using the quadratic formula.

$$12x^2-11x-15=0,\ a=12,\ b=-11,\ c=-15$$
$$x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$
$$x=\frac{-(-11)\pm\sqrt{(-11)^2-4(12)(-15)}}{2(12)}$$
$$x=\frac{11\pm\sqrt{121+720}}{24}=\frac{11\pm\sqrt{841}}{24}$$
$$x=\frac{11\pm29}{24}$$
$$x=\frac{11+29}{24}=\frac{40}{24}=\frac{5}{3} \quad \text{or} \quad x=\frac{11-29}{24}=\frac{-18}{24}=-\frac{3}{4}$$
$$x=\frac{5}{3} \text{ or } x=-\frac{3}{4}$$

54. Solve by using the quadratic formula.

$$10x^2+19x-15=0,\ a=10,\ b=19,\ c=-15$$
$$x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$
$$x=\frac{-19\pm\sqrt{(19)^2-4(10)(-15)}}{2(10)}$$
$$x=\frac{-19\pm\sqrt{361+600}}{20}=\frac{-19\pm\sqrt{961}}{20}$$
$$x=\frac{-19\pm31}{20}$$
$$x=\frac{-19+31}{20} \quad \text{or} \quad x=\frac{-19-31}{20}$$
$$x=\frac{3}{5} \qquad x=-\frac{5}{2}$$

55. Solve by using the quadratic formula.

$$x^2-2x=2$$
$$x^2-2x-2=0,\ a=1,\ b=-2,\ c=-2$$
$$x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$
$$x=\frac{-(-2)\pm\sqrt{(-2)^2-4(1)(-2)}}{2(1)}$$
$$x=\frac{2\pm\sqrt{4+8}}{2}=\frac{2\pm\sqrt{12}}{2}$$
$$x=\frac{2\pm2\sqrt{3}}{2}=1\pm\sqrt{3}$$
$$x=1+\sqrt{3} \quad \text{or} \quad x=1-\sqrt{3}$$

56. Solve by using the quadratic formula.

$$x^2+4x-1=0,\ a=1,\ b=4,\ c=-1$$

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

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

$$x=\frac{-4\pm\sqrt{16+4}}{2}=\frac{-4\pm\sqrt{20}}{2}$$

$$x=\frac{-4\pm2\sqrt{5}}{2}=-2\pm\sqrt{5}$$

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

57. Solve by using the quadratic formula.

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

$$x^2+x-1=0,\ a=1,\ b=1,\ c=-1$$

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

$$x=\frac{-1\pm\sqrt{1+4}}{2}=\frac{-1\pm\sqrt{5}}{2}$$

$$x=\frac{-1+\sqrt{5}}{2}\quad\text{or}\quad x=\frac{-1-\sqrt{5}}{2}$$

58. Solve by using the quadratic formula.

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

$$2x^2+4x-1=0,\ a=2,\ b=4,\ c=-1$$

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

$$x=\frac{-4\pm\sqrt{16+8}}{4}=\frac{-4\pm\sqrt{24}}{4}$$

$$x=\frac{-4\pm2\sqrt{6}}{4}=\frac{-2\pm\sqrt{6}}{2}$$

$$x=\frac{-2+\sqrt{6}}{2}\quad\text{or}\quad x=\frac{-2-\sqrt{6}}{2}$$

59. Solve by using the quadratic formula.

$$4x^2=41-8x$$

$$4x^2+8x-41=0,\ a=4,\ b=8,\ c=-41$$

$$x=\frac{-8\pm\sqrt{8^2-4(4)(-41)}}{2(4)}$$

$$x=\frac{-8\pm\sqrt{64+656}}{8}=\frac{-8\pm\sqrt{720}}{8}$$

$$x=\frac{-8\pm12\sqrt{5}}{8}=\frac{-2\pm3\sqrt{5}}{2}$$

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

60. Solve by using the quadratic formula.

$$2x=9-3x^2$$

$$3x^2+2x-9=0,\ a=3,\ b=2,\ c=-9$$

$$x=\frac{-2\pm\sqrt{2^2-4(3)(-9)}}{2(3)}$$

$$x=\frac{-2\pm\sqrt{4+108}}{6}=\frac{-2\pm\sqrt{112}}{6}=\frac{-1\pm2\sqrt{7}}{3}$$

$$x=\frac{-1+2\sqrt{7}}{3}\quad\text{or}\quad x=\frac{-1-2\sqrt{7}}{3}$$

61. Solve by using the quadratic formula.

$$\frac{1}{2}x^2+\frac{3}{4}x-1=0$$

$$4\left(\frac{1}{2}x^2+\frac{3}{4}x-1\right)=4(0)$$

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

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

$$x=\frac{-3\pm\sqrt{9+32}}{4}$$

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

$$x=\frac{-3+\sqrt{41}}{4}\quad\text{or}\quad x=\frac{-3-\sqrt{41}}{4}$$

62. Solve by using the quadratic formula.

$$x^2+\frac{5x}{2}-\frac{19}{8}=0$$
$$8\left(x^2+\frac{5x}{2}-\frac{19}{8}\right)=8(0)$$
$$8x^2+20x-19=0,\ a=8,\ b=20,\ c=-19$$
$$x=\frac{-20\pm\sqrt{20^2-4(8)(-19)}}{2(8)}$$
$$x=\frac{-20\pm\sqrt{400+608}}{16}$$
$$x=\frac{-20\pm\sqrt{1008}}{16}$$
$$=\frac{-20\pm12\sqrt{7}}{16}=\frac{-5\pm3\sqrt{7}}{4}$$
$$x=\frac{-5+3\sqrt{7}}{4}\quad\text{or}\quad x=\frac{-5-3\sqrt{7}}{4}$$

63. Solve by using the quadratic formula.

$$x^2+6x+13=0,\ a=1,\ b=6,\ c=13$$
$$x=\frac{-6\pm\sqrt{6^2-4(1)(13)}}{2(1)}$$
$$x=\frac{-6\pm\sqrt{36-52}}{2}=\frac{-6\pm\sqrt{-16}}{2}$$
$$x=\frac{-6\pm4i}{2}=-3\pm2i$$
$$x=-3-2i\quad\text{or}\quad x=-3+2i$$

64. Solve by using the quadratic formula.

$$x^2=2x-26$$
$$x^2-2x+26=0,\ a=1,\ b=-2,\ c=26$$
$$x=\frac{-(-2)\pm\sqrt{(-2)^2-4(1)(26)}}{2(1)}$$
$$x=\frac{2\pm\sqrt{4-104}}{2}=\frac{2\pm\sqrt{-100}}{2}$$
$$x=\frac{2\pm10i}{2}=1\pm5i$$
$$x=1-5i\quad\text{or}\quad x=1+5i$$

65. Solve by using the quadratic formula.

$$2x^2=2x-13$$
$$2x^2-2x+13=0,\ a=1,\ b=-2,\ c=13$$
$$x=\frac{-(-2)\pm\sqrt{(-2)^2-4(2)(13)}}{2(2)}$$
$$x=\frac{2\pm\sqrt{4-104}}{4}=\frac{2\pm\sqrt{-100}}{4}$$
$$x=\frac{2\pm10i}{4}=\frac{1\pm5i}{2}$$
$$x=\frac{1-5i}{2}\quad\text{or}\quad x=\frac{1+5i}{2}$$

66. Solve by using the quadratic formula.

$$9x^2-24x+20=0,\ a=9,\ b=-24,\ c=20$$
$$x=\frac{-(-24)\pm\sqrt{(-24)^2-4(9)(20)}}{2(9)}$$
$$x=\frac{24\pm\sqrt{576-720}}{18}=\frac{24\pm\sqrt{-144}}{18}$$
$$x=\frac{24\pm12i}{18}=\frac{4\pm2i}{3}$$
$$x=\frac{4-2i}{3}\quad\text{or}\quad x=\frac{4+2i}{3}$$

67. Solve by using the quadratic formula.

$$x^2+2x+29=0,\ a=1,\ b=2,\ c=29$$
$$x=\frac{-2\pm\sqrt{2^2-4(1)(29)}}{2(1)}$$
$$x=\frac{-2\pm\sqrt{4-116}}{2}=\frac{-2\pm\sqrt{-112}}{2}$$
$$x=\frac{-2\pm4i\sqrt{7}}{2}=-1\pm2i\sqrt{7}$$
$$x=-1-2i\sqrt{7}\quad\text{or}\quad x=-1+2i\sqrt{7}$$

68. Solve by using the quadratic formula.

$$x^2+6x+21=0,\ a=1,\ b=6,\ c=21$$
$$x=\frac{-6\pm\sqrt{6^2-4(1)(21)}}{2(1)}$$
$$x=\frac{-6\pm\sqrt{36-84}}{2}=\frac{-6\pm\sqrt{-48}}{2}$$
$$x=\frac{-6\pm4i\sqrt{3}}{2}=-3\pm2i\sqrt{3}$$
$$x=-3-2i\sqrt{3}\quad\text{or}\quad x=-3+2i\sqrt{3}$$

69. Solve by using the quadratic formula.

$4x^2+4x+13=0,\ a=4,\ b=4,\ c=13$

$$x=\frac{-4\pm\sqrt{4^2-4(4)(13)}}{2(4)}$$

$$x=\frac{-4\pm\sqrt{16-208}}{8}=\frac{-4\pm\sqrt{-192}}{8}$$

$$x=\frac{-4\pm 8i\sqrt{3}}{8}=\frac{-1\pm 2i\sqrt{3}}{2}$$

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

70. Solve by using the quadratic formula.

$$9x^2=12x-49$$

$9x^2-12x+49=0,\ a=9,\ b=-12,\ c=49$

$$x=\frac{-(-12)\pm\sqrt{(-12)^2-4(9)(49)}}{2(9)}$$

$$x=\frac{12\pm\sqrt{144-1764}}{18}=\frac{12\pm\sqrt{-1620}}{18}$$

$$x=\frac{12\pm 18i\sqrt{5}}{18}=\frac{2\pm 3i\sqrt{5}}{3}$$

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

71. Determine the discriminant, state the number of real solutions. $2x^2-5x-7=0$

$$b^2-4ac=(-5)^2-4(2)(-7)$$
$$=25+56=81>0$$

Two real solutions

72. Determine the discriminant, state the number of real solutions. $x^2+3x-11=0$

$$b^2-4ac=(3)^2-4(1)(-11)$$
$$=9+44=53>0$$

Two real solutions

73. Determine the discriminant, state the number of real solutions. $3x^2-2x+10=0$

$$b^2-4ac=(-2)^2-4(3)(10)$$
$$=4-120=-116<0$$

No real solutions

74. Determine the discriminant, state the number of real solutions. $x^2+3x+3=0$

$$b^2-4ac=(3)^2-4(1)(3)$$
$$=9-12=-3<0$$

No real solutions

75. Determine the discriminant, state the number of real solutions. $x^2-20x+100=0$

$$b^2-4ac=(-20)^2-4(1)(100)$$
$$=400-400=0$$

One real solution

76. Determine the discriminant, state the number of real solutions. $4x^2+12x+9=0$

$$b^2-4ac=(12)^2-4(4)(9)$$
$$=144-144=0$$

One real solution

77. Determine the discriminant, state the number of real solutions.

$24x^2+10x-21=0$

$$b^2-4ac=(10)^2-4(24)(-21)$$
$$=100+2016=2116>0$$

Two real solutions

78. Determine the discriminant, state the number of real solutions. $32x^2-44x+15=0$

$$b^2-4ac=(-44)^2-4(32)(15)$$
$$=1936-1920=16>0$$

Two real solutions

79. Determine the discriminant, state the number of real solutions. $12x^2+15x+7=0$

$$b^2-4ac=(15)^2-4(12)(7)$$
$$=225-336=-111<0$$

No real solutions

80. Determine the discriminant, state the number of real solutions. $8x^2-5x+3=0$

$$b^2-4ac=(-5)^2-4(8)(3)$$
$$=25-96=-71<0$$

No real solutions

81. Find the distance from the left side. Round to the nearest tenth of a foot.

$$h = 0.045x^2 - 1.33x + 20$$
$$11 = 0.045x^2 - 1.33x + 20$$
$$0 = 0.045x^2 - 1.33x + 9$$
$$a = 0.045,\ b = -1.33,\ c = 9$$

$$x = \frac{1.33 \pm \sqrt{(-1.33)^2 - 4(0.045)(9)}}{2(0.045)}$$
$$= \frac{1.33 \pm \sqrt{0.1489}}{0.09} \approx \frac{1.33 \pm 0.4}{0.09}$$

$$x = \frac{1.33 + 0.4}{0.09} \quad \text{or} \quad x = \frac{1.33 - 0.4}{0.09}$$
$$x \approx 19.1 \text{ ft} \qquad x \approx 10.5 \text{ ft}$$

The suspension cable hangs 11 ft above the footbridge 10.5 ft and 19.1 ft from the left side of the bridge.

82. Find the distance.

$$a^2 + b^2 = c^2$$
$$(90)^2 + (90)^2 = c^2$$
$$16{,}200 = c^2$$
$$127.3 = c$$

The distance is about 127.3 ft.

83. Find the depth of the water. Round to the nearest tenth of a foot.

$$V = 32d^2 + 32d$$
$$850 = 32d^2 + 32d$$
$$0 = 32d^2 + 32d - 850$$
$$0 = 2(16d^2 + 16d - 425)$$
$$a = 16,\ b = 16\ c = -425$$

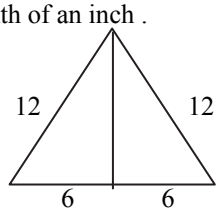
$$x = \frac{-16 \pm \sqrt{16^2 - 4(16)(-425)}}{2(16)}$$
$$= \frac{-16 \pm \sqrt{27{,}456}}{32} \approx \frac{-16 \pm 165.7}{32}$$

$$x = \frac{-16 + 165.7}{32} \quad \text{or} \quad x = \frac{-16 - 165.7}{32}$$
$$= \frac{149.7}{32} \approx 4.7 \qquad = \frac{-181.7}{32} \approx -5.7$$

The depth is 4.7 ft.

(Reject negative x-value; x must be positive.)

84. Find the altitude of the triangle. Round to the nearest tenth of an inch .



$$a^2 + 6^2 = 12^2$$
$$a^2 = 144 - 36$$
$$d = \sqrt{108}$$
$$d \approx 10.4 \text{ in.}$$

85. Find the distance.

$$h = -0.0114x^2 + 1.732x$$
$$10 = -0.0114x^2 + 1.732x$$
$$0 = -0.0114x^2 + 1.732x - 10$$
$$a = -0.0114,\ b = 1.732,\ c = -10$$

$$x = \frac{-1.732 \pm \sqrt{1.732^2 - 4(-0.0114)(-10)}}{2(-0.0114)}$$
$$x = \frac{-1.732 \pm \sqrt{2.999824 - 0.456}}{-0.0228}$$
$$x = \frac{-1.732 \pm \sqrt{2.543824}}{-0.0228}$$
$$x = \frac{-1.732 + \sqrt{2.543824}}{-0.0228} \approx 6.0$$
$$x = \frac{-1.732 - \sqrt{2.543824}}{-0.0228} \approx 145.9$$

Since x = 6.0 ft is not realistic, it is not a solution.

Convert from feet to yards: $145.9 \text{ ft} \cdot \frac{1 \text{ yd}}{3 \text{ ft}} \approx 48.6 \text{ yd}$

The kicker can be up to 48.6 yd from the goalpost.

86. Find the number of books.

$$250{,}000 = 40{,}000 + 20x + 0.0001x^2$$
$$0 = 0.0001x^2 + 20x - 210{,}000$$
$$a = 0.0001,\ b = 20,\ c = -210{,}000$$

$$x = \frac{-20 \pm \sqrt{20^2 - 4(0.0001)(-210{,}000)}}{2(0.0001)}$$
$$= \frac{-20 \pm \sqrt{484}}{0.0002} = \frac{-20 + 22}{0.0002} = 10{,}000 \text{ books}$$

(Reject negative x-value; x must be positive.)

87. Find the number of items sold.

$$R = xp$$
$$16{,}500 = x(26 - 0.01x)$$
$$16{,}500 = 26x - 0.01x^2$$
$$0 = -0.01x^2 + 26x - 16{,}500$$
$$a = -0.01,\ b = 26,\ c = -16{,}500$$
$$x = \frac{-26 \pm \sqrt{26^2 - 4(-0.01)(-16{,}500)}}{2(-0.01)}$$
$$= \frac{-26 \pm \sqrt{16}}{-0.02} = \frac{-26 \pm 4}{-0.02}$$
$$x = \frac{-26+4}{-0.02} = 1100 \quad \text{or} \quad x = \frac{-26-4}{-0.02} = 1500$$

1100 or 1500 items must be sold.

88. a. Find the surface area.

Evaluate $A = 0.72(1.28)h^2$ with $h = 7$.

$$A = 0.72(1.28)(7)^2$$
$$\approx 45.2 \text{ square inches}$$

The surface area is about 45.2 square inches.

b. Find the height.

Solve $A = 0.72(1.28)h^2$ for h with $A = 92$.

$$92 = 0.72(1.28)h^2$$
$$92 = 0.9216h^2$$
$$99.82639 \approx h^2$$
$$h \approx \sqrt{99.82639}$$
$$\approx 10.0 \text{ inches}$$

The height is about 10.0 inches.

89. Find the dimensions.

Let w = width of region

Then $\frac{132-3w}{2}$ = length.

$$\text{Area} = \text{length(width)}$$
$$576 = \frac{132-3w}{2} \cdot w$$
$$1152 = 132w - 3w^2$$
$$3w^2 - 132w + 1152 = 0$$
$$3(w^2 - 44w + 384) = 0$$
$$w^2 - 44w + 384 = 0$$
$$(w-32)(w-12) = 0$$
$$w - 32 = 0 \quad \text{or} \quad w - 12 = 0$$
$$w = 32 \qquad w = 12$$
$$\frac{132-3w}{2} = \frac{132-3(32)}{2} \qquad \frac{132-3w}{2} = \frac{132-3(12)}{2}$$
$$= 18 \qquad = 48$$

The region is either 32 feet wide and 18 feet long, or 12 feet wide and 48 feet long.

90. Find the dimensions of the cardboard.

Let x = side of cardboard.

Then $(x - 6)$ = length of box.

Volume = (length)(width)(height)
$$126.75 = (x-6)(x-6)(3)$$
$$126.75 = (x^2 - 12x + 36)(3)$$
$$126.75 = 3x^2 - 36x + 108$$
$$0 = 3x^2 - 36x - 18.75$$
$$a = 3,\ b = -36,\ c = -18.75$$
$$x = \frac{-(-36) \pm \sqrt{(-36)^2 - 4(3)(-18.75)}}{2(3)}$$
$$= \frac{36 \pm \sqrt{1521}}{6} = \frac{36 \pm 39}{6}$$
$$x = \frac{36+39}{6} = \frac{75}{6} \quad \text{or} \quad x = \frac{36-39}{6} = \frac{-3}{6}$$
$$= 12.5 \qquad = -0.5 \text{ (no)}$$

Since length cannot be a negative number, each side of the cardboard is 12.5 inches.

91. Find the distances.

Solve $D = -45x^2 + 190x + 200$ for x with $D = 250$.

$$250 = -45x^2 + 190x + 200$$
$$0 = -45x^2 + 190x - 50$$
$$a = -45,\ b = 190,\ c = -50$$
$$x = \frac{-190 \pm \sqrt{190^2 - 4(-45)(-50)}}{2(-45)}$$
$$= \frac{-190 \pm \sqrt{27100}}{-90} \approx \frac{-190 \pm 164.2}{-90}$$
$$x \approx \frac{-190+164.2}{-90} \quad \text{or} \quad x \approx \frac{-190-164.2}{-90}$$
$$\approx 0.3 \text{ mile} \qquad \approx 3.9 \text{ miles}$$

92. Find the times.

Solve $N = -5t^2 + 80t - 280$ for t with $N = 35$.

$$35 = -5t^2 + 80t - 280$$
$$0 = -5t^2 + 80t - 315$$
$$0 = -5(t^2 - 16t + 63)$$
$$0 = -5(t-7)(t-9)$$
$$t - 7 = 0 \quad \text{or} \quad t - 9 = 0$$
$$t = 7 \text{ A.M.} \qquad t = 9 \text{ A.M.}$$

93. Find the time in the air.

Solve $h = -16t^2 + 25.3t + 20$ for t where $h = 17$.

$$17 = -16t^2 + 25.3t + 20$$
$$0 = -16t^2 + 25.3t + 3$$
$$t = \frac{-25.3 \pm \sqrt{(25.3)^2 - 4(-16)(3)}}{2(-16)} = \frac{-25.3 \pm \sqrt{832.09}}{-32}$$

$t = 1.7$ or $t = -0.11$

He was in the air for 1.7 s.

94. Find the dimensions.

Original candy bar

$$lwh = V$$
$5 \cdot 2 \cdot 0.5 = 5$ cubic inches

80%(5) = 0.80(5) = 4 cubic inches

Let w represent the width.

Let $2.5w$ represent the length.

$$lwh = V$$
$$2.5w(w)(0.5) = 4$$
$$1.25w^2 = 4$$
$$w^2 = 3.2$$
$$w = \pm\sqrt{3.2} \text{ reject the negative value}$$
$$w \approx 1.8 \text{ in.}$$

The dimensions are 1.8 in. by 4.5 in. by 0.5 in.

95. Find the times.

Solve $h = -16t^2 + 220t$ for t where $h = 350$.

$$350 = -16t^2 + 220t$$
$$0 = -16t^2 + 220t - 350$$
$$a = -16,\ b = 220,\ c = -350$$
$$t = \frac{-220 \pm \sqrt{220^2 - 4(-16)(-350)}}{2(-16)}$$
$$= \frac{-220 \pm \sqrt{26000}}{-32} \approx \frac{-220 \pm 161.245}{-32}$$
$$t \approx \frac{-220 + 161.245}{-32} \quad \text{or} \quad t \approx \frac{-220 - 161.245}{-32}$$
$$\approx 1.8 \text{ seconds} \qquad \approx 11.9 \text{ seconds}$$

96. Find the time.

When the ball hits the ground, the height is 0.

Solve $h = -16t^2 + 52t + 4.5$ for t where $h = 0$.

$$0 = -16t^2 + 52t + 4.5$$
$$a = -16,\ b = 52,\ c = 4.5$$
$$t = \frac{-52 \pm \sqrt{52^2 - 4(-16)(4.5)}}{2(-16)} = \frac{-52 \pm \sqrt{2992}}{-32}$$
$$t \approx \frac{-52 \pm 54.699}{-32} \text{ reject the negative value}$$
$$t \approx \frac{-52 - 54.699}{-32} \approx \frac{-106.699}{-32}$$
$$\approx 3.3 \text{ seconds}$$

97. Determine whether the baseball will clear the fence.

Solve $s = 103.9t$ for t where $s = 360$ to find the time it takes the ball to reach the fence.

$$360 = 103.9t$$
$$t \approx 3.465 \text{ seconds}$$

Next, evaluate $h = -16t^2 + 50t + 4.5$ where $t = 3.465$ to determine if the ball is at least 10 feet in the air when it reaches the fence.

$$h = -16(3.465)^2 + 50(3.465) + 4.5$$
$$h \approx -14.3$$

No, the ball will not clear the fence.

98. Find the hang time.

Solve $s = -16t^2 + 26.6t$ for t where $s = 0$.

$$0 = -16t^2 + 26.6t$$
$$0 = t(-16t + 26.6)$$
$$t = 0 \quad \text{or} \quad -16t + 26.6 = 0$$
$$t \approx 1.7 \text{ seconds}$$

The hang time is about 1.7 seconds.

99. Find the year.

Solve $M = 0.0001t^2 + 0.16t + 4.34$ for t where $M = 10$.

$$10 = 0.0001t^2 + 0.16t + 4.34$$
$$0 = 0.0001t^2 + 0.16t - 5.66$$
$$a = 0.0001,\ b = 0.16,\ c = -5.66$$
$$t = \frac{-0.16 \pm \sqrt{0.16^2 - 4(0.0001)(-5.66)}}{2(0.0001)}$$
$$= \frac{-0.16 \pm \sqrt{0.027864}}{0.0002}$$
$$= \frac{-0.16 \pm 0.166925}{0.0002}$$
$$= \frac{-0.16 + 0.166925}{0.0002} \quad \text{reject the negative value}$$
$$\approx 34.5 \text{ years from 2000, or 2034}$$

100. Find the year.

Solve $D = 0.40x^2 - 8.81x + 49.25$ for x,

where $D = 25$.

$$25 = 0.40x^2 - 8.81x + 49.25$$
$$0 = 0.40x^2 - 8.81x + 24.25$$
$$a = 0.40,\ b = -8.81,\ c = 24.25$$
$$x = \frac{-(-8.81) \pm \sqrt{(-8.81)^2 - 4(0.40)(24.25)}}{2(0.40)}$$
$$= \frac{8.81 \pm \sqrt{38.8161}}{0.8} \approx \frac{8.81 \pm 6.23}{0.8}$$
$$x \approx \frac{8.81 + 6.23}{0.8} \quad \text{or} \quad x \approx \frac{8.81 - 6.23}{0.8}$$
$$\approx 18.8 \qquad \approx 3.225 \text{ (not greater than 16)}$$

The year that mobile data traffic will first exceed 25 exabytes is in 19 years, after 2000, which is in 2019.

101. Find the year.

Solve $N = 0.3453x^2 - 9.417x + 164.1$ for x,

where $N = 200$.

$$200 = 0.3453x^2 - 9.417x + 164.1$$
$$0 = 0.3453x^2 - 9.417x - 35.9$$
$$a = 0.3453,\ b = -9.417,\ c = -35.9$$
$$x = \frac{-(-9.417) \pm \sqrt{(-9.417)^2 - 4(0.3453)(-35.9)}}{2(0.3453)}$$
$$= \frac{9.417 \pm \sqrt{138.265}}{0.6906} \approx \frac{9.417 \pm 11.759}{0.6906}$$
$$x \approx \frac{9.417 + 11.759}{0.6906} \quad \text{or} \quad x \approx \frac{9.417 - 11.759}{0.6906}$$
$$\approx 30.663 \qquad \approx -3.39 \text{ (not in the future)}$$

There will be more than 200,000 centenarians living in the US in about 31 years from 2000, or 2031.

102. Find the maximum speed.

Solve $N = -0.015v^2 + 3v$ for v where $N = 100$.

$$100 = -0.015v^2 + 3v$$
$$0 = -0.015v^2 + 3v - 100$$
$$a = -0.015,\ b = 3,\ c = -100$$
$$v = \frac{-3 \pm \sqrt{3^2 - 4(-0.015)(-100)}}{2(-0.015)}$$
$$= \frac{-3 \pm \sqrt{9 - 6}}{-0.03}$$
$$= \frac{-3 \pm \sqrt{3}}{-0.03}$$
$$v = \frac{-3 + \sqrt{3}}{-0.03} \qquad v = \frac{-3 - \sqrt{3}}{-0.03}$$
$$\approx 42 \text{ miles per hour} \qquad \approx 158 \text{ (not } 0 \le v \le 90)$$

103. Verify the discriminant is the same for both definitions.

a. coefficient definition:

$$x^2 - x - 6 = 0$$
$$a = 1,\ b = -1,\ c = -6$$
$$b^2 - 4ac = (-1)^2 - 4(1)(-6) = 25$$

roots definition:

$$x^2 - x - 6 = 0$$
$$(x + 2)(x - 3) = 0$$
$$x + 2 = 0 \quad \text{or} \quad x - 3 = 0$$
$$x = -2 \qquad x = 3$$
$$a = 1,\ r_1 = -2,\ r_2 = 3$$
$$a^2(r_1 - r_2)^2 = (1)^2(-2 - 3)^2 = 25$$

b. coefficient definition:

$$9x^2 - 6x - 1 = 0$$
$$a = 9,\ b = -6,\ c = -1$$
$$b^2 - 4ac = (-6)^2 - 4(9)(-1) = 72$$

roots definition:

$$x=\frac{-(-6)\pm\sqrt{(-6)^2-4(9)(-1)}}{2(9)}$$
$$=\frac{6\pm\sqrt{72}}{18}=\frac{6\pm6\sqrt{2}}{18}$$
$$=\frac{1\pm\sqrt{2}}{3}$$

$$a=9,\ r_1=\frac{1+\sqrt{2}}{3},\ r_2=\frac{1-\sqrt{2}}{3}$$

$$a^2(r_1-r_2)^2=(9)^2\left(\frac{1+\sqrt{2}}{3}-\frac{1-\sqrt{2}}{3}\right)^2$$
$$=81\left(\frac{1+\sqrt{2}-1+\sqrt{2}}{3}\right)^2$$
$$=81\left(\frac{2\sqrt{2}}{3}\right)^2=81\cdot\frac{8}{9}$$
$$=72$$

c. coefficient definition:

$$x^2+4x+4=0$$
$$a=1,\ b=4,\ c=4$$
$$b^2-4ac=(4)^2-4(1)(4)=0$$

roots definition:

$$x^2+4x+4=0$$
$$(x+2)(x+2)=0$$
$$x+2=0 \quad \text{or} \quad x+2=0$$
$$x=-2 \qquad\qquad x=-2$$
$$a=1,\ r_1=-2,\ r_2=-2$$
$$a^2(r_1-r_2)^2=(1)^2[-2-(-2)]^2=0$$

104. Show that the statement is true.

$$a^2(r_1-r_2)^2$$
$$=a^2\left(\frac{-b-\sqrt{b^2-4ac}}{2a}-\frac{-b+\sqrt{b^2-4ac}}{2a}\right)^2$$
$$=a^2\left(\frac{-b-\sqrt{b^2-4ac}+b-\sqrt{b^2-4ac}}{2a}\right)^2$$
$$=a^2\left(\frac{-2\sqrt{b^2-4ac}}{2a}\right)^2=a^2\left(\frac{-\sqrt{b^2-4ac}}{a}\right)^2$$
$$=a^2\cdot\frac{b^2-4ac}{a^2}$$
$$=b^2-4ac$$

105. Find the discriminant.

$$x^3-4x^2-4x+16=0$$
$$x^2(x-4)-4(x-4)=0$$
$$(x^2-4)(x-4)=0$$
$$(x+2)(x-2)(x-4)=0$$
$$x+2=0 \quad \text{or} \quad x-2=0 \quad \text{or} \quad x-4=0$$
$$x=-2 \qquad x=2 \qquad x=4$$
$$a=1,\ r_1=-2,\ r_2=2,\ r_3=4$$
$$a^4(r_1-r_2)^2(r_1-r_3)^2(r_2-r_3)^2$$
$$=1^4(-2-2)^2(-2-4)^2(2-4)^2$$
$$=(16)(36)(4)$$
$$=2304$$

106. If the discriminant of a cubic equation is 0, then at least two of the roots are equal.

Mid-Chapter 1 Quiz

1. Solve.

$$6-4(2x+1)=5(3-2x)$$
$$6-8x-4=15-10x$$
$$2-8x=15-10x$$
$$2x=13$$
$$x=\frac{13}{2}$$

2. Solve.

$$\frac{2}{3}x-\frac{1}{4}=\frac{x}{6}+\frac{3}{2}$$
$$12\left(\frac{2}{3}x-\frac{1}{4}\right)=12\left(\frac{x}{6}+\frac{3}{2}\right)$$
$$8x-3=2x+18$$
$$6x=21$$
$$x=\frac{7}{2}$$

3. Solve by factoring.

$$x^2-5x=6$$
$$x^2-5x-6=0$$
$$(x+1)(x-6)=0$$
$$x=-1 \text{ or } x=6$$

4. Solve by completing the square.

$$x^2+4x-2=0$$
$$x^2+4x=2$$
$$x^2+4x+4=2+4$$
$$(x+2)^2=6$$
$$x+2=\pm\sqrt{6}$$
$$x=-2\pm\sqrt{6}$$

$x=-2-\sqrt{6}$ or $-2+\sqrt{6}$

5. Solve by quadratic formula.

$$x^2-6x+12=0$$
$$a=1,\ b=-6,\ c=12$$
$$x=\frac{-(-6)\pm\sqrt{(-6)^2-4(1)(12)}}{2(1)}$$
$$x=\frac{6\pm\sqrt{-12}}{2}=\frac{6\pm 2i\sqrt{3}}{2}=3\pm i\sqrt{3}$$

$x=3-i\sqrt{3}$ or $x=3+i\sqrt{3}$

6. Find the time.

Let x = the number of hours for the cyclist.

$$8(x+1)=16x$$
$$8x+8=16x$$
$$8=8x$$
$$1=x$$
$$x+1=2$$

The cyclist will overtake the runner after 2 hours.

7. Find the amount of each solution.

9%	x
4%	$500-x$
6%	500

$$0.09x+0.04(500-x)=0.06(500)$$
$$0.09x+20-0.04x=30$$
$$0.05x=10$$
$$x=200$$
$$500-x=300$$

200 ml of 9% solution and 300 ml of 4% solution.

8. Find the time working together.

Let t = the number of hours working together.

$$\frac{1}{10}t+\frac{1}{15}t=1$$
$$30\left(\frac{1}{10}t+\frac{1}{15}t\right)=30(1)$$
$$3t+2t=30$$
$$5t=30$$
$$t=6$$

Working together, it will take 6 hours.

Prepare for Section 1.4

P1. Factor.

$$x^3-16x=x(x^2-16)$$
$$=x(x+4)(x-4)$$

P2. Factor.

$$x^4-36x^2=x^2(x^2-36)$$
$$=x^2(x+6)(x-6)$$

P3. Evaluate.

$$8^{2/3}=\left(\sqrt[3]{8}\right)^2=2^2=4$$

P4. Evaluate.

$$16^{3/2}=\left(\sqrt{16}\right)^3=4^3=64$$

P5. Multiply.

$$\left(1+\sqrt{x-5}\right)^2=1^2+2\sqrt{x-5}+\left(\sqrt{x-5}\right)^2$$
$$=1+2\sqrt{x-5}+x-5$$
$$=x+2\sqrt{x-5}-4$$

P6. Multiply.

$$\left(2-\sqrt{x+3}\right)^2=2^2-2(2)\sqrt{x+3}+\left(\sqrt{x+3}\right)^2$$
$$=4-4\sqrt{x+3}+x+3$$
$$=x-4\sqrt{x+3}+7$$

Section 1.4 Exercises

1. Write the solutions.

Using the principle of zero products,

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

$x=0,\ x=3,$ or $x=-2$

2. Find the value not in the domain.

For $\frac{1}{x-5}+3=\frac{x+1}{x-5}$, 5 is excluded from the domain.

3. Find the expression to clear fractions.

For $\frac{1}{x-5}+3=\frac{x+1}{x-5}$, multiply each side by $x-5$.

4. Find the extraneous solution.

When $x=-3$,

$$\begin{aligned}\sqrt{x+7}-x&=5\\ \sqrt{-3+7}-(-3)&\stackrel{?}{=}5\\ 2+3&\stackrel{?}{=}5\\ 5&=5\end{aligned}$$

Therefore –3 is not an extraneous solution.

When $x=-6$,

$$\begin{aligned}\sqrt{x+7}-x&=5\\ \sqrt{-6+7}-(-6)&\stackrel{?}{=}5\\ 1+6&\stackrel{?}{=}5\\ 7&\neq 5\end{aligned}$$

Therefore –6 is an extraneous solution.

5. To solve $x^{2/3}=9$ for x, raise each side to the $\frac{3}{2}$ power.

6. To solve rewrite $2x^{1/2}+7x^{1/4}-4=0$ as $2u^2+7u-4=0$, use the substitution $u=x^{1/4}$.

7. Solve by factoring and using principle of zero products.

$$\begin{aligned}x^3-25x&=0\\ x(x^2-25)&=0\\ x(x-5)(x+5)&=0\end{aligned}$$

$x=0,\ x=5,\ \text{or}\ x=-5$

8. Solve by factoring and using principle of zero products.

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

$x=0,\ x=1,\ \text{or}\ x=-1$

9. Solve by factoring and using principle of zero products.

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

$x=2,\ x=1,\ \text{or}\ x=-1$

10. Solve by factoring and using principle of zero products.

$$\begin{aligned}4x^3+4x^2-9x-9&=0\\ 4x^2(x+1)-9(x+1)&=0\\ (x+1)(4x^2-9)&=0\\ (x+1)(2x+3)(2x-3)&=0\end{aligned}$$

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

11. Solve by factoring and using principle of zero products.

$$\begin{aligned}x^3-3x^2-5x+15&=0\\ x^2(x-3)-5(x-3)&=0\\ (x-3)(x^2-5)&=0\end{aligned}$$

$$\begin{aligned}x-3=0\quad&\text{or}\quad x^2-5=0\\ x=3\qquad&\qquad x^2=5\\ &\qquad x=\pm\sqrt{5}\end{aligned}$$

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

12. Solve by factoring and using principle of zero products.

$$\begin{aligned}x^3-4x^2-2x+8&=0\\ x^2(x-4)-2(x-4)&=0\\ (x-4)(x^2-2)&=0\end{aligned}$$

$$\begin{aligned}x-4=0\quad&\text{or}\quad x^2-2=0\\ x=4\qquad&\qquad x^2=2\\ &\qquad x=\pm\sqrt{2}\end{aligned}$$

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

13. Solve by factoring and using principle of zero products.

$$\begin{aligned}3x^3+2x^2-27x-18&=0\\ x^2(3x+2)-9(3x+2)&=0\\ (3x+2)(x^2-9)&=0\\ (3x+2)(x+3)(x-3)&=0\end{aligned}$$

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

14. Solve by factoring and using principle of zero products.

$$4x^3+5x^2-16x-20=0$$
$$x^2(4x+5)-4(4x+5)=0$$
$$(4x+5)(x^2-4)=0$$
$$(4x+5)(x+2)(x-2)=0$$
$$x=-\frac{5}{4},\ x=-2,\ x=2$$

15. Solve by factoring and using principle of zero products.

$$x^3-8=0$$
$$(x-2)(x^2+2x+4)=0$$
$$x=2,\ \text{or}\ x^2+2x+4=0$$
$$x^2+2x=-4 \quad \text{Use completing the square.}$$
$$x^2+2x+1=-4+1$$
$$(x+1)^2=-3$$
$$x+1=\pm\sqrt{-3}$$
$$x=-1\pm i\sqrt{3}$$

Thus the solutions are $2,\ -1+i\sqrt{3},\ -1-i\sqrt{3}$.

16. Solve by factoring and using principle of zero products.

$$x^3+8=0$$
$$(x+2)(x^2-2x+4)=0$$
$$x^2-2x=-4 \quad \text{Use completing the square.}$$
$$x^2-2x+1=-4+1$$
$$(x-1)^2=-3$$
$$x-1=\pm\sqrt{-3}$$
$$x=1\pm i\sqrt{3}$$

Thus the solutions are $-2,\ 1+i\sqrt{3},\ 1-i\sqrt{3}$.

17. Solve the rational equation.

$$\frac{5}{x+4}-2=\frac{7x+18}{x+4}$$
$$(x+4)\left(\frac{5}{x+4}-2\right)=(x+4)\left(\frac{7x+18}{x+4}\right)$$
$$5-2(x+4)=7x+18$$
$$5-2x-8=7x+18$$
$$-2x-3=7x+18$$
$$-9x=21$$
$$x=-\frac{7}{3}$$

18. Solve the rational equation.

$$\frac{x+4}{x-2}+3=\frac{-2}{x-2}$$
$$(x-2)\left(\frac{x+4}{x-2}+3\right)=(x-2)\left(\frac{-2}{x-2}\right)$$
$$x+4+3(x-2)=-2$$
$$x+4+3x-6=-2$$
$$4x-2=-2$$
$$4x=0$$
$$x=0$$

19. Solve the rational equation.

$$2+\frac{9}{r-3}=\frac{3r}{r-3}$$
$$(r-3)\left(2+\frac{9}{r-3}\right)=(r-3)\left(\frac{3r}{r-3}\right)$$
$$2(r-3)+9=3r$$
$$2r-6+9=3r$$
$$2r+3=3r$$
$$2r-3r=-3$$
$$-r=-3$$
$$r=3$$

No solution because each side is undefined when $r=3$.

20. Solve the rational equation.

$$\frac{t}{t-4}+3=\frac{4}{t-4}$$
$$(t-4)\left(\frac{t}{t-4}+3\right)=(t-4)\left(\frac{4}{t-4}\right)$$
$$t+3(t-4)=4$$
$$t+3t-12=4$$
$$4t-12=4$$
$$4t=4+12$$
$$4t=16$$
$$t=4$$

No solution because each side is undefined when $t=4$.

21. Solve the rational equation.

$$\frac{3}{x+2}=\frac{5}{2x-7}$$
$$3(2x-7)=5(x+2)$$
$$6x-21=5x+10$$
$$6x-5x=10+21$$
$$x=31$$

22. Solve the rational equation.

$$\frac{4}{y+2}=\frac{7}{y-4}$$
$$4(y-4)=7(y+2)$$
$$4y-16=7y+14$$
$$4y-7y=14+16$$
$$-3y=30$$
$$y=-10$$

23. Solve the rational equation.

$$x-\frac{2x+3}{x+3}=\frac{2x+9}{x+3}$$
$$(x+3)\left(x-\frac{2x+3}{x+3}\right)=(x+3)\left(\frac{2x+9}{x+3}\right)$$
$$x(x+3)-(2x+3)=2x+9$$
$$x^2+3x-2x-3=2x+9$$
$$x^2-x-12=0$$
$$(x+3)(x-4)=0$$

$x=-3$ or $x=4$

4 checks as a solution. –3 is not in the domain and does not check as a solution.

24. Solve the rational equation.

$$2x+\frac{3}{x-1}=\frac{-7x+10}{x-1}$$
$$(x-1)\left(2x+\frac{3}{x-1}\right)=(x-1)\left(\frac{-7x+10}{x-1}\right)$$
$$2x(x-1)+3=-7x+10$$
$$2x^2-2x+3=-7x+10$$
$$2x^2+5x-7=0$$
$$(2x+7)(x-1)=0$$

$x=-\frac{7}{2}$ or $x=1$

$-\frac{7}{2}$ checks as a solution. 1 is not in the domain and does not check as a solution.

25. Solve the rational equation.

$$\frac{5}{x-3}-\frac{3}{x-2}=\frac{4}{x-3}$$
$$(x-3)(x-2)\left(\frac{5}{x-3}-\frac{3}{x-2}\right)=(x-3)(x-2)\left(\frac{4}{x-3}\right)$$
$$5(x-2)-3(x-3)=4(x-2)$$
$$5x-10-3x+9=4x-8$$
$$2x-1=4x-8$$
$$2x-4x=-8+1$$
$$-2x=-7$$
$$x=\frac{7}{2}$$

26. Solve the rational equation.

$$\frac{4}{x-1}+\frac{7}{x+7}=\frac{5}{x-1}$$
$$(x-1)(x+7)\left(\frac{4}{x-1}+\frac{7}{x+7}\right)=(x-1)(x+7)\left(\frac{5}{x-1}\right)$$
$$4(x+7)+7(x-1)=5(x+7)$$
$$4x+28+7x-7=5x+35$$
$$11x+21=5x+35$$
$$11x-5x=35-21$$
$$6x=14$$
$$x=\frac{7}{3}$$

27. Solve the rational equation.

$$\frac{x}{x+1}-\frac{x+2}{x-1}=\frac{x-12}{x+1}$$
$$(x+1)(x-1)\left(\frac{x}{x+1}-\frac{x+2}{x-1}\right)=(x+1)(x-1)\left(\frac{x-12}{x+1}\right)$$
$$x(x-1)-(x+1)(x+2)=(x-1)(x-12)$$
$$x^2-x-x^2-3x-2=x^2-13x+12$$
$$-4x-2=x^2-13x+12$$
$$0=x^2-9x+14$$
$$0=(x-2)(x-7)$$
$$x=2 \text{ or } x=7$$

28. Solve the rational equation.

$$\frac{2x+1}{x-3}-\frac{x-4}{x+5}=-\frac{10x+13}{x+5}$$
$$(x-3)(x+5)\left(\frac{2x+1}{x-3}-\frac{x-4}{x+5}\right)=(x-3)(x+5)\left(-\frac{10x+13}{x+5}\right)$$
$$(x+5)(2x+1)-(x-3)(x-4)=(x-3)(-10x-13)$$
$$2x^2+11x+5-x^2+7x-12=-10x^2+17x+39$$
$$x^2+18x-7=-10x^2+17x+39$$
$$11x^2+x-46=0$$
$$(11x+23)(x-2)=0$$
$$x=-\frac{23}{11} \text{ or } x=2$$

29. Solve the rational equation.

$$\frac{3-2x}{x+3}-\frac{2x+1}{x-4}=\frac{5x-29}{x-4}$$
$$(x+3)(x-4)\left(\frac{3-2x}{x+3}-\frac{2x+1}{x-4}\right)=(x+3)(x-4)\left(\frac{5x-29}{x-4}\right)$$
$$(x-4)(3-2x)-(x+3)(2x+1)=(x+3)(5x-29)$$
$$-2x^2+11x-12-2x^2-7x-3=5x^2-14x-87$$
$$-4x^2+4x-15=5x^2-14x-87$$
$$0=9x^2-18x-72$$
$$0=9(x^2-2x-8)$$
$$0=9(x-4)(x+2)$$
$$x=4 \text{ or } x=-2$$

–2 checks as a solution. 4 is not in the domain and does not check as a solution.

30. Solve the rational equation.

$$\frac{5x+3}{3x-2}-\frac{x-1}{x-3}=\frac{2x+3}{x-3}$$
$$(3x-2)(x-3)\left(\frac{5x+3}{3x-2}-\frac{x-1}{x-3}\right)=(3x-2)(x-3)\left(\frac{2x+3}{x-3}\right)$$
$$(x-3)(5x+3)-(3x-2)(x-1)=(3x-2)(2x+3)$$
$$5x^2-12x-9-3x^2+5x-2=6x^2+5x-6$$
$$2x^2-7x-11=6x^2+5x-6$$
$$0=4x^2+12x+5$$
$$0=(2x+5)(2x+1)$$
$$x=-\frac{5}{2} \text{ or } x=-\frac{1}{2}$$

31. Solve the radical equation.

$$\sqrt{x-4}-6=0$$
$$\sqrt{x-4}=6$$
$$x-4=36$$
$$x=40$$

Check $\sqrt{40-4}-6=0$
$$\sqrt{36}-6=0$$
$$6-6=0$$
$$0=0$$

The solution is 40.

32. Solve the radical equation.

$$\sqrt{10-x}=4$$
$$10-x=16$$
$$-x=6$$
$$x=-6$$

Check $\sqrt{10-(-6)}=4$
$$\sqrt{16}=4$$
$$4=4$$

The solution is –6.

33. Solve the radical equation.

$$\sqrt{9x-20}=x$$
$$\left(\sqrt{9x-20}\right)^2=x^2$$
$$9x-20=x^2$$
$$0=x^2-9x+20$$
$$0=(x-4)(x-5)$$
$$x=4 \text{ or } x=5$$

Check $\sqrt{9(4)-20}=4$ $\qquad$ $\sqrt{9(5)-20}=5$
$$\sqrt{16}=4 \qquad \sqrt{25}=5$$
$$4=4 \qquad 5=5$$

4 and 5 check as solutions.

34. Solve the radical equation.

$$x=\sqrt{12x-35}$$
$$x^2=(\sqrt{12x-35})^2$$
$$x^2=12x-35$$
$$x^2-12x+35=0$$
$$(x-5)(x-7)=0$$
$$x=5 \text{ or } x=7$$

Check $5=\sqrt{12(5)-35}$ $\qquad$ $7=\sqrt{12(7)-35}$
$$5=\sqrt{60-35} \qquad 7=\sqrt{84-35}$$
$$5=\sqrt{25} \qquad 7=\sqrt{49}$$
$$5=5 \qquad 7=7$$

5 and 7 check as solutions.

35. Solve the radical equation.

$$\begin{aligned}
\sqrt{-7x+2}+x &= 2\\
\sqrt{-7x+2} &= 2-x\\
\left(\sqrt{-7x+2}\right)^2 &= (2-x)^2\\
-7x+2 &= 4-4x+x^2\\
0 &= x^2+3x+2\\
0 &= (x+2)(x+1)\\
x &= -2 \text{ or } x=-1
\end{aligned}$$

Check

$$\begin{aligned}
\sqrt{-7(-2)+2}+(-2) &= 2 & \sqrt{-7(-1)+2}+(-1) &= 2\\
\sqrt{16}-2 &= 2 & \sqrt{9}-1 &= 2\\
4-2 &= 2 & 3-1 &= 2\\
2 &= 2 & 2 &= 2
\end{aligned}$$

–2 and –1 check as solutions.

36. Solve the radical equation.

$$\begin{aligned}
\sqrt{-9x-9}+x &= 1\\
\sqrt{-9x-9} &= 1-x\\
\left(\sqrt{-9x-9}\right)^2 &= (1-x)^2\\
-9x-9 &= 1-2x+x^2\\
0 &= x^2+7x+10\\
0 &= (x+5)(x+2)\\
x &= -5 \text{ or } x=-2
\end{aligned}$$

Check

$$\begin{aligned}
\sqrt{-9(-5)-9}+(-5) &= 1 & \sqrt{-9(-2)-9}+(-2) &= 1\\
\sqrt{36}-5 &= 1 & \sqrt{9}-2 &= 1\\
6-5 &= 1 & 3-2 &= 1\\
1 &= 1 & 1 &= 1
\end{aligned}$$

Both –5 and –2 check as solutions.

37. Solve the radical equation.

$$\begin{aligned}
\sqrt{3x-5}-\sqrt{x+2} &= 1\\
(\sqrt{3x-5})^2 &= (1+\sqrt{x+2})^2\\
3x-5 &= 1+2\sqrt{x+2}+x+2\\
2x-8 &= 2\sqrt{x+2}\\
(x-4)^2 &= (\sqrt{x+2})^2\\
x^2-8x+16 &= x+2\\
x^2-9x+14 &= 0\\
(x-7)(x-2) &= 0\\
x=7 &\text{ or } x=2
\end{aligned}$$

Check $\sqrt{3(7)-5}-\sqrt{7+2}=1$

$$\begin{aligned}
\sqrt{16}-\sqrt{9} &= 1\\
4-3 &= 1\\
1 &= 1
\end{aligned}$$

Check $\sqrt{3(2)-5}-\sqrt{2+2}=1$

$$\begin{aligned}
\sqrt{1}-\sqrt{4} &= 1\\
1-2 &= 1\\
-1 &= 1 \quad \text{(No)}
\end{aligned}$$

The solution is 7.

38. Solve the radical equation.

$$\begin{aligned}
(\sqrt{x+7}-2)^2 &= (\sqrt{x-9})^2\\
x+7-4\sqrt{x+7}+4 &= x-9\\
-4\sqrt{x+7} &= -20\\
(\sqrt{x+7})^2 &= (5)^2\\
x+7 &= 25\\
x &= 18
\end{aligned}$$

Check $\sqrt{18+7}-2=\sqrt{18-9}$

$$\begin{aligned}
\sqrt{25}-2 &= \sqrt{9}\\
5-2 &= 3\\
3 &= 3
\end{aligned}$$

18 checks as a solution.

39. Solve the radical equation.

$$\begin{aligned}
\sqrt{2x+11}-\sqrt{2x-5} &= 2\\
(\sqrt{2x+11})^2 &= (2+\sqrt{2x-5})^2\\
2x+11 &= 4+4\sqrt{2x-5}+2x-5\\
12 &= 4\sqrt{2x-5}\\
(3)^2 &= (\sqrt{2x-5})^2\\
9 &= 2x-5\\
14 &= 2x\\
7 &= x
\end{aligned}$$

Check $\sqrt{2(7)+11}-\sqrt{2(7)-5}=2$

$$\begin{aligned}
\sqrt{25}-\sqrt{9} &= 2\\
5-3 &= 2\\
2 &= 2
\end{aligned}$$

7 checks as the solution.

40. Solve the radical equation.

$$\sqrt{x+7}+\sqrt{x-5}=6$$
$$(\sqrt{x+7})^2=(6-\sqrt{x-5})^2$$
$$x+7=36-12\sqrt{x-5}+x-5$$
$$12\sqrt{x-5}=24$$
$$(\sqrt{x-5})^2=(2)^2$$
$$x-5=4$$
$$x=9$$

Check $\sqrt{9+7}+\sqrt{9-5}=6$
$$\sqrt{16}+\sqrt{4}=6$$
$$4+2=6$$
$$6=6$$

9 checks as a solution.

41. Solve the radical equation.

$$\sqrt{x-4}+\sqrt{x+1}=1$$
$$\sqrt{x-4}=1-\sqrt{x+1}$$
$$\left(\sqrt{x-4}\right)^2=\left(1-\sqrt{x+1}\right)^2$$
$$x-4=1-2\sqrt{x+1}+x+1$$
$$2\sqrt{x+1}=6$$
$$\left(2\sqrt{x+1}\right)^2=6^2$$
$$4(x+1)=36$$
$$4x+4=36$$
$$4x=32$$
$$x=8$$

Check $\sqrt{8-4}+\sqrt{8+1}=1$
$$\sqrt{4}+\sqrt{9}=1$$
$$2+3=1$$
$$5=1 \text{ (No)}$$

There is no solution.

42. Solve the radical equation.

$$\sqrt{2x-9}+\sqrt{2x+6}=3$$
$$\sqrt{2x-9}=3-\sqrt{2x+6}$$
$$\left(\sqrt{2x-9}\right)^2=\left(3-\sqrt{2x+6}\right)^2$$
$$2x-9=9-6\sqrt{2x+6}+2x+6$$
$$6\sqrt{2x+6}=24$$
$$\left(\sqrt{2x+6}\right)^2=4^2$$
$$2x+6=16$$
$$2x=10$$
$$x=5$$

Check $\sqrt{2(5)-9}+\sqrt{2(5)+6}=3$
$$\sqrt{1}+\sqrt{16}=3$$
$$1+4=3$$
$$5=3 \text{ (No)}$$

There is no solution.

43. Solve the radical equation.

$$\sqrt{2x-1}-\sqrt{x-1}=1$$
$$\sqrt{2x-1}=1+\sqrt{x-1}$$
$$\left(\sqrt{2x-1}\right)^2=\left(1+\sqrt{x-1}\right)^2$$
$$2x-1=1+2\sqrt{x-1}+x-1$$
$$x-1=2\sqrt{x-1}$$
$$(x-1)^2=\left(2\sqrt{x-1}\right)^2$$
$$x^2-2x+1=4(x-1)$$
$$x^2-2x+1=4x-4$$
$$x^2-6x+5=0$$
$$(x-1)(x-5)=0$$
$$x=1 \text{ or } x=5$$

Check $\sqrt{2(1)-1}-\sqrt{(1)-1}=1$
$$\sqrt{1}-\sqrt{0}=1$$
$$1=1$$

$\sqrt{2(5)-1}-\sqrt{5-1}=1$
$$\sqrt{9}-\sqrt{4}=1$$
$$3-2=1$$
$$1=1$$

1 and 5 check as solutions.

44. Solve the radical equation.

$$\sqrt{6-x}+\sqrt{5x+6}=6$$
$$(\sqrt{5x+6})^2=(6-\sqrt{6-x})^2$$
$$5x+6=36-12\sqrt{6-x}+6-x$$
$$6x-36=-12\sqrt{6-x}$$
$$(x-6)^2=(-2\sqrt{6-x})^2$$
$$x^2-12x+36=4(6-x)$$
$$x^2-12x+36=24-4x$$
$$x^2-8x+12=0$$
$$(x-6)(x-2)=0$$
$$x=6, \text{ or } x=2$$

Check $\sqrt{6-6}+\sqrt{30+6}=6$ $\quad$ $\sqrt{6-2}+\sqrt{10+6}=6$

$0+6=6$ $\quad$ $\sqrt{4}+\sqrt{16}=6$

$6=6$ $\quad$ $2+4=6$

$6=6$

Both 6 and 2 check as solutions.

45. Solve.

$$x^{1/3}=2$$
$$\left(x^{1/3}\right)^3=(2)^3$$
$$x=8$$

46. Solve.

$$x^{1/2}=5$$
$$\left(x^{1/2}\right)^2=(5)^2$$
$$x=25$$

47. Solve.

$$x^{2/5}=9$$
$$\left(x^{2/5}\right)^{5/2}=(9)^{5/2}$$
$$|x|=243$$
$$x=-243,\ 243$$

48. Solve.

$$x^{4/3}=81$$
$$\left(x^{4/3}\right)^{3/4}=(81)^{3/4}$$
$$|x|=27$$
$$x=-27,\ 27$$

49. Solve.

$$x^{3/2}=27$$
$$\left(x^{3/2}\right)^{2/3}=(27)^{2/3}$$
$$x=9$$

50. Solve.

$$x^{3/4}=125$$
$$\left(x^{3/4}\right)^{4/3}=(125)^{4/3}$$
$$x=625$$

51. Solve.

$$3x^{2/3}-16=59$$
$$3x^{2/3}=75$$
$$x^{2/3}=25$$
$$\left(x^{2/3}\right)^{3/2}=(25)^{3/2}$$
$$|x|=125$$
$$x=-125,\ 125$$

52. Solve.

$$4x^{4/5}-27=37$$
$$4x^{4/5}=64$$
$$x^{4/5}=16$$
$$\left(x^{4/5}\right)^{5/4}=(16)^{5/4}$$
$$|x|=32$$
$$x=-32,\ 32$$

53. Solve.

$$4x^{3/4}-31=77$$
$$4x^{3/4}=108$$
$$x^{3/4}=27$$
$$\left(x^{3/4}\right)^{4/3}=(27)^{4/3}$$
$$x=81$$

54. Solve.

$$4x^{4/5}-54=270$$
$$4x^{4/5}=324$$
$$x^{4/5}=81$$
$$\left(x^{4/5}\right)^{5/4}=(81)^{5/4}$$
$$|x|=243$$
$$x=-243,\ 243$$

55. Find all real solutions.

$x^4 - 9x^2 + 14 = 0$

Let $u = x^2$.

$u^2 - 9u + 14 = 0$
$(u-7)(u-2) = 0$

$u = 7$ or $u = 2$
$x^2 = 7$ $x^2 = 2$
$x = \pm\sqrt{7}$ $x = \pm\sqrt{2}$

The solutions are $\sqrt{7},\ -\sqrt{7},\ \sqrt{2},\ -\sqrt{2}$.

56. Find all real solutions.

$x^4 - 10x^2 + 9 = 0$

Let $u = x^2$.

$u^2 - 10u + 9 = 0$
$(u-9)(u-1) = 0$

$u = 9$ or $u = 1$
$x^2 = 9$ $x^2 = 1$
$x = \pm 3$ $x = \pm 1$

The solutions are –3, 3, –1, 1.

57. Find all real solutions.

$2x^4 - 11x^2 + 12 = 0$

Let $u = x^2$.

$2u^2 - 11u + 12 = 0$
$(2u-3)(u-4) = 0$

$u = \frac{3}{2}$ or $u = 4$
$x^2 = \frac{3}{2}$ $x^2 = 4$
$x = \pm\sqrt{\frac{3}{2}} = \pm\frac{\sqrt{6}}{2}$ $x = \pm 2$

The solutions are $\frac{\sqrt{6}}{2},\ -\frac{\sqrt{6}}{2},\ 2,\ -2$.

58. Find all real solutions.

$6x^4 - 7x^2 + 2 = 0$

Let $u = x^2$.

$6u^2 - 7u + 2 = 0$
$(2u-1)(3u-2) = 0$

$u = \frac{1}{2}$ or $u = \frac{2}{3}$
$x^2 = \frac{1}{2}$ $x^2 = \frac{2}{3}$
$x = \pm\sqrt{\frac{1}{2}} = \pm\frac{\sqrt{2}}{2}$ $x = \pm\sqrt{\frac{2}{3}} = \pm\frac{\sqrt{6}}{3}$

The solutions are $\frac{\sqrt{2}}{2},\ -\frac{\sqrt{2}}{2},\ \frac{\sqrt{6}}{3},\ -\frac{\sqrt{6}}{3}$.

59. Find all real solutions.

$x^6 + x^3 - 6 = 0$

Let $u = x^3$.

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

$u = 2$ or $u = -3$
$x^3 = 2$ $x^3 = -3$
$x = \sqrt[3]{2}$ $x = \sqrt[3]{-3} = -\sqrt[3]{3}$

The solutions are $\sqrt[3]{2}$ and $-\sqrt[3]{3}$.

60. Find all real solutions.

$6x^6 + x^3 - 15 = 0$

Let $u = x^3$.

$6u^2 + u - 15 = 0$
$(2u-3)(3u+5) = 0$

$u = \frac{3}{2}$ or $u = -\frac{5}{3}$
$x^3 = \frac{3}{2}$ $x^3 = -\frac{5}{3}$
$x = \sqrt[3]{\frac{3}{2}} = \sqrt[3]{\frac{3\cdot 4}{2\cdot 4}}$ $x = -\sqrt[3]{\frac{5}{3}} = -\sqrt[3]{\frac{5\cdot 9}{3\cdot 9}}$
$x = \frac{\sqrt[3]{12}}{2}$ $x = -\frac{\sqrt[3]{45}}{3}$

The solutions are $\frac{\sqrt[3]{12}}{2}$ and $-\frac{\sqrt[3]{45}}{3}$.

61. Find all real solutions.

$$x^{1/2} - 3x^{1/4} + 2 = 0$$

Let $u = x^{1/4}$.

$$u^2 - 3u + 2 = 0$$
$$(u-1)(u-2) = 0$$

$$u = 1 \quad \text{or} \quad u = 2$$
$$x^{1/4} = 1 \qquad x^{1/4} = 2$$
$$x = 1 \qquad x = 16$$

The solutions are 1 and 16.

62. Find all real solutions.

$$2x^{1/2} - 5x^{1/4} - 3 = 0$$

Let $u = x^{1/4}$.

$$2u^2 - 5u - 3 = 0$$
$$(2u+1)(u-3) = 0$$

$$u = -\frac{1}{2} \quad \text{or} \quad u = 3$$
$$x^{1/4} = -\frac{1}{2} \qquad x^{1/4} = 3$$
$$x = 81$$

$\left(x^{1/4} \neq -\frac{1}{2} \text{ since } x^{1/4} \geq 0\right)$

The solution is 81.

63. Find all real solutions.

$$3x^{2/3} - 11x^{1/3} - 4 = 0$$

Let $u = x^{1/3}$.

$$3u^2 - 11u - 4 = 0$$
$$(3u+1)(u-4) = 0$$

$$u = -\frac{1}{3} \quad \text{or} \quad u = 4$$
$$x^{1/3} = -\frac{1}{3} \qquad x^{1/3} = 4$$
$$x = -\frac{1}{27} \qquad x = 64$$

The solutions are $-\frac{1}{27}$ and 64.

64. Find all real solutions.

$$6x^{2/3} - 7x^{1/3} - 20 = 0$$

Let $u = x^{1/3}$.

$$6u^2 - 7u - 20 = 0$$
$$(3u+4)(2u-5) = 0$$

$$u = -\frac{4}{3} \quad \text{or} \quad u = \frac{5}{2}$$
$$x^{1/3} = -\frac{4}{3} \qquad x^{1/3} = \frac{5}{2}$$
$$x = -\frac{64}{27} \qquad x = \frac{125}{8}$$

The solutions are $-\frac{64}{27}$ and $\frac{125}{8}$.

65. Find all real solutions.

$$x^4 + 8x^2 - 9 = 0$$

Let $u = x^2$.

$$u^2 + 8u - 9 = 0$$
$$(u+9)(u-1) = 0$$

$$u = -9 \quad \text{or} \quad u = 1$$
$$x^2 = -9 \qquad x^2 = 1$$
$$x = \pm\sqrt{-9} \qquad x = \pm 1$$
$$x = \pm 3i$$

The solutions are -1, 1, $-3i$, $3i$.

66. Find all real solutions.

$$4x^4 + 7x^2 - 36 = 0$$

Let $u = x^2$.

$$4u^2 + 7u - 36 = 0$$
$$(u+4)(4u-9) = 0$$

$$u = -4 \quad \text{or} \quad u = \frac{9}{4}$$
$$x^2 = -4 \qquad x^2 = \frac{9}{4}$$
$$x = \pm\sqrt{-4} \qquad x = \pm\sqrt{\frac{9}{4}}$$
$$x = \pm 2i \qquad x = \pm\frac{3}{2}$$

The solutions are $-\frac{3}{2}$, $\frac{3}{2}$, $-2i$, $2i$.

67. Find all real solutions.

$x^{2/5} - x^{1/5} - 2 = 0$

Let $u = x^{1/5}$.

$$u^2 - u - 2 = 0$$
$$(u+1)(u-2) = 0$$
$$u = -1 \quad \text{or} \quad u = 2$$
$$x^{1/5} = -1 \qquad x^{1/5} = 2$$
$$x = -1 \qquad x = 32$$

The solutions are –1 and 32.

68. Find all real solutions.

$2x^{2/5} - x^{1/5} = 6$

Let $u = x^{1/5}$.

$$2u^2 - u - 6 = 0$$
$$(2u+3)(u-2) = 0$$
$$u = -\frac{3}{2} \quad \text{or} \quad u = 2$$
$$x^{1/5} = -\frac{3}{2} \qquad x^{1/5} = 2$$
$$x = \left[-\frac{3}{2}\right]^5 \qquad x = 32$$
$$x = -\frac{243}{32}$$

The solutions are $-\frac{243}{32}$ and 32.

69. Find all real solutions.

$9x - 52\sqrt{x} + 64 = 0$

Let $\sqrt{x} = u$.

$$9u^2 - 52u + 64 = 0$$
$$(9u-16)(u-4) = 0$$
$$u = \frac{16}{9} \quad \text{or} \quad u = 4$$
$$\sqrt{x} = \frac{16}{9} \qquad \sqrt{x} = 4$$
$$x = \frac{256}{81} \qquad x = 16$$

The solutions are $\frac{256}{81}$ and 16.

70. Find all real solutions.

$8x - 38\sqrt{x} + 9 = 0$

Let $u = \sqrt{x}$.

$$8u^2 - 38u + 9 = 0$$
$$(4u-1)(2u-9) = 0$$
$$u = \frac{1}{4} \quad \text{or} \quad u = \frac{9}{2}$$
$$\sqrt{x} = \frac{1}{4} \qquad \sqrt{x} = \frac{9}{2}$$
$$x = \frac{1}{16} \qquad x = \frac{81}{4}$$

The solutions are $\frac{1}{16}$ and $\frac{81}{4}$.

71. Find the speed of the boat.

Using the formula $t = \frac{d}{r}$, we get the equation.

$$\frac{24}{v+3} + \frac{24}{v-3} = 6$$
$$(v+3)(v-3)\left(\frac{24}{v+3} + \frac{24}{v-3}\right) = (v+3)(v-3)6$$
$$24(v-3) + 24(v+3) = (v^2 - 9)(6)$$
$$24v - 72 + 24v + 72 = 6v^2 - 54$$
$$48v = 6v^2 - 54$$
$$0 = 6v^2 - 48v - 54$$
$$0 = 6(v^2 - 8v - 9)$$
$$0 = 6(v+1)(v-9)$$
$$v = -1 \text{ (No)} \text{ or } v = 9$$

The speed is 9 mph.

72. Find the speed for each runner.

Let x = Hector's speed.

$$\frac{12}{x} = \frac{12}{x+2} + \frac{1}{2}$$
$$2x(x+2)\left(\frac{12}{x}\right) = 2x(x+2)\left(\frac{12}{x+2} + \frac{1}{2}\right)$$
$$24(x+2) = 24x + x(x+2)$$
$$24x + 48 = 24x + x^2 + 2x$$
$$0 = x^2 + 2x - 48$$
$$0 = (x+8)(x-6)$$
$$x = -8 \text{ (No)} \text{ or } x = 6$$

Hector's speed is 6 mph. Maureen's speed is 8 mph.

73. Find the time it takes the assistant, working alone.

Let x = the number of hours the assistant would take to build the fence working alone.

The worker does $\frac{1}{8}$ of the job per hour; the assistant does $\frac{1}{x}$ of the job per hour.

worker	$\frac{1}{8}$	5
assistant	$\frac{1}{x}$	5

$$\left(\frac{1}{8}\right)(5)+\left(\frac{1}{x}\right)(5)=1$$
$$\frac{5}{8}+\frac{5}{x}=1$$
$$8x\left(\frac{5}{8}+\frac{5}{x}\right)=1(8x)$$
$$5x+40=8x$$
$$40=3x$$
$$\frac{40}{3}=x$$
$$x=13\frac{1}{3} \text{ hours}$$

74. Find the additional time the assistants needs.

Let x = the additional number of hours for the assistants to finish the job. In two hours,

$\frac{1}{3}$ of the job is done, $\frac{2}{3}$ of the job is left to do.

$$\frac{1}{14}x=\frac{2}{3}$$
$$x=\frac{2}{3}\cdot 14$$
$$x=\frac{28}{3}=9\frac{1}{3} \text{ hours}$$

75. Find the time for the experienced painter.

Let t = the time for the experienced painter.

$2t-5$ is the time for the apprentice painter.

$\frac{1}{t}$ is the rate for the experienced painter.

$\frac{1}{2t-5}$ is the rate for the apprentice painter.

$$\frac{1}{t}\cdot 6+\frac{1}{2t-5}\cdot 6=1$$
$$t(2t-5)\left(\frac{6}{t}+\frac{6}{2t-5}\right)=t(2t-5)\cdot 1$$
$$6(2t-5)+6t=2t^2-5t$$
$$12t-30+6t=2t^2-5t$$
$$0=2t^2-23t+30$$
$$0=(2t-3)(t-10)$$
$$t=\frac{3}{2} \text{ (No) or } t=10$$

It takes the experience painter 10 hours.

76. Find the time for the faster computer, working alone.

Let t = the time for the slower computer.

$t-7$ is the time for the faster computer.

$\frac{1}{t}$ is the rate for the slower computer.

$\frac{1}{t-7}$ is the rate for the faster computer.

$$\frac{1}{t}\cdot 12+\frac{1}{t-7}\cdot 12=1$$
$$t(t-7)\left(\frac{12}{t}+\frac{12}{t-7}\right)=t(t-7)\cdot 1$$
$$12(t-7)+12t=t^2-7t$$
$$12t-84+12t=t^2-7t$$
$$0=t^2-31t+84$$
$$0=(t-28)(t-3)$$
$$t=28 \text{ or } t=3 \text{ (No)}$$

$t-7=28-7=21$

The faster computer completes the problem in 21 min.

77. Find the time.

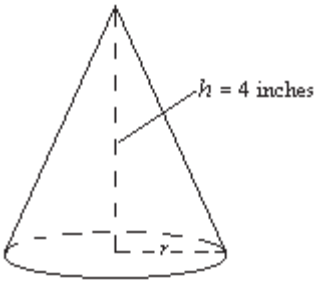
$$T=\frac{\sqrt{s}}{4}+\frac{s}{1100}$$
$$T=\frac{\sqrt{7100}}{4}+\frac{7100}{1100}$$
$T\approx 27.5$ seconds

78. Find the depth.

$$T=3$$
$$s=\left[\frac{-275+5\sqrt{3025+176(3)}}{2}\right]^2$$
$s\approx 11.5176^2\approx 132.65$

The distance is approximately 133 ft.

79. Find the radius.



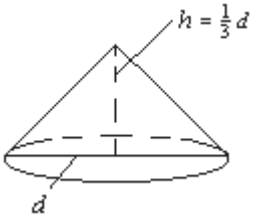
$$L = \pi r \sqrt{r^2 + h^2}$$
$$15\pi = \pi r\sqrt{r^2 + 4^2}$$
$$15 = r\sqrt{r^2 + 16}$$
$$225 = r^2(r^2 + 16)$$
$$0 = r^4 + 16r^2 - 225$$

Let $u = r^2$.

$$u^2 + 16u - 225 = 0$$
$$(u + 25)(u - 9) = 0$$
$$u = 9 \quad \text{or} \quad u = -25 \text{ (No)}$$
$$r^2 = 9$$
$$r = 3$$

The radius is 3 in.

80. Find the diameter.

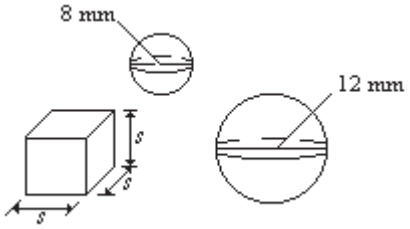


$$h = \frac{1}{3}d = \frac{1}{3}(2r) = \frac{2}{3}r$$
$$V = \frac{1}{3}\pi r^2 h$$
$$192 = \frac{1}{3}\pi r^2\left[\frac{2}{3}r\right]$$
$$192 = \frac{2}{9}\pi r^3$$
$$\frac{192(9)}{2\pi} = r^3$$
$$275 \approx r^3$$
$$6.50 \approx r$$

$r \approx 6.50$ in.

diameter $d = 2r \approx 13.0$ in.

81. Find the length of the edge.



$d_1 = 8$ mm, $d_2 = 12$ mm

$V_c = s^3 \qquad V_s = \frac{4}{3}\pi r^3$

$$s^3 = \frac{4}{3}\pi (4)^3 + \frac{4}{3}\pi (6)^3 = \frac{4}{3}\pi (64 + 216) \approx 1172.86$$

$s \approx 10.5$ mm

The side is approximately 10.5 mm.

82. Find the length of the pendulum.

$$T = 2\pi \sqrt{\frac{L}{32}}$$
$$4 = 2\pi \sqrt{\frac{L}{32}}$$
$$\frac{2}{\pi} = \sqrt{\frac{L}{32}}$$
$$\frac{4}{\pi^2} = \frac{L}{32}$$
$$L = \frac{32(4)}{\pi^2}$$
$$L \approx 12.969$$

The length is 13.0 ft (to the nearest tenth).

83. Find the height.

$$d = \sqrt{1.5h}$$
$$14 = \sqrt{1.5h}$$
$$14^2 = 1.5h$$
$$196 = 1.5h$$
$$131 \approx h$$

The height is approximately 131 ft.

84. Find the distance.

$$0.125x+0.2\sqrt{1+(6-x)^2}=1$$
$$0.2\sqrt{1+(6-x)^2}=1-0.125x$$
$$\left(0.2\sqrt{1+(6-x)^2}\right)^2=(1-0.125x)^2$$
$$0.04\left(1+(6-x)^2\right)=1-0.25x+0.015625x^2$$
$$0.04\left(1+36-12x+x^2\right)=0.015625x^2-0.25x+1$$
$$0.04x^2-0.48x+1.48=0.015625x^2-0.25x+1$$
$$0.024375x^2-0.23x+0.48=0$$

Use quadratic formula to solve for x.

$$x=\frac{-(-0.23)\pm\sqrt{(-0.23)^2-4(0.024375)(0.48)}}{2(0.024375)}$$
$$x=\frac{0.23\pm\sqrt{0.0061}}{0.04875}$$
$$x=\frac{0.23+\sqrt{0.0061}}{0.04875}\approx 6.3 \text{ miles (No)}$$
$$x=\frac{0.23-\sqrt{0.0061}}{0.04875}\approx 3.1 \text{ miles}$$

The distance is about 3.1 miles.

85. Find the distance.

$$\frac{16-x}{22}+\frac{\sqrt{16+x^2}}{7}=2$$
$$154\left(\frac{16-x}{22}+\frac{\sqrt{16+x^2}}{7}\right)=154(2)$$
$$7(16-x)+22\sqrt{16+x^2}=308$$
$$112-7x+22\sqrt{16+x^2}=308$$
$$22\sqrt{16+x^2}=7x+196$$
$$\left(22\sqrt{16+x^2}\right)^2=(7x+196)^2$$
$$484\left(16+x^2\right)=49x^2+2744x+38,416$$
$$7744+484x^2=49x^2+2744x+38,416$$
$$435x^2-2744x-30,672=0$$

Use quadratic formula to solve for x.

$$x=\frac{-(-2744)\pm\sqrt{(-2744)^2-4(435)(-30,672)}}{2(435)}$$
$$x=\frac{2744\pm\sqrt{60,898,816}}{870}$$
$$x=\frac{2744-\sqrt{60,898,816}}{870}\approx -5.8 \text{ km (No)}$$
$$x=\frac{2744+\sqrt{60,898,816}}{870}\approx 12.1 \text{ km}$$

The distance is about 12.1 km.

86. Solve.

$$x^4+3x^3-8x-24=0$$
$$x^3(x+3)-8(x+3)=0$$
$$(x+3)(x^3-8)=0$$
$$(x+3)(x-2)(x^2+2x+4)=0$$

$x^2+2x=-4$ Use completing the square.

$$x^2+2x+1=-4+1$$
$$(x+1)^2=-3$$
$$x+1=\pm\sqrt{-3}$$
$$x=-1\pm i\sqrt{3}$$

Thus the solutions are $-3,\ 2,\ -1+i\sqrt{3},\ -1-i\sqrt{3}$.

87. Solve.

$$x^4-2x^3+27x-54=0$$
$$x^3(x-2)+27(x-2)=0$$
$$(x-2)\left(x^3+27\right)=0$$
$$(x-2)(x+3)\left(x^2-3x+9\right)=0$$
$$x=\frac{-(-3)\pm\sqrt{(-3)^2-4(1)(9)}}{2(1)}$$
$$x=\frac{3\pm\sqrt{-27}}{2}=\frac{3\pm 3i\sqrt{3}}{2}$$

The solutions are 2, –3, $\frac{3-3i\sqrt{3}}{2}$, $\frac{3+3i\sqrt{3}}{2}$.

88. Solve.

$$\sqrt[3]{x^3-5x-17}=x-1$$
$$\left(\sqrt[3]{x^3-5x-17}\right)^3=(x-1)^3$$
$$x^3-5x-17=x^3-3x^2+3x-1$$
$$3x^2-8x-16=0$$
$$(3x+4)(x-4)=0$$
$$3x+4=0 \quad \text{or} \quad x-4=0$$
$$x=-\frac{4}{3} \qquad x=4$$

Check $\sqrt[3]{\left(-\frac{4}{3}\right)^3-5\left(-\frac{4}{3}\right)-17}=-\frac{4}{3}-1$

$$\sqrt[3]{-\frac{343}{27}}=-\frac{7}{3}$$
$$-\frac{7}{3}=-\frac{7}{3}$$

$\sqrt[3]{(4)^3-5(4)-17}=4-1$

$$\sqrt[3]{27}=3$$
$$3=3$$

Both $-\frac{4}{3}$ and 4 check as solutions.

89. Solve.

$$\sqrt[3]{x^3-2x-13}=x-1$$
$$\left(\sqrt[3]{x^3-2x-13}\right)^3=(x-1)^3$$
$$x^3-2x-13=x^3-3x^2+3x-1$$
$$3x^2-5x-12=0$$
$$(3x+4)(x-3)=0$$
$$3x+4=0 \quad \text{or} \quad x-3=0$$
$$x=-\frac{4}{3} \qquad x=3$$

Check $\sqrt[3]{\left(-\frac{4}{3}\right)^3-2\left(-\frac{4}{3}\right)-13}=-\frac{4}{3}-1$

$$\sqrt[3]{-\frac{343}{27}}=-\frac{7}{3}$$
$$-\frac{7}{3}=-\frac{7}{3}$$

$\sqrt[3]{(3)^3-2(3)-13}=3-1$

$$\sqrt[3]{8}=2$$
$$2=2$$

Both $-\frac{4}{3}$ and 3 check as solutions.

90. Solve the equation for ϕ.

$$1+\frac{b}{a}=\phi$$
$$\frac{b}{a}=\phi-1$$
$$\frac{1}{\phi}=\phi-1 \quad \text{Substitute } \frac{1}{\phi} \text{ for } \frac{b}{a}.$$
$$1=\phi^2-\phi \quad \text{Clear fractions}$$
$$0=\phi^2-\phi-1$$

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

$\phi=\frac{1+\sqrt{5}}{2}$ (reject negative solution)

91. Show that $\frac{AD}{AB}=\phi$.

Label the point G that is between B and C.

Note that $EG = ED$, by construction.

Let $x = FD$.

Then $EG = 1 + x$.

$$EG=\sqrt{EF^2+FG^2}=\sqrt{1^2+2^2}=\sqrt{5}$$
$$\sqrt{5}=1+x$$
$$x=\sqrt{5}-1$$

$$\frac{AD}{AB}=\frac{2+x}{2}=\frac{2+\sqrt{5}-1}{2}=\frac{1+\sqrt{5}}{2}=\phi$$

Prepare for Section 1.5

P1. Find $\{x|x>2\}\cap\{x|x>5\}$.

$\{x \mid x > 5\}$

P2. Evaluate.

$3(-3)^2-2(-3)+5=38$

P3. Evaluate.

$\frac{7+3}{7-2}=2$

P4. Factor.

$10x^2+9x-9=(2x+3)(5x-3)$

P5. Find the value of x where the expression is undefined.

$\frac{x-3}{2x-7}$, $2x-7\neq 0$

It is undefined for $x=\frac{7}{2}$.

P6. Solve.

$$2x^2 - 11x + 15 = 0$$
$$(2x-5)(x-3) = 0$$
$$2x-5=0 \quad \text{or} \quad x-3=0$$
$$x = \frac{5}{2} \qquad x = 3$$

Section 1.5 Exercises

1. State whether the inequalities are equivalent.

a. No, $x > -3$ is not equivalent to $x > 0$.

b. $3x \le -6$ can be simplified as $x \le -2$ which is not equivalent to $x \ge -2$.

c. $-2x < 0$ can be simplified as $x > 0$ which is equivalent to $x > 0$.

d. $\frac{2}{3}x \ge -6$ can be simplified as $x \ge -9$ which is equivalent to $x \ge -9$.

2. Rewrite $|x+2| > 3$.

$x+2 < -3$ or $x+2 > 3$

3. Rewrite $|x-5| \le 8$.

$x-5 \ge -8$ and $x-5 \le 8$

4. Identify the critical values.

a. $x^2 + 8x < 0$ can be factored as $x(x+8) < 0$.

The critical values are 0 and –8.

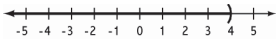
b. Critical values of $(2x+5)(x-4) \ge 0$ are $-\frac{5}{2}$, 4.

c. Critical values of $\frac{x-4}{x+2} \le 0$ are –2, 4.

d. Critical values of $\frac{2x-1}{x(x-3)} > 0$ are 0, $\frac{1}{2}$, 3.

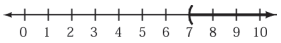
5. Find the solution set in set builder notation and graph.

$$2x+3 < 11$$
$$2x < 11-3$$
$$2x < 8$$
$$x < 4$$
$$\{x \mid x < 4\}$$



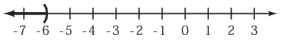
6. Find the solution set in set builder notation and graph.

$$3x-5 > 16$$
$$3x > 21$$
$$x > 7$$
$$\{x \mid x > 7\}$$



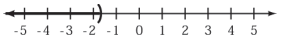
7. Find the solution set in set builder notation and graph.

$$x+4 > 3x+16$$
$$-2x > 12$$
$$x < -6$$
$$\{x \mid x < -6\}$$



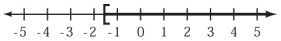
8. Find the solution set in set builder notation and graph.

$$5x+6 < 2x+1$$
$$3x < -5$$
$$x < -\frac{5}{3}$$
$$\left\{x \mid x < -\frac{5}{3}\right\}$$



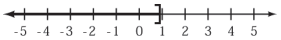
9. Find the solution set in set builder notation and graph.

$$-3(x+2) \le 5x+7$$
$$-3x-6 \le 5x+7$$
$$-8x \le 13$$
$$x \ge -\frac{13}{8}$$
$$\left\{x \mid x \ge -\frac{13}{8}\right\}$$



10. Find the solution set in set builder notation and graph.

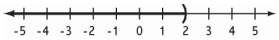
$$-4(x-5) \ge 2x+15$$
$$-4x+20 \ge 2x+15$$
$$-6x \ge -5$$
$$x \le \frac{5}{6}$$
$$\left\{x \mid x \le \frac{5}{6}\right\}$$



11. Find the solution set in set builder notation and graph.

$$-4(3x-5) > 2(x-4)$$
$$-12x+20 > 2x-8$$
$$-14x > -28$$
$$x < 2$$

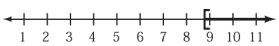
$$\{x \mid x < 2\}$$



12. Find the solution set in set builder notation and graph.

$$3(x+7) \le 5(2x-8)$$
$$3x+21 \le 10x-40$$
$$-7x \le -61$$
$$x \ge \frac{61}{7}$$

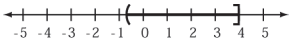
$$\left\{x \,\middle|\, x \ge \frac{61}{7}\right\}$$



13. Find the solution set in set builder notation and graph.

$$4x+1 > -2 \quad \text{and} \quad 4x+1 \le 17$$
$$4x > -3 \quad \text{and} \quad 4x \le 16$$
$$x > -\frac{3}{4} \quad \text{and} \quad x \le 4$$

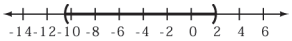
$$\left\{x \,\middle|\, x > -\frac{3}{4}\right\} \cap \{x \mid x \le 4\} = \left\{x \,\middle|\, -\frac{3}{4} < x \le 4\right\}$$



14. Find the solution set in set builder notation and graph.

$$2x+5 > -16 \quad \text{and} \quad 2x+5 < 9$$
$$2x > -21 \quad \text{and} \quad 2x < 4$$
$$x > -\frac{21}{2} \quad \text{and} \quad x < 2$$

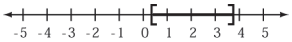
$$\left\{x \,\middle|\, x > -\frac{21}{2}\right\} \cap \{x \mid x < 2\} = \left\{x \,\middle|\, -\frac{21}{2} < x < 2\right\}$$



15. Find the solution set in set builder notation and graph.

$$10 \ge 3x-1 \ge 0$$
$$11 \ge 3x \ge 1$$
$$\frac{11}{3} \ge x \ge \frac{1}{3}$$

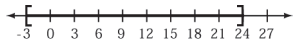
$$\left\{x \,\middle|\, \frac{1}{3} \le x \le \frac{11}{3}\right\}$$



16. Find the solution set in set builder notation and graph.

$$0 \le 2x+6 \le 54$$
$$-6 \le 2x \le 48$$
$$-3 \le x \le 24$$

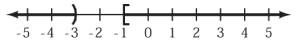
$$\{x \mid -3 \le x \le 24\}$$



17. Find the solution set in set builder notation and graph.

$$x+2 < -1 \quad \text{or} \quad x+3 \ge 2$$
$$x < -3 \quad \text{or} \quad x \ge -1$$

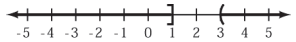
$$\{x \mid x < -3\} \cup \{x \mid x \ge -1\} = \{x \mid x < -3 \quad \text{or} \quad x \ge -1\}$$



18. Find the solution set in set builder notation and graph.

$$x+1 > 4 \quad \text{or} \quad x+2 \le 3$$
$$x > 3 \quad \text{or} \quad x \le 1$$

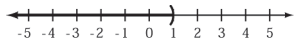
$$\{x \mid x \le 1\} \cup \{x \mid x > 3\} = \{x \mid x \le 1 \quad \text{or} \quad x > 3\}$$



19. Find the solution set in set builder notation and graph.

$$-4x+5 > 9 \quad \text{or} \quad 4x+1 < 5$$
$$-4x > 4 \quad \text{or} \quad 4x < 4$$
$$x < -1 \quad \text{or} \quad x < 1$$

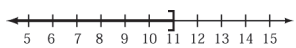
$$\{x \mid x < -1\} \cup \{x \mid x < 1\} = \{x \mid x < 1\}$$



20. Find the solution set in set builder notation and graph.

$$2x-7 \le 15 \quad \text{or} \quad 3x-1 \le 5$$
$$2x \le 22 \quad \text{or} \quad 3x \le 6$$
$$x \le 11 \quad \text{or} \quad x \le 2$$

$$\{x \mid x \le 11\} \cup \{x \mid x \le 2\} = \{x \mid x \le 11\}$$



21. Find the solution set in interval notation

$$|2x-1| > 4$$

$$2x-1 < -4 \quad \text{or} \quad 2x-1 > 4$$
$$2x < -3 \quad \text{or} \quad 2x > 5$$
$$x < -\frac{3}{2} \quad \text{or} \quad x > \frac{5}{2}$$

$$\left(-\infty, -\frac{3}{2}\right) \cup \left(\frac{5}{2}, \infty\right)$$

22. Find the solution set in interval notation

$|2x-9|<7$

$-7<2x-9<7$
$2<2x<16$
$1<x<8$

$(1, 8)$

23. Find the solution set in interval notation

$|x+3|\geq 5$

$x+3\leq -5$ or $x+3\geq 5$
$x\leq -8$ or $x\geq 2$

$(-\infty, -8]\cup[2, \infty)$

24. Find the solution set in interval notation

$|x-10|\geq 2$

$x-10\leq -2$ or $x-10\geq 2$
$x\leq 8$ or $x\geq 12$

$(-\infty, 8]\cup[12, \infty)$

25. Find the solution set in interval notation

$|3x-10|\leq 14$

$-14\leq 3x-10\leq 14$
$-4\leq 3x\leq 24$
$-\frac{4}{3}\leq x\leq 8$

$\left[-\frac{4}{3}, 8\right]$

26. Find the solution set in interval notation

$|2x-5|\geq 1$

$2x-5\leq -1$ or $2x-5\geq 1$
$2x\leq 4$ or $2x\geq 6$
$x\leq 2$ or $x\geq 3$

$(-\infty, 2]\cup[3, \infty)$

27. Find the solution set in interval notation

$|4-5x|\geq 24$

$4-5x\leq -24$ or $4-5x\geq 24$
$-5x\leq -28$ or $-5x\geq 20$
$x\geq \frac{28}{5}$ or $x\leq -4$

$(-\infty, -4]\cup\left[\frac{28}{5}, \infty\right)$

28. Find the solution set in interval notation

$|3-2x|\leq 5$

$-5\leq 3-2x\leq 5$
$-8\leq -2x\leq 2$
$4\geq x\geq -1$

$[-1, 4]$

29. Find the solution set in interval notation

$|x-5|\geq 0$ (Note: The absolute value of *any* real number is greater than or equal to 0.)

$(-\infty, \infty)$

30. Find the solution set in interval notation

$|x-7|\geq 0$ (Note: The absolute value of *any* real number is greater than or equal to 0.)

$(-\infty, \infty)$

31. Find the solution set in interval notation

$|x-4|\leq 0$

(Note: No absolute value is less than 0.)

$x-4=0$
$x=4$

$\{4\}$

32. Find the solution set in interval notation

$|2x+7|\leq 0$

(Note: No absolute value is less than 0.)

$2x+7=0$
$2x=-7$
$x=-\frac{7}{2}$

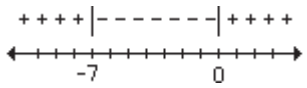
$\left\{-\frac{7}{2}\right\}$

33. Use the critical value method to solve. Write solution in interval notation.

$x^2+7x>0$
$x(x+7)>0$

The product $x(x+7)$ is positive.

$x=0$ is a critical value.
$x+7=0\Rightarrow x=-7$ is a critical value.

$x(x+7)$ 

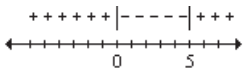
$(-\infty, -7) \cup (0, \infty)$

34. Use the critical value method to solve. Write solution in interval notation.

$x^2 - 5x \le 0$
$x(x-5) \le 0$

The product $x(x-5)$ is negative or zero.

$x = 0$ is a critical value.
$x - 5 = 0 \Rightarrow x = 5$ is a critical value.

$x(x-5)$ 

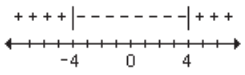
$[0, 5]$

35. Use the critical value method to solve. Write solution in interval notation.

$x^2 - 16 \le 0$
$(x-4)(x+4) \le 0$

The product $(x-4)(x+4)$ is negative or zero.

$x - 4 = 0 \Rightarrow x = 4$ is a critical value.
$x + 4 = 0 \Rightarrow x = -4$ is a critical value.

$(x-4)(x+4)$ 

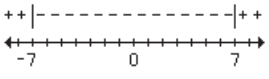
$[-4, 4]$

36. Use the critical value method to solve. Write solution in interval notation.

$x^2 - 49 > 0$
$(x-7)(x+7) > 0$

The product $(x-7)(x+7)$ is positive.

$x = 7$ is a critical value.
$x + 7 = 0 \Rightarrow x = -7$ is a critical value.

$(x-7)(x+7)$ 

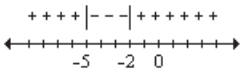
$(-\infty, -7) \cup (7, \infty)$

37. Use the critical value method to solve. Write solution in interval notation.

$x^2 + 7x + 10 < 0$
$(x+5)(x+2) < 0$

The product $(x+5)(x+2)$ is negative.

$x + 5 = 0 \Rightarrow x = -5$ is a critical value.
$x + 2 = 0 \Rightarrow x = -2$ is a critical value.

$(x+5)(x+2)$ 

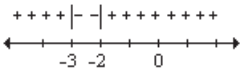
$(-5, -2)$

38. Use the critical value method to solve. Write solution in interval notation.

$x^2 + 5x + 6 < 0$
$(x+3)(x+2) < 0$

The product $(x+3)(x+2)$ is negative.

$x + 3 = 0 \Rightarrow x = -3$ is a critical value.
$x + 2 = 0 \Rightarrow x = -2$ is a critical value.

$(x+3)(x+2)$ 

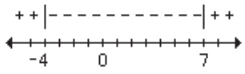
$(-3, -2)$

39. Use the critical value method to solve. Write solution in interval notation.

$x^2 - 3x \ge 28$
$x^2 - 3x - 28 \ge 0$
$(x-7)(x+4) \ge 0$

The product $(x-7)(x+4)$ is positive or zero.

$x - 7 = 0 \Rightarrow x = 7$ is a critical value.
$x + 4 = 0 \Rightarrow x = -4$ is a critical value.

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

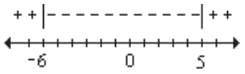
$(-\infty, -4] \cup [7, \infty)$

40. Use the critical value method to solve. Write solution in interval notation.

$$x^2 < -x + 30$$
$$x^2 + x - 30 < 0$$
$$(x+6)(x-5) < 0$$

The product $(x+6)(x-5)$ is negative.

$x+6=0 \Rightarrow x=-6$ is a critical alue.
$x-5=0 \Rightarrow x=5$ is a critical value.

$(x+6)(x-5)$ 

(–6, 5)

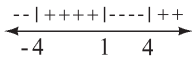
41. Use the critical value method to solve. Write solution in interval notation.

$$x^3 - x^2 - 16x + 16 < 0$$
$$x^2(x-1) - 16(x-1) < 0$$
$$(x-1)(x^2-16) < 0$$
$$(x-1)(x+4)(x-4) < 0$$

The product $(x-1)(x+4)(x-4)$ is negative.

$x-1=0 \Rightarrow x=1$ is a critical value.
$x-4=0 \Rightarrow x=4$ is a critical value.
$x+4=0 \Rightarrow x=-4$ is a critical value.

The critical values are –4, 1, and 4.

$(x-1)(x+4)(x-4)$ 

$(-\infty, -4) \cup (1, 4)$

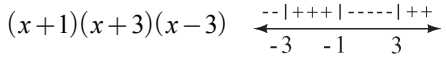
42. Use the critical value method to solve. Write solution in interval notation.

$$x^3 + x^2 - 9x - 9 > 0$$
$$x^2(x+1) - 9(x+1) > 0$$
$$(x+1)(x^2-9) > 0$$
$$(x+1)(x+3)(x-3) > 0$$

The product $(x+1)(x+3)(x-3)$ is positive.

$x+1=0 \Rightarrow x=-1$ is a critical value.
$x-3=0 \Rightarrow x=3$ is a critical value.
$x+3=0 \Rightarrow x=-3$ is a critical value.

The critical values are –3, –1, and 3.

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

$(-3,-1) \cup (3, \infty)$

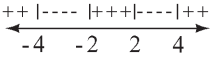
43. Use the critical value method to solve. Write solution in interval notation.

$$x^4 - 20x^2 + 64 \geq 0$$
$$(x^2-16)(x^2-4) \geq 0$$
$$(x+4)(x-4)(x+2)(x-2) \geq 0$$

The product is positive or zero.

$x+4=0 \Rightarrow x=-4$ is a critical value.
$x-4=0 \Rightarrow x=4$ is a critical value.
$x+2=0 \Rightarrow x=-2$ is a critical value.
$x-2=0 \Rightarrow x=2$ is a critical value.

The critical values are –4, –2, 2, and 4.

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

$(-\infty, -4] \cup [-2, 2] \cup [4, \infty)$

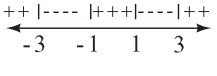
44. Use the critical value method to solve. Write solution in interval notation.

$$x^4 - 10x^2 + 9 \leq 0$$
$$(x^2-9)(x^2-1) \leq 0$$
$$(x+3)(x-3)(x+1)(x-1) \leq 0$$

The product is negative or zero.

$x+3=0 \Rightarrow x=-3$ is a critical value.
$x-3=0 \Rightarrow x=3$ is a critical value.
$x+1=0 \Rightarrow x=-1$ is a critical value.
$x-1=0 \Rightarrow x=1$ is a critical value.

The critical values are –3, –1, 1, and 3.

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

$[-3,-1] \cup [1, 3]$

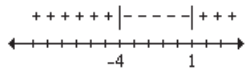
45. Use the critical value method to solve. Write solution in interval notation.

$$\frac{x+4}{x-1} < 0$$

The quotient $\frac{x+4}{x-1}$ is negative.

$x+4=0 \Rightarrow x=-4$
$x-1=0 \Rightarrow x=1$

The critical values are –4 and 1.

$\frac{x+4}{x-1}$ 

(–4, 1)

46. Use the critical value method to solve. Write solution in interval notation.

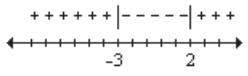
$$\frac{x-2}{x+3} > 0$$

The quotient $\frac{x-2}{x+3}$ is positive.

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

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

The critical values are 2 and –3.

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

$(-\infty, -3) \cup (2, \infty)$

47. Use the critical value method to solve. Write solution in interval notation.

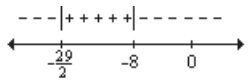
$$\frac{x-5}{x+8} \geq 3$$
$$\frac{x-5}{x+8} - 3 \geq 0$$
$$\frac{x-5-3(x+8)}{x+8} \geq 0$$
$$\frac{x-5-3x-24}{x+8} \geq 0$$
$$\frac{-2x-29}{x+8} \geq 0$$

The quotient $\frac{-2x-29}{x+8}$ is positive or zero.

$-2x-29=0 \Rightarrow x=-\frac{29}{2}$

$x+8=0 \Rightarrow x=-8$

The critical values are $-\frac{29}{2}$ and -8.

$\frac{-2x-29}{x+8}$ 

The denominator cannot equal zero $\Rightarrow x \neq -8$.

$\left[-\frac{29}{2}, -8\right)$

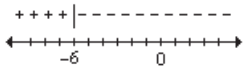
48. Use the critical value method to solve. Write solution in interval notation.

$$\frac{x-4}{x+6} \leq 1$$
$$\frac{x-4}{x+6} - 1 \leq 0$$
$$\frac{x-4-1(x+6)}{x+6} \leq 0$$
$$\frac{x-4-x-6}{x+6} \leq 0$$
$$\frac{-10}{x+6} \leq 0$$

The quotient $\frac{-10}{x+6}$ is negative or zero.

$x+6=0 \Rightarrow x=-6$

The critical value is –6.

$\frac{-10}{x+6}$ 

The denominator cannot equal zero $\Rightarrow x \neq -6$.

$(-6, \infty)$

49. Use the critical value method to solve. Write solution in interval notation.

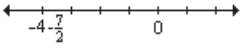
$$\frac{x}{2x+7} \geq 4$$
$$\frac{x}{2x+7} - 4 \geq 0$$
$$\frac{x-4(2x+7)}{2x+7} \geq 0$$
$$\frac{x-8x-28}{2x+7} \geq 0$$
$$\frac{-7x-28}{2x+7} \geq 0$$

The quotient $\frac{-7x-28}{2x+7}$ is positive or zero.

$-7x-28=0 \Rightarrow x=-4$

$2x+7=0 \Rightarrow x=-\frac{7}{2}$

The critical values are -4 and $-\frac{7}{2}$.

$\frac{-7x-28}{2x+7}$ 

The denominator cannot equal zero $\Rightarrow x \neq -\frac{7}{2}$.

$\left[-4, -\frac{7}{2}\right)$

50. Use the critical value method to solve. Write solution in interval notation.

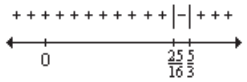
$$\frac{x}{3x-5} \le -5$$
$$\frac{x}{3x-5} + 5 \le 0$$
$$\frac{x+5(3x-5)}{3x-5} \le 0$$
$$\frac{x+15x-25}{3x-5} \le 0$$
$$\frac{16x-25}{3x-5} \le 0$$

The quotient $\frac{16x-25}{3x-5}$ is negative or zero.

$16x-25=0 \Rightarrow x=\frac{25}{16}$

$3x-5=0 \Rightarrow \ x=\frac{5}{3}$

The critical values are $\frac{25}{16}$ and $\frac{5}{3}$.

$\frac{16x-25}{3x-5}$ 

The denominator cannot equal zero $\Rightarrow x \ne \frac{5}{3}$.

$\left[\frac{25}{16}, \frac{5}{3}\right)$

51. Use the critical value method to solve. Write solution in interval notation.

$$\frac{(x+1)(x-4)}{x-2} < 0$$

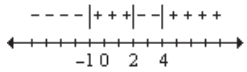
The quotient $\frac{(x+1)(x-4)}{x-2}$ is negative.

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

$x-4=0 \Rightarrow x=4$

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

The critical values are –1, 4, and 2.

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

$(-\infty, -1) \cup (2, 4)$

52. Use the critical value method to solve. Write solution in interval notation.

$$\frac{x(x-4)}{x+5} > 0$$

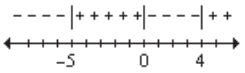
The quotient $\frac{x(x-4)}{x+5} > 0$ is positive.

$x=0$

$x-4=0 \Rightarrow x=4$

$x+5=0 \Rightarrow x=-5$

The critical values are 0, 4, and –5.

$\frac{x(x-4)}{x+5}$ 

$(-5, 0) \cup (4, \infty)$

53. Use the critical value method to solve. Write solution in interval notation.

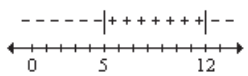
$$\frac{x+2}{x-5} \le 2$$
$$\frac{x+2}{x-5} - 2 \le 0$$
$$\frac{x+2-2(x-5)}{x-5} \le 0$$
$$\frac{x+2-2x+10}{x-5} \le 0$$
$$\frac{-x+12}{x-5} \le 0$$

The quotient $\frac{-x+12}{x-5}$ is negative or zero.

$-x+12=0 \Rightarrow x=12$

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

The critical values are 12 and 5.

$\frac{-x+12}{x-5}$ 

The denominator cannot equal zero $\Rightarrow x \ne 5$.

$(-\infty, 5) \cup [12, \infty)$

54. Use the critical value method to solve. Write solution in interval notation.

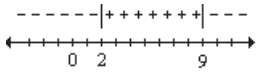
$$\frac{3x+1}{x-2} \geq 4$$
$$\frac{3x+1}{x-2} - 4 \geq 0$$
$$\frac{3x+1-4(x-2)}{x-2} \geq 0$$
$$\frac{3x+1-4x+8}{x-2} \geq 0$$
$$\frac{-x+9}{x-2} \geq 0$$

The quotient $\frac{-x+9}{x-2}$ is positive or zero.

$-x+9=0 \Rightarrow x=9$

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

The critical values are 9 and 2.

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

The denominator cannot equal zero $\Rightarrow x \neq 2$.

$(2,\ 9]$

55. Use the critical value method to solve. Write solution in interval notation.

$$\frac{6x^2-11x-10}{x} > 0$$
$$\frac{(3x+2)(2x-5)}{x} > 0$$

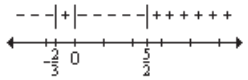
The quotient $\frac{(3x+2)(2x-5)}{x}$ is positive.

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

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

$x=0$

The critical values are $-\frac{2}{3}$, $\frac{5}{2}$, and 0.

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

$\left(-\frac{2}{3},\ 0\right)\cup\left(\frac{5}{2},\ \infty\right)$

56. Use the critical value method to solve. Write solution in interval notation.

$$\frac{3x^2-2x-8}{x-1} \geq 0$$
$$\frac{(3x+4)(x-2)}{x-1} \geq 0$$

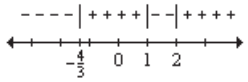
The quotient $\frac{(3x+4)(x-2)}{x-1}$ is positive or zero.

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

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

$x-1 \Rightarrow x=1$

The critical values are $-\frac{4}{3}$, 2, and 1.

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

The denominator cannot equal zero $\Rightarrow x \neq 1$.

$\left[-\frac{4}{3},\ 1\right)\cup[2,\ \infty)$

57. Use the critical value method to solve. Write solution in interval notation.

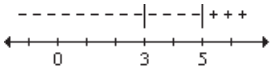
$$\frac{x^2-6x+9}{x-5} \leq 0$$
$$\frac{(x-3)(x-3)}{x-5} \leq 0$$

The quotient $\frac{(x-3)(x-3)}{x-5}$ is negative or zero.

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

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

The critical values are 3 and 5.

$\frac{(x-3)(x-3)}{x-5}$ 

The denominator cannot equal zero $\Rightarrow x \neq 5$.

$(-\infty,\ 5)$

58. Use the critical value method to solve. Write solution in interval notation.

$$\frac{x^2+10x+25}{x+1} \geq 0$$
$$\frac{(x+5)(x+5)}{x+1} \geq 0$$

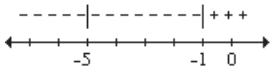
The quotient $\frac{(x+5)(x+5)}{x+1}$ is positive or zero.

$x+5=0 \Rightarrow x=-5$

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

The critical values are –5 and –1.

$\dfrac{(x+5)(x+5)}{x+1}$



The denominator cannot equal zero $\Rightarrow x \neq -1$.

$\{-5\} \cup (-1, \infty)$

59. Find the conditions to use the LowCharge plan.

LowCharge: $5 + 0.01x$

FeeSaver: $1 + 0.08x$

$5+0.01x<1+0.08x$

$4<0.07x$

$57.1<x$

LowCharge is less expensive if you use more than 57 checks.

60. Find the number of miles so that renting from Company A is cheaper.

Company A: $29 + 0.12m$

Company B: $22 + 0.21m$

$29+0.12m<22+0.21m$

$7<0.09m$

$77.8<m$

Company A is less expensive if you drive at least 78 miles.

61. Find the range of heights, h.

Let h = the height of the package.

$\text{length} + \text{girth} \le 165$

$\text{length} + 2(\text{width}) + 2(\text{height}) \le 165$

$47+2(22)+2h \le 165$

$47+44+2h \le 165$

$91+2h \le 165$

$2h \le 74$

$h \le 37$

The height must be more than 0 but less than or equal to 37 inches.

62. Find the year when attendance will be less than 1 billion people.

$-0.03x+1.59<1$

$-0.03x<-0.59$

$x>19.7$

19.7 years after 2000 is in the year 2019.

63. Find the mileage if the value is $41,000.

$41{,}000=-176.05m+50{,}520$

$-9520=-176.05m$

$m \approx 54$

The mileage is about 54,000 miles.

64. Find the corresponding temperature range.

$68 \le F \le 104$

$68 \le \frac{9}{5}\text{C}+32 \le 104$

$36 \le \frac{9}{5}\text{C} \le 72$

$\frac{5}{9}(36) \le \frac{5}{9}\left(\frac{9}{5}\text{C}\right) \le \frac{5}{9}(72)$

$20^\circ \le C \le 40^\circ$

65. Estimate the range of heights.

Solve $|h-(2.47f+54.10)| \le 3.72$ for h

where $f = 32.24$.

$|h-(2.47f+54.10)| \le 3.72$

$|h-[2.47(32.24)+54.10]| \le 3.72$

$|h-(79.6328+54.10)| \le 3.72$

$|h-133.7328| \le 3.72$

$h-133.7328 \le 3.72$ or $h-133.7328 \ge -3.72$

$h \le 137.4528$ $h \ge 130.0128$

The height, to the nearest 0.1 cm, is from 130.0 cm to 137.5 cm.

66. Estimate the range of heights.

To determine potential stature, solve

$|h-(3.32r+85.43)| \le 4.57$ for h where $r = 26.36$.

$|h-(3.32r+85.43)| \le 4.57$

$|h-[3.32(26.36)+85.43]| \le 4.57$

$|h-(87.5152+85.43)| \le 4.57$

$|h-172.9452| \le 4.57$

$h-172.9452 \le 4.57$ or $h-172.9452 \ge -4.57$

$h \le 177.5152$ $h \ge 168.3752$

The potential stature, to the nearest 0.1 cm, is from 168.4 to 177.5 cm.

67. Find the interval where monthly revenue is greater than zero.

$R = 420x - 2x^2$

$420x - 2x^2 > 0$

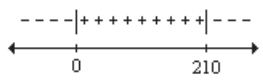
$2x(210 - x) > 0$

The product is positive.

$2x = 0 \Rightarrow x = 0$

$210 - x = 0 \Rightarrow x = 210$

Critical values are 0 and 210.

$2x(210-x)$ 

($0, $210)

68. Find the interval where monthly revenue is greater than or equal to $5925.

$R = 312x - 3x^2$

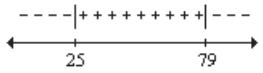
$312x - 3x^2 \geq 5925$

$-3x^2 + 312x - 5925 \geq 0$

$3(-x^2 + 104x - 1975) \geq 0$

$3(-x + 25)(x - 79) \geq 0$

Critical values are 25 and 79.

$3(-x+25)(x-79)$ 

[$25, $79]

69. Find the number of books.

$$\frac{14.25x + 350{,}000}{x} < 50$$

$$14.25x + 350{,}000 < 50x$$

$$-35.75x < -350{,}000$$

$$x > 9790.2$$

At least 9791 books must be published.

70. Find the number of pairs of running shoes.

$$\overline{C} = \frac{0.00014x^2 + 12x + 400{,}000}{x} < 30$$

$$0.00014x^2 + 12x + 400{,}000 < 30x$$

$$0.00014x^2 - 18x + 400{,}000 < 0$$

Solve $0.00014x^2 - 18x + 400{,}000 = 0$ to find the critical values.

$$x = \frac{-(-18) \pm \sqrt{(-18)^2 - 4(0.00014)(400{,}000)}}{2(0.00014)}$$

$$= \frac{18 \pm \sqrt{324 - 224}}{0.00028} = \frac{18 \pm \sqrt{100}}{0.00028} = \frac{18 \pm 10}{0.00028}$$

$$x = \frac{18+10}{0.00028} = \frac{28}{0.00028} = 100{,}000 \quad \text{or} \quad x = \frac{18-10}{0.00028} = \frac{8}{0.00028} \approx 28{,}571.4$$

The critical values are 100,000 and $\approx 28{,}571.4$.

Since x is a non-negative integer, the intervals are $(0,\ 26{,}571.4)$, $(28{,}571.4,\ 100{,}000)$, and $(100{,}000,\ \infty)$.

Test 1: $\dfrac{0.00014(1)^2 + 12(1) + 400{,}000}{1} < 30$

$400{,}012.00014 < 30$

which is false.

Test 50,000:

$$\frac{0.00014(50{,}000)^2 + 12(50{,}000) + 400{,}000}{50{,}000} < 30$$

$27 < 30$

which is true.

Test 150,000:

$$\frac{0.00014(150000)^2 + 12(150000) + 400{,}000}{150000} < 30$$

$35.\overline{6} < 30$

which is false.

The company should manufacture from 28,572 to 99,999 pairs of running shoes.

71. Find the time interval.

$s = -16t^2 + v_0 t + s_0, \quad s > 96,\ t > 0,\ v_0 = 80,\ s_0 = 32$

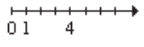
$-16t^2 + 80t + 32 > 96$

$-16t^2 + 80t - 64 > 0$

$-16(t^2 - 5t + 4) > 0$

$-16(t-1)(t-4) > 0$

The product is positive. The critical values are 1 and 4.

$(t-1)(t-4)$ 

1 second < t < 4 seconds

The ball is higher than 96 ft between 1 and 4 seconds.

72. Find the range of mean weights of women.

$$-2.33 < \frac{163-\mu}{1.79} < 2.33$$
$$-4.1707 < 163-\mu < 4.1707$$
$$-167.2 < -\mu < -158.8$$
$$167.2 > \mu > 158.8$$
$$158.8 \text{ lb} < \mu < 167.2 \text{ lb}$$

73. Find the range of mean weights of men.

$$-2.575 < \frac{190-\mu}{2.45} < 2.575$$
$$-6.30875 < 190-\mu < 6.30875$$
$$-196.30875 < -\mu < -183.69125$$
$$196.30875 > \mu > 183.69125$$
$$183.7 \text{ lb} < \mu < 196.3 \text{ lb}$$

Prepare for Section 1.6

P1. Solve.

$$1820 = k(28)$$
$$65 = k$$

P2. Solve.

$$20 = \frac{k}{1.5^2}$$
$$45 = k$$

P3. Evaluate.

$$k \cdot \frac{3}{5^2}$$
$$225 \cdot \frac{3}{5^2} = 27$$

P4. Evaluate.

$$k \cdot \frac{4.5 \cdot 32}{8^2}$$
$$12.5 \cdot \frac{4.5 \cdot 32}{8^2} = 28.125$$

P5. The area becomes 4 times as large.

P6. No. The volume becomes 9 times as large.

Section 1.6 Exercises

1. Write the equation of variation.

$d = kt$

2. Write the equation of variation.

$r = ks^2$

3. Write the equation of variation.

$y = \frac{k}{x}$

4. Write the equation of variation.

$p = \frac{k}{q}$

5. Write the equation of variation.

$m = knp$

6. Write the equation of variation.

$t = krs^3$

7. Write the equation of variation.

$V = klwh$

8. Write the equation of variation.

$u = \frac{kv}{w^2}$

9. Write the equation of variation.

$A = ks^2$

10. Write the equation of variation.

$A = khr^2$

11. Write the equation of variation.

$F = \frac{km_1m_2}{d^2}$

12. Write the equation of variation.

$T = ktra^2$

13. Write the equation and solve for k.

$$y = kx$$
$$64 = k \cdot 48$$
$$\frac{64}{48} = k$$
$$\frac{4}{3} = k$$

14. Write the equation and solve for k.

$$m = kn$$
$$92 = k \cdot 23$$
$$\frac{92}{23} = k$$
$$4 = k$$

15. Write the equation and solve for k.

$$r = kt^2$$
$$144 = k \cdot 108^2$$
$$\frac{144}{108^2} = k$$
$$\frac{2^4 \cdot 3^2}{2^4 \cdot 3^6} = k$$
$$\frac{1}{81} = k$$

16. Write the equation and solve for k.

$$C = kr$$
$$94.2 = k \cdot 15$$
$$\frac{94.2}{15} = k$$
$$6.28 = k$$

17. Write the equation and solve for k.

$$T = krs^2$$
$$210 = k \cdot 30 \cdot 5^2$$
$$\frac{210}{30 \cdot 5^2} = k$$
$$\frac{7}{25} = k$$
$$0.28 = k$$

18. Write the equation and solve for k.

$$u = \frac{kv}{\sqrt{w}}$$
$$0.04 = \frac{k \cdot 8}{\sqrt{0.04}}$$
$$\frac{0.04\sqrt{0.04}}{8} = k$$
$$\frac{(0.04))0.2)}{8} = k$$
$$0.001 = k$$

19. Write the equation and solve for k.

$$V = klwh$$
$$240 = k \cdot 8 \cdot 6 \cdot 5$$
$$\frac{240}{8 \cdot 6 \cdot 5} = k$$
$$1 = k$$

20. Write the equation and solve for k.

$$t = \frac{kr^3}{\sqrt{s}}$$
$$10 = \frac{k \cdot 5^3}{\sqrt{0.09}}$$
$$\frac{10\sqrt{0.09}}{5^3} = k$$
$$\frac{2(0.3)}{25} = k$$
$$\frac{.06}{25} = k$$
$$0.024 = k$$

21. Find the volume of the balloon.

$$V = kT$$
$$0.85 = k \cdot 270$$
$$\frac{0.85}{270} = k$$
$$\frac{0.17}{54} = k$$

Thus $V = \frac{0.17}{54}T = \frac{0.17}{54} \cdot 324 = (0.17)6 = 1.02$ liters

22. Find the length of the spring.

$$d = k \cdot w$$
$$6 = k \cdot 80$$
$$6 = k \cdot 80$$
$$\frac{6}{80} = k$$
$$\frac{3}{40} = k$$

Therefore $d = \frac{3}{40} \cdot 100 = 7.5$ inches

23. Find the number of semester hours.

$$s = k \cdot q$$
$$34 = k \cdot 51$$
$$\frac{2}{3} = k$$
$$p = \frac{2}{3} \cdot 93$$
$$p = 62 \text{ semester hours}$$

24. Find the pressure.

$$p = kd$$
$$187.5 = k \cdot 3$$
$$62.5 = k$$
$$p = 62.5 \cdot 7$$
$$p = 437.5 \text{ lb/ft}^2$$

25. Find the amount of juice. Round to the nearest tenth of a fluid ounce.

$$j = k \cdot d^3$$
$$6 = k \cdot (4)^3$$
$$\frac{3}{32} = k$$
$$p = \frac{3}{32} \cdot (5)^3$$
$$p \approx 11.7 \text{ fl oz}$$

26. Find the distance. Round to the nearest tenth of a foot.

$$r = kv^2$$
$$140 = k \cdot 60^2$$
$$\frac{140}{60^2} = k$$
$$\frac{7}{180} = k$$

Thus $r = \frac{7}{180} \cdot 65^2 \approx 164.3$ ft.

27. $T = k\sqrt{l}$
$1.8 = k\sqrt{3}$
$k = \frac{1.8}{\sqrt{3}} \approx 1.03923$

a. $T = \frac{1.8}{\sqrt{3}}\sqrt{10} = \frac{1.8\sqrt{30}}{3} = 0.6\sqrt{30} \approx 3.3$ seconds

b.
$$T = k\sqrt{l}$$
$$\frac{T}{k} = \sqrt{l}$$
$$\frac{2}{1.03923} = \sqrt{l}$$
$$l = \frac{4}{1.03923^2} \approx 3.7 \text{ ft}$$

28. Find the distance.

$$A = kd^2$$
$$64 = k \cdot 20^2$$
$$6 = k \cdot 400$$
$$\frac{64}{400} = k$$
$$\frac{4}{25} = k$$

$$100 = \frac{4}{25} \cdot d^2$$
$$625 = d^2$$
$$d = 25 \text{ ft}$$

29. Find the speed of the gear with 48 teeth.

$$r = \frac{k}{t}$$
$$30 = \frac{k}{64}$$
$$1920 = k$$
$$r = \frac{1920}{48}$$
$$r = 40 \text{ revolutions per minute}$$

30. Find the frequency of the 18-inch guitar string.

$$f = \frac{k}{l}$$
$$144 = \frac{k}{20}$$
$$2880 = k$$
$$f = \frac{2880}{18}$$
$$f = 160 \text{ vibrations per second}$$

31. Find the sound intensity.

$$I = \frac{k}{d^2}$$
$$0.5 = \frac{k}{7^2}$$
$$24.5 = k$$
$$I = \frac{24.5}{d^2}$$
$$I = \frac{24.5}{10^2}$$
$$I = 0.245 \text{ W/m}^2$$

32. Find the illumination. Round to the nearest tenth of a footcandle.

$$l = \frac{k}{d^2}$$
$$50 = \frac{k}{10^2}$$
$$5000 = k$$
Thus $I = \frac{5000}{d^2}$
$$I = \frac{5000}{15^2} = \frac{5000}{225}$$
$$I \approx 22.2 \text{ footcandles}$$

33. a. $V = kr^2h$

$$V_1 = k(3r)^2 h$$
$$= 9(kr^2h)$$
$$= 9V$$

Thus the new volume is 9 times the original volume.

b. $V_2 = kr^2(3h)$

$$= 3(kr^2h)$$
$$= 3V$$

Thus the new volume is 3 times the original volume.

c. $V_3 = k(3r)^2(3h)$

$$= k9r^2 \cdot 3 \cdot h$$
$$= 27(kr^2h)$$
$$= 27V$$

Thus the new volume is 27 times the original volume.

34. Find the weight the beam can support. Round to the nearest pound.

$$L = kwd^2$$
$$200 = k \cdot 2 \cdot 6^2$$
$$\frac{200}{2 \cdot 6^2} = k$$
$$\frac{25}{9} = k$$

$$\text{Thus L} = \frac{25}{9} \cdot 4 \cdot 4^2$$
$$= \frac{1600}{9}$$
$$\approx 178 \text{ lb}$$

35. Find what happens to the volume.

$$V = \frac{knT}{P}$$
$$V_1 = \frac{k(3n)T}{\left(\frac{1}{2}p\right)}$$
$$= 6\left(\frac{knT}{p}\right)$$
$$= 6V$$

Thus the new volume is 6 times larger than the original volume.

36. Find the weight the 14 ft column can support.

$$L = \frac{k \cdot d^4}{h^2}$$
$$6 = \frac{k \cdot 2^4}{10^2}$$
$$\frac{6 \cdot 10^2}{2^4} = k$$
$$\frac{600}{16} = 37.5 = k$$

$$\text{Thus L} = \frac{37.5 \cdot 3^4}{14^2} \approx 15.5 \text{ tons}$$

37. a. Find the variation constant.

For Kershaw,

$$\text{ERA} = \frac{kr}{i}$$
$$2.28 = \frac{k(59)}{(233.1)}$$
$$9.0 = k$$

b. Find Wilson's ERA.

$$\text{ERA} = \frac{9(73)}{(223.1)} = 2.94$$

38. Find the weight the 16-foot beam can support. Round to the nearest pound.

$$L = \frac{kwd^2}{l}$$
$$800 = \frac{k \cdot 4 \cdot 8^2}{12}$$
$$\frac{800 \cdot 12}{4 \cdot 8^2} = k$$
$$37.5 = k$$

$$\text{Thus L} = \frac{37.5(3.5)(6)^2}{16} \approx 295 \text{ pounds}$$

39. Find the force. Round to the nearest 10 lb.

$$F = \frac{kws^2}{r}$$
$$2800 = \frac{k \cdot 1800 \cdot 45^2}{425}$$
$$\frac{2800 \cdot 425}{1800 \cdot 45^2} = k$$
$$\frac{14 \cdot 425}{9 \cdot 45^2} = k$$
$$0.3264746 \approx k$$

$$\text{Thus F} = \frac{(0.3264746) \cdot 1800 \cdot 55^2}{450} \approx 3950 \text{ pounds}$$

40. Find the depth.

$$S = kwd^3$$

when $d = 10,\ w = \sqrt{18^2 - 10^2} \approx 15$

$$S \approx k(15)(10)^3 = 15{,}000k$$

$d = 12,\ w = \sqrt{18^2 - 12^2} \approx 13.4$

$$S \approx k(13.4)(12)^3 = 23{,}155k$$

$d = 14,\ w = \sqrt{18^2 - 14^2} \approx 11.3$

$$S \approx k(11.3)(14)^3 = 31{,}007k$$

$d = 16,\ w = \sqrt{18^2 - 16^2} \approx 8.2$

$$S \approx k(8.2)(16)^3 = 33{,}587k$$

The strongest beam occurs when $d = 16$ inches.

41. Find the distance. Round to the nearest million miles.

$$t = kd^{3/2}$$

$$365 = k \cdot 93^{3/2}$$

$$\frac{365}{93^{3/2}} = k$$

Thus $\quad 686 = \dfrac{365}{93^{3/2}} \cdot d^{3/2}$

$$\frac{686 \cdot 93^{3/2}}{365} = d^{3/2}$$

$$\left(\frac{686 \cdot 93^{3/2}}{365}\right)^{2/3} = d$$

$$93\left(\frac{686}{365}\right)^{2/3} = d$$

142 million miles $\approx d$

42. Find the force. Round to the nearest tenth.

$$F = k\frac{m_1 m_2}{r^2}$$

$$9.8 = k\frac{(6\times10^{24})(1)}{(6400)^2}$$

$$\frac{(9.8)(6400)^2}{6\times10^{24}} = k$$

$$6.69\times10^{-17} \approx k$$

Thus $\quad F = (6.69\times10^{-17})\dfrac{(6\times10^{24})(1)}{(7200)^2}$

$F \approx 7.7$ Newtons

Chapter 1 Review Exercises

1. Solve. [1.1]

$$4 - 5x = 3x + 14$$
$$-8x = 10$$
$$x = -\frac{5}{4}$$

2. Solve. [1.1]

$$7 - 5(1 - 2x) = 3(2x + 1)$$
$$7 - 5 + 10x = 6x + 3$$
$$10x + 2 = 6x + 3$$
$$4x = 1$$
$$x = \frac{1}{4}$$

3. Solve. [1.1]

$$\frac{4x}{3} - \frac{4x-1}{6} = \frac{1}{2}$$
$$6\left(\frac{4x}{3} - \frac{4x-1}{6}\right) = 6\left(\frac{1}{2}\right)$$
$$2(4x) - (4x - 1) = 3$$
$$8x - 4x + 1 = 3$$
$$4x + 1 = 3$$
$$4x = 2$$
$$x = \frac{1}{2}$$

4. Solve. [1.1]

$$\frac{3x}{4} - \frac{2x-1}{8} = \frac{3}{2}$$
$$8\left(\frac{3x}{4} - \frac{2x-1}{8}\right) = 8\left(\frac{3}{2}\right)$$
$$2(3x) - (2x - 1) = 4(3)$$
$$6x - 2x + 1 = 12$$
$$4x + 1 = 12$$
$$4x = 11$$
$$x = \frac{11}{4}$$

5. Solve. [1.1]

$$|x - 3| = 2$$

$x - 3 = 2$ or $x - 3 = -2$

$x = 5$ $\qquad$ $x = 1$

6. Solve. [1.1]

$$|x+5|=4$$

$$x+5=4 \quad \text{or} \quad x+5=-4$$
$$x=-1 \qquad\qquad x=-9$$

7. Solve. [1.1]

$$|2x+1|=5$$

$$2x+1=5 \quad \text{or} \quad 2x+1=-5$$
$$2x=4 \qquad\qquad 2x=-6$$
$$x=2 \qquad\qquad x=-3$$

8. Solve. [1.1]

$$|3x-7|=8$$

$$3x-7=8 \quad \text{or} \quad 3x-7=-8$$
$$3x=15 \qquad\qquad 3x=-1$$
$$x=5 \qquad\qquad x=-\frac{1}{3}$$

9. Solve. [1.2]

$$V=\pi r^2 h$$
$$\frac{V}{\pi r^2}=h$$

10. Solve. [1.2]

$$P=\frac{A}{1+rt}$$
$$P(1+rt)=A$$
$$P+Prt=A$$
$$Prt=A-P$$
$$t=\frac{A-P}{Pr}$$

11. Solve. [1.2]

$$A=\frac{h}{2}(b_1+b_2)$$
$$2A=h(b_1+b_2)$$
$$2A=hb_1+hb_2$$
$$2A-hb_2=hb_1$$
$$\frac{2A-hb_2}{h}=b_1$$

12. Solve. [1.2]

$$P=2(l+w)$$
$$P=2l+2w$$
$$P-2l=2w$$
$$\frac{P-2l}{2}=w$$

13. Solve. [1.3]

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

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

14. Solve. [1.3]

$$6x^2+x-12=0$$
$$(3x-4)(2x+3)=0$$

$$3x-4=0 \quad \text{or} \quad 2x+3=0$$
$$3x=4 \qquad\qquad 2x=-3$$
$$x=\frac{4}{3} \qquad\qquad x=-\frac{3}{2}$$

15. Solve. [1.3]

$$(x-2)^2=50$$
$$x-2=\pm\sqrt{50}$$
$$x=2\pm 5\sqrt{2}$$

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

16. Solve. [1.3]

$$2(x+4)^2+18=0$$
$$2(x+4)^2=-18$$
$$(x+4)^2=-9$$
$$x+4=\pm\sqrt{-9}$$
$$x=-4\pm 3i$$

$$x=-4+3i \text{ or } x=-4-3i$$

17. Solve. [1.3]

$$x^2-6x-1=0$$
$$x^2-6x=1$$
$$x^2-6x+9=1+9$$
$$(x-3)^2=10$$
$$x-3=\pm\sqrt{10}$$
$$x=3\pm\sqrt{10}$$

$$x=3+\sqrt{10} \text{ or } x=3-\sqrt{10}$$

18. Solve. [1.3]

$$4x^2-4x-1=0$$
$$4x^2-4x=1$$
$$x^2-x=\frac{1}{4}$$
$$x^2-x+\frac{1}{4}=\frac{1}{4}+\frac{1}{4}$$
$$\left(x-\frac{1}{2}\right)^2=\frac{1}{2}$$
$$x-\frac{1}{2}=\pm\sqrt{\frac{1}{2}}$$
$$x=\frac{1}{2}\pm\frac{1}{\sqrt{2}}\cdot\frac{\sqrt{2}}{\sqrt{2}}$$
$$x=\frac{1}{2}\pm\frac{\sqrt{2}}{2} \text{ or } \frac{1\pm\sqrt{2}}{2}$$

$x=\frac{1+\sqrt{2}}{2}$ or $x=\frac{1-\sqrt{2}}{2}$

19. Solve. [1.3]

$3x^2-x-1=0$ Use the quadratic formula.

$$x=\frac{-(-1)\pm\sqrt{(-1)^2-4(3)(-1)}}{2(3)}$$
$$x=\frac{1\pm\sqrt{13}}{6}$$
$$x=\frac{1+\sqrt{13}}{6} \quad \text{or} \quad x=\frac{1-\sqrt{13}}{6}$$

20. Solve. [1.3]

$x^2-x+1=0$ Use the quadratic formula.

$$x=\frac{-(-1)\pm\sqrt{(-1)^2-4(1)(1)}}{2(1)}$$
$$x=\frac{1\pm\sqrt{-3}}{2}=\frac{1\pm i\sqrt{3}}{2}$$
$$x=\frac{1}{2}+\frac{\sqrt{3}}{2}i \quad \text{or} \quad x=\frac{1}{2}-\frac{\sqrt{3}}{2}i$$

21. Determine whether the equations has real or complex solutions. [1.3]

$$2x^2+4x=5$$
$$2x^2+4x-5=0$$
$$b^2-4ac=(4)^2-4(2)(-5)$$
$$=16+40=56>0$$

There are two real number solutions.

22. Determine whether the equations has real or complex solutions. [1.3]

$$x^2+4x+7=0$$
$$b^2-4ac=(4)^2-4(1)(7)$$
$$=16-28=-12<0$$

There are nonreal complex number solutions.

23. Solve the equation. [1.4]

$$3x^3-5x^2=0$$
$$x^2(3x-5)=0$$
$$x^2=0\Rightarrow x=0$$
$$3x-5=0\Rightarrow x=\frac{5}{3}$$

$x=0$ or $x=\frac{5}{3}$

24. Solve the equation. [1.4]

$$2x^3-8x=0$$
$$2x(x^2-4)=0$$
$$2x(x-2)(x+2)=0$$

$x=0,\ x=2,$ or $x=-2$

25. Solve the equation. [1.4]

$$2x^3+3x^2-8x-12=0$$
$$x^2(2x+3)-4(2x+3)=0$$
$$(2x+3)(x^2-4)=0$$
$$(2x+3)(x+2)(x-2)=0$$

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

26. Solve the equation. [1.4]

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

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

27. Solve the equation. [1.4]

$$\frac{x}{x+2}+\frac{1}{4}=5$$
$$4(x+2)\left(\frac{x}{x+2}+\frac{1}{4}\right)=5(4)(x+2)$$
$$4x+x+2=20(x+2)$$
$$5x+2=20x+40$$
$$-15x=38$$
$$x=-\frac{38}{15}$$

28. Solve the equation. [1.4]

$$\frac{y-1}{y+1}-1=\frac{2}{y}$$
$$y(y+1)\left(\frac{y-1}{y+1}-1\right)=y(y+1)\left(\frac{2}{y}\right)$$
$$y(y-1)-y(y+1)=2(y+1)$$
$$y^2-y-y^2-y=2y+2$$
$$-4y=2$$
$$y=-\frac{1}{2}$$

29. Solve the equation. [1.4]

$$3x+\frac{2}{x-2}=\frac{4x-1}{x-2}$$
$$(x-2)\left(3x+\frac{2}{x-2}\right)=(x-2)\left(\frac{4x-1}{x-2}\right)$$
$$3x(x-2)+2=4x-1$$
$$3x^2-6x+2=4x-1$$
$$3x^2-10x+3=0$$
$$(3x-1)(x-3)=0$$
$$3x-1=0 \quad \text{or} \quad x-3=0$$
$$x=\frac{1}{3} \qquad x=3$$

30. Solve the equation. [1.4]

$$\frac{x+1}{x+3}+\frac{2x-1}{x-2}=\frac{3x+5}{x+3}$$
$$(x+3)(x-2)\left(\frac{x+1}{x+3}+\frac{2x-1}{x-2}\right)=(x+3)(x-2)\left(\frac{3x+5}{x+3}\right)$$
$$(x-2)(x+1)+(x+3)(2x-1)=(x-2)(3x+5)$$
$$x^2-x-2+2x^2+5x-3=3x^2-x-10$$
$$3x^2+4x-5=3x^2-x-10$$
$$5x=-5$$
$$x=-1$$

31. Solve the equation. [1.4]

$$\sqrt{2x+6}-1=3$$
$$\sqrt{2x+6}=4$$
$$\left(\sqrt{2x+6}\right)^2=4^2$$
$$2x+6=16$$
$$2x=10$$
$$x=5$$

Check $\sqrt{2(5)+6}-1=3$

$$\sqrt{16}-1=3$$
$$4-1=3$$
$$3=3$$

5 checks as a solution.

32. Solve the equation. [1.4]

$$\sqrt{5x-1}+3=1$$
$$\sqrt{5x-1}=-2$$

There is no solution.

33. Solve the equation. [1.4]

$$\sqrt{-2x-7}+2x=-7$$
$$\sqrt{-2x-7}=-2x-7$$
$$\left(\sqrt{-2x-7}\right)^2=(-2x-7)^2$$
$$-2x-7=4x^2+28x+49$$
$$0=4x^2+30x+56$$
$$0=2\left(2x^2+15x+28\right)$$
$$0=2(2x+7)(x+4)$$

$x=-\frac{7}{2}$ or $x=-4$

Check $\sqrt{-2\left(-\frac{7}{2}\right)-7}+2\left(-\frac{7}{2}\right)=-7$

$$\sqrt{7-7}-7=-7$$
$$-7=-7$$
$$\sqrt{-2(-4)-7}+2(-4)=-7$$
$$\sqrt{8-7}-8=-7$$
$$1-8=-7$$
$$-7=-7$$

$-\frac{7}{2}$ and –4 check as solutions.

34. Solve the equation. [1.4]

$$\sqrt{-8x-2}+4x=-1$$
$$\sqrt{-8x-2}=-4x-1$$
$$\left(\sqrt{-8x-2}\right)^2=(-4x-1)^2$$
$$-8x-2=16x^2+8x+1$$
$$0=16x^2+16x+3$$
$$0=(4x+3)(4x+1)$$

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

Check $\sqrt{-8\left(-\frac{3}{4}\right)-2}+4\left(-\frac{3}{4}\right)=-1$

$$\sqrt{6-2}-3=-1$$
$$\sqrt{4}-3=-1$$
$$2-3=-1$$
$$-1=-1$$

$$\sqrt{-8\left(-\frac{1}{4}\right)-2}+4\left(-\frac{1}{4}\right)=-1$$
$$\sqrt{2-2}-1=-1$$
$$-1=-1$$

$-\frac{3}{4}$ and $-\frac{1}{4}$ check as solutions.

35. Solve the equation. [1.4]

$$\sqrt{3x+4}+\sqrt{x-3}=5$$
$$\sqrt{3x+4}=5-\sqrt{x-3}$$
$$\left[\sqrt{3x+4}\right]^2=\left[5-\sqrt{x-3}\right]^2$$
$$3x+4=25-10\sqrt{x-3}+x-3$$
$$2x-18=-10\sqrt{x-3}$$
$$x-9=-5\sqrt{x-3}$$
$$(x-9)^2=\left[-5\sqrt{x-3}\right]^2$$
$$x^2-18x+81=25(x-3)$$
$$x^2-18x+81=25x-75$$
$$x^2-43x+156=0$$
$$(x-4)(x-39)=0$$

$x=4$ or $x=39$

Check $\sqrt{3(4)+4}+\sqrt{4-3}=5$

$$\sqrt{16}+\sqrt{1}=5$$
$$4+1=5$$
$$5=5$$

$\sqrt{3(39)+4}+\sqrt{39-3}=5$

$$\sqrt{121}+\sqrt{36}=5$$
$$11+6=5$$
$$17=5 \text{ (No)}$$

The solution is 4.

36. Solve the equation. [1.4]

$$\sqrt{2x+2}-\sqrt{x+2}=1$$
$$\sqrt{2x+2}=\sqrt{x+2}+1$$
$$\left(\sqrt{2x+2}\right)^2=\left(\sqrt{x+2}+1\right)^2$$
$$2x+2=x+2+2\sqrt{x+2}+1$$
$$x-1=2\sqrt{x+2}$$
$$(x-1)^2=\left(2\sqrt{x+2}\right)^2$$
$$x^2-2x+1=4(x+2)$$
$$x^2-2x+1=4x+8$$
$$x^2-6x-7=0$$
$$(x+1)(x-7)=0$$

$x=-1$ or $x=7$

Check $\sqrt{2(-1)+2}-\sqrt{-1+2}=1$

$$\sqrt{0}-\sqrt{1}=1$$
$$-1=1 \text{ (No)}$$

$\sqrt{2(7)+2}-\sqrt{7+2}=1$

$$\sqrt{16}-\sqrt{9}=1$$
$$4-3=1$$
$$1=1$$

7 checks as a solution.

37. Solve the equation. [1.4]

$$x^{5/4}-32=0$$
$$x^{5/4}=32$$
$$\left(x^{5/4}\right)^{4/5}=(32)^{4/5}$$
$$x=16$$

38. Solve the equation. [1.4]

$$2x^{2/3} - 5 = 13$$
$$2x^{2/3} = 18$$
$$x^{2/3} = 9$$
$$\left(x^{2/3}\right)^{3/2} = \pm 9^{3/2}$$
$$x = \pm 27$$

The solutions are –27 and 27.

39. Solve the equation. [1.4]

$$6x^4 - 23x^2 + 20 = 0$$

Let $u = x^2$.

$$6u^2 - 23u + 20 = 0$$
$$(3u - 4)(2u - 5) = 0$$

$$a = \frac{4}{3} \quad \text{or} \quad u = \frac{5}{2}$$
$$x^2 = \frac{4}{3} \qquad x^2 = \frac{5}{2}$$
$$x = \pm\sqrt{\frac{4}{3}} \qquad x = \pm\sqrt{\frac{5}{2}}$$
$$x = \pm\frac{2}{\sqrt{3}}\left(\frac{\sqrt{3}}{\sqrt{3}}\right) \qquad x = \pm\frac{\sqrt{5}}{\sqrt{2}}\left(\frac{\sqrt{2}}{\sqrt{2}}\right)$$
$$x = \pm\frac{2\sqrt{3}}{3} \qquad x = \pm\frac{\sqrt{10}}{2}$$

40. Solve the equation. [1.4]

$$3x + 16\sqrt{x} - 12 = 0$$

Let $u = \sqrt{x}$.

$$3u^2 + 16u - 12 = 0$$
$$(3u - 2)(u + 6) = 0$$

$$u = \frac{2}{3} \quad \text{or} \quad u = -6$$
$$\sqrt{x} = \frac{2}{3} \qquad \sqrt{x} = -6$$
$$x = \frac{4}{9} \qquad \text{No solution.}$$

Thus, $x = \frac{4}{9}$.

41. Solve and write the solution in interval notation. [1.5]

$$-3x + 4 \geq -2$$
$$-3x \geq -2 - 4$$
$$-3x \geq -6$$
$$x \leq 2$$

$(-\infty,\ 2]$

42. Solve and write the solution in interval notation. [1.5]

$$-2x + 7 \leq 5x + 1$$
$$-7x \leq -6$$
$$x \geq \frac{6}{7}$$

$\left[\frac{6}{7},\ \infty\right)$

43. Solve and write the solution in interval notation. [1.5]

$$3x + 1 > 7 \quad \text{or} \quad 3x + 2 < -7$$
$$3x > 6 \qquad\qquad 3x < -9$$
$$x > 2 \qquad\qquad x < -3$$

$(-\infty, -3) \cup (2,\ \infty)$

44. Solve and write the solution in interval notation. [1.5]

$$5x - 4 \leq 6 \quad \text{and} \quad 4x + 1 > -7$$
$$5x \leq 10 \quad \text{and} \quad 4x > -8$$
$$x \leq 2 \quad \text{and} \quad x > -2$$

$(-2,\ 2]$

45. Solve and write the solution in interval notation. [1.5]

$$61 \leq \frac{9}{5}C + 32 \leq 95$$
$$29 \leq \frac{9}{5}C \leq 63$$
$$\frac{145}{9} \leq C \leq 35$$

$\left[\frac{145}{9},\ 35\right]$

46. Solve and write the solution in interval notation. [1.5]

$$30 < \frac{5}{9}(F - 32) < 65$$
$$54 < F - 32 < 117$$
$$86 < F < 149$$

(86, 149)

47. Solve and write the solution in interval notation. [1.5]

$$|3x - 4| < 2$$
$$-2 < 3x - 4 < 2$$
$$2 < 3x < 6$$
$$\frac{2}{3} < x < 2$$

$\left(\frac{2}{3},\ 2\right)$

48. Solve and write the solution in interval notation. [1.5]

$|2x-3|\geq 1$

$2x-3\geq 1$ or $2x-3\leq -1$

$2x\geq 4$ $\quad$ $2x\leq 2$

$x\geq 2$ $\quad$ $x\leq 1$

$(-\infty,\ 1]\cup[2,\ \infty)$

49. Solve and write the solution in interval notation. [1.5]

$0<|x-2|<1$

If $x-2\geq 0$, then $2<\ x\ <3$.

If $x-2<0$, then $0<x-2<-1$

$2>\ x\ >1$.

$(1,\ 2)\cup(2,\ 3)$

50. Solve and write the solution in interval notation. [1.5]

$0<|x-a|<b$

If $x-a>0$, then $a<\ x\ <a+b$.

If $x-a<0$, then $0<x-a<-b$

$a>\ x\ >a-b$.

$(a-b,\ a)\cup(a,\ a+b)$

51. Solve and write the solution in interval notation. [1.5]

$x^2+x-6\geq 0$

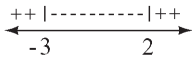
$(x+3)(x-2)\geq 0$

The product is positive or zero.

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

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

Critical values are –3 and 2.

$(x+3)(x-2)$ $\quad$ 

$(-\infty,-3]\cup[2,\ \infty)$

52. Solve and write the solution in interval notation. [1.5]

$x^3+2x^2-16x-32<0$

$x^2(x+2)-16(x+2)<0$

$(x+2)(x^2-16)<0$

$(x+2)(x+4)(x-4)<0$

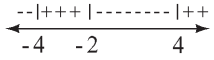
The product is negative.

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

$x+4=0\Rightarrow x=-4$

$x-4=0\Rightarrow x=4$

Critical values are –4, –2 and 4.

$(x+2)(x+4)(x-4)$ $\quad$ 

$(-\infty,-4)\cup(-2,\ 4)$

53. Solve and write the solution in interval notation. [1.5]

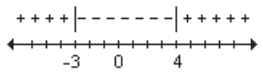
$\dfrac{x+3}{x-4}>0$

The quotient is positive.

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

$x-4=0\Rightarrow x=4$

The critical values are –3 and 4.

$\dfrac{x+3}{x-4}$ $\quad$ 

$(-\infty,\ -3)\cup(4,\ \infty)$

54. Solve and write the solution in interval notation. [1.5]

$\dfrac{x(x-5)}{x+7}\leq 0$

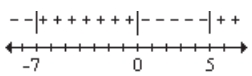
The quotient is negative or zero.

$x=0$

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

$x+7=0\Rightarrow x=-7$

The critical values are 0, 5 and -7.

$\dfrac{x(x-5)}{x+7}$ $\quad$ 

Denominator $\neq 0\Rightarrow x\neq -7$.

$(-\infty,\ -7)\cup[0,\ 5]$

55. Solve and write the solution in interval notation. [1.5]

$\dfrac{2x}{3-x}\leq 10$

$\dfrac{2x}{3-x}-10\leq 0$

$\dfrac{2x-10(3-x)}{3-x}\leq 0$

$\dfrac{2x-30+10x}{3-x}\leq 0$

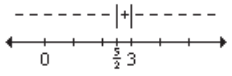
$\dfrac{12x-30}{3-x}\leq 0$

The quotient is negative or zero.

$12x-30=0 \Rightarrow x=\frac{5}{2}$

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

The critical values are $\frac{5}{2}$ and 3.

$\frac{12x-30}{3-x}$ 

Denominator $\neq 0 \Rightarrow x \neq 3$.

$\left(-\infty, \frac{5}{2}\right] \cup (3, \infty)$

56. Solve and write the solution in interval notation. [1.5]

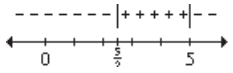
$$\frac{x}{5-x} \geq 1$$
$$\frac{x}{5-x}-1 \geq 0$$
$$\frac{x-(5-x)}{5-x} \geq 0$$
$$\frac{x-5+x}{5-x} \geq 0$$
$$\frac{2x-5}{5-x} \geq 0$$

The quotient is positive or zero.

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

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

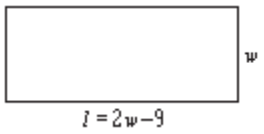
The critical values are $\frac{5}{2}$ and 5.

$\frac{2x-5}{5-x}$ 

Denominator $\neq 0 \Rightarrow x \neq 5$.

$\left[\frac{5}{2}, 5\right)$

57. Find the width and length. [1.2]



$P=54$

$54=2l+2w$

$54=2(2w-9)+2w$

$54=4w-18+2w$

$72=6w$

$12=w$

$2w-9=2(12)-9=24-9=15$

width = 12 ft, length = 15 ft

58. Find the length and width. [1.2]

$P=40$

$A=96$

$40=2l+2w$

$20=l+w$

$l=20-w$

$96=lw$

$96=(20-w)w$

$96=20w-w^2$

$w^2-20w+96=0$

$(w-12)(w-8)=0$

$w=12$ or $w=8$

$l=20-12$ or $l=20-8$

$l=8$ $l=12$

Length = 8 in. and width = 12 in.,

or length = 12 in. and width = 8 in.

59. Find the height of the tree. [1.2]

$\frac{h}{15}=\frac{9}{6}$

$h=22.5$ ft

60. Find the length of the person's shadow. [1.2]

$\frac{x}{5.5}=\frac{12+x}{22}$

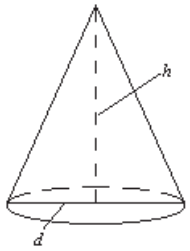
$22x=5.5(12+x)$

$22x=66+5.5x$

$16.5x=66$

$x=4$ ft

61. Find the diameter. Round to the nearest foot. [1.2]



$h=\frac{1}{4}d$

$V=144$

$d=2r$

$r=\frac{d}{2}$

$$V = \frac{1}{3}\pi r^2 h$$
$$144 = \frac{1}{3}\pi\left(\frac{d}{2}\right)^2\left(\frac{1}{4}d\right)$$
$$144 = \frac{\pi d^3}{48}$$
$$\frac{144(48)}{\pi} = d^3$$
$$d \approx 13 \text{ ft}$$

62. Find the price of the calculator and battery. [1.2]

Let x = price of battery.

$x + 20$ = price of calculator

$$x + x + 20 = 21$$
$$2x + 20 = 21$$
$$2x = 1$$
$$x = 0.50$$
$$x + 20 = 20.50$$

Price of calculator is \$20.50.

Price of battery is \$0.50.

63. Find the monthly maintenance cost. [1.2]

Let x = monthly maintenance cost per owner

$$18x = 24(x - 12)$$
$$18x = 24x - 288$$
$$-6x = -288$$
$$x = 48$$
$$18x = 864$$

The total monthly maintenance cost is \$864.

64. Find the amount of each investment. [1.2]

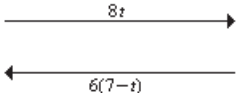
4%	x
6%	$5500 - x$

$$0.04x + 0.06(5500 - x) = 295$$
$$0.04x + 330 - 0.06x = 295$$
$$-0.02x = -35$$
$$x = 1750$$
$$5500 - 1750 = 3750$$

\$1750 in the 4% account

\$3750 in the 6% account

65. Find the distance. [1.2]



$$d = rt$$
$$d = 8t \qquad d = 6(7 - t)$$
$$6(7 - t) = 8t$$
$$42 - 6t = 8t$$
$$42 = 14t$$
$$3 = t$$

$d = 8(3) = 24$ nautical miles

66. Find the speed of each runner. [1.4]

Let x = the rate for Olivia.

$$\frac{5}{x} = \frac{5}{x+2} + \frac{25}{60}$$
$$12x(x+2)\left(\frac{5}{x}\right) = 12x(x+2)\left(\frac{5}{x+2} + \frac{5}{12}\right)$$
$$60(x+2) = 60x + 5x(x+2)$$
$$60x + 120 = 60x + 5x^2 + 10x$$
$$0 = 5x^2 + 10x - 120$$
$$0 = 5(x^2 + 2x - 24)$$
$$0 = 5(x+6)(x-4)$$

$x = -6$ (No) or $x = 4$

$x = 4$ mph for Olivia

$x + 2 = 4 + 2 = 6$ mph for Inez

67. Find the amount of each solution. [1.2]

5%	x
11%	$600 - x$
7%	600

$$0.05x + 0.11(600 - x) = 0.07(600)$$
$$0.05x + 66 - 0.11x = 42$$
$$-0.06x = -24$$
$$x = 400 \text{ ml of } 5\%$$
$$600 - x = 200 \text{ ml of } 11\%$$

68. Find the amount of pure water. [1.2]

0%	x
5%	40
2%	$x + 40$

$$0.05(40) = 0.02(x + 40)$$
$$2 = 0.02x + 0.8$$
$$1.2 = 0.02x$$
$$60 = x$$

60 ml of pure water

69. Find the amount of gold alloy. [1.2]

\$460	x
\$220	25
\$310	$x+25$

$$460x+220(25)=310(x+25)$$
$$460x+5500=310x+7750$$
$$150x=2250$$
$$x=15 \text{ oz}$$

70. Find the amount of each. [1.2]

2.50	x
4.50	$20-x$
3.25	20

$$2.50x+4.50(20-x)=3.25(20)$$
$$2.50x+90-4.50x=65$$
$$-2x=-25$$
$$x=12.5 \text{ lb of raisins}$$
$$20-x=7.5 \text{ lb of nuts}$$

71. Find the time it would take the apprentice, working alone. [1.4]

Let x = time for apprentice

$x-9$ = time for mason

$\frac{1}{x}$ = rate for apprentice

$\frac{1}{x-9}$ = rate for mason

$$6\left(\frac{1}{x}+\frac{1}{x-9}\right)=1$$
$$6x(x-9)\left(\frac{1}{x}+\frac{1}{x-9}\right)=1x(x-9)$$
$$6(x-9)+6x=x^2-9x$$
$$6x-54+6x=x^2-9x$$
$$0=x^2-21x+54$$
$$0=(x-18)(x-3)$$
$$x=18 \quad \text{or} \quad x=3$$

Note: $x=3 \Rightarrow$ mason's time $=-6$ hours. Thus $x \neq 3$.

Apprentice takes 18 hours to build the wall.

72. Find the time for the faster computer. [1.3]

Let x = time for faster computer

$x+5$ = time for slower computer

$\frac{1}{x}$ = rate for faster computer

$\frac{1}{x+5}$ = rate for slower computer

$$6\left(\frac{1}{x}+\frac{1}{x+5}\right)=1$$
$$6x(x+5)\left(\frac{1}{x}+\frac{1}{x+5}\right)=1x(x+5)$$
$$6(x+5)+6x=x^2+5x$$
$$6x+30+6x=x^2+5x$$
$$0=x^2-7x-30$$
$$0=(x+3)(x-10)$$
$$x=-3 \text{ (No)} \text{ or } x=10$$

The faster computer takes 10 minutes.

73. Find the distance of AX. [1.3]

Let x = the distance of AX.

$$\sqrt{60^2+x^2}=\sqrt{40^2+(100-x)^2}$$
$$\left(\sqrt{60^2+x^2}\right)^2=\left(\sqrt{40^2+(100-x)^2}\right)^2$$
$$3600+x^2=1600+10{,}000-200x+x^2$$
$$200x=8000$$
$$x=40$$

The distance AX is 40 yards.

74. Find the dimensions. [1.3]

Let x = the length of the side.

$$8(x-16)^2=80{,}000$$
$$(x-16)^2=10{,}000$$
$$x-16=\pm\sqrt{10{,}000}$$
$$x-16=\pm 100$$
$$x=16\pm 100$$
$$x=116 \text{ or } x=-84 \text{ (No)}$$

The box is 116 by 116 cm.

75. Find the time. [1.3]

$$5=-4.9t^2+7.5t+10$$
$$0=-4.9t^2+7.5t+5$$
$$t=\frac{-7.5\pm\sqrt{(7.5)^2-4(-4.9)(5)}}{2(-4.9)}$$
$$t=\frac{-7.5\pm\sqrt{154.25}}{-9.8}$$
$$t\approx 2.0 \quad \text{or} \quad t\approx -0.5 \text{ (No)}$$

In about 2.0 seconds.

76. Find the range. [1.5]

$$-1.96 < \frac{x-50}{5} < 1.96$$
$$-9.8 < 1.63 - x < 9.8$$
$$40.2 < -x < 59.8$$
$$41 < x < 59, \text{ where } x \text{ is an integer}$$

77. Find the range of mean heights. [1.5]

$$-1.645 < \frac{63.8-\mu}{0.45} < 1.645$$
$$-0.74025 < 63.8 - \mu < 0.74025$$
$$-64.54025 < -\mu < -63.05975$$
$$64.5 > \mu > 63.1$$
$$63.1 < \mu < 64.5 \text{ lb}$$

78. Find the range of mean waist sizes. [1.5]

$$-1.96 < \frac{39-\mu}{0.53} < 1.96$$
$$-1.0388 < 39 - \mu < 1.0388$$
$$-40.0388 < -\mu < -37.9612$$
$$40.0 > \mu > 38.0$$
$$38.0 < \mu < 40.0 \text{ lb}$$

79. Find the range of diameters. [1.5]

Let C = the circumference, r = the radius, and d = the diameter.

$$C = 2\pi r = \pi d$$
$$29.5 \le C \le 30.0$$
$$29.5 \le \pi d \le 30.0$$
$$\frac{29.5}{\pi} \le d \le \frac{30.0}{\pi}$$
$$9.39 \le d \le 9.55$$

The diameter of the basketball is from 9.39 to 9.55 inches.

80. Find the region. [1.5]

$$300 = -45x^2 + 190x + 200$$
$$45x^2 - 190x + 100 = 0$$
$$9x^2 - 38x + 20 = 0$$
$$x = \frac{-(-38) \pm \sqrt{(-38)^2 - 4(9)(20)}}{2(9)} = \frac{38 \pm \sqrt{724}}{18}$$
$$x \approx 0.6 \text{ or } x \approx 3.6$$

More than 0.6 mi but less than 3.6 mi from the city center.

81. Find the acceleration. [1.6]

$$F = ka$$
$$10 = k(2)$$
$$5 = k$$
$$F = 5a$$
$$15 = 5a$$
$$3 = a$$
$$a = 3 \text{ ft/s}^2$$

82. Find the distance. [1.6]

$$d = kt^2$$
$$10.6 = k(2)^2$$
$$2.65 = k$$
$$d = 2.65t^2$$
$$d = 2.65(3)^2$$
$$d = 23.85 \text{ ft}$$

83. Find the number of players. [1.6]

$$N = \frac{k}{p}$$
$$5000 = \frac{k}{150}$$
$$750{,}000 = k$$
$$N = \frac{750{,}000}{p}$$
$$N = \frac{750{,}000}{125}$$
$$N = 6000 \text{ players}$$

84. Find the repulsive force. [1.6]

$$F = \frac{k}{d^2}$$
$$40 = \frac{k}{(2)^2}$$
$$160 = k$$
$$F = \frac{160}{d^2}$$
$$F = \frac{160}{4^2}$$
$$F = 10 \text{ lb}$$

85. Find the acceleration. Round to the nearest hundredth of a meter per second squared. [1.6]

$$a = \frac{km}{r^2}$$
$$9.8 = \frac{k(5.98\times10^{26})}{(6{,}370{,}000)^2}$$
$$9.8(6{,}370{,}000)^2 = k(5.98\times10^{26})$$
$$\frac{9.8(6{,}370{,}000)^2}{5.98\times10^{26}} = k$$
$$k \approx 6.6497\times10^{-13}$$
$$a = \frac{6.6497\times10^{-13}m}{r^2}$$
$$a = \frac{(6.6497\times10^{-13})(7.46\times10^{24})}{(1{,}740{,}000)^2}$$
$$a \approx 1.64 \text{ meters/sec}^2$$

Chapter 1 Test

1. Solve. [1.1]

$$\frac{2x}{3}+\frac{1}{2}=\frac{x}{2}-\frac{3}{4}$$
$$12\left(\frac{2x}{3}+\frac{1}{2}\right)=12\left(\frac{x}{2}-\frac{3}{4}\right)$$
$$8x+6=6x-9$$
$$2x=-15$$
$$x=-\frac{15}{2}$$

2. Solve. [1.1]

$$|2x+5|=13$$

$$2x+5=13 \quad \text{or} \quad 2x+5=-13$$
$$2x=8 \qquad\qquad 2x=-18$$
$$x=4 \qquad\qquad x=-9$$

3. Solve for x. [1.2]

$$ax-c=c(x-d)$$
$$ax-c=cx-cd$$
$$ax-cx=c-cd$$
$$x(a-c)=c-cd$$
$$x=\frac{c-cd}{a-c},\ a\neq c$$

4. Solve: factor and apply zero product principle. [1.3]

$$6x^2-13x-8=(3x-8)(2x+1)=0$$

$$3x-8=0 \quad \text{or} \quad 2x+1=0$$
$$x=\frac{8}{3} \qquad\qquad x=-\frac{1}{2}$$

5. Solve by completing the square. [1.3]

$$2x^2-8x+1=0$$
$$x^2-4x=-\frac{1}{2}$$
$$x^2-4x+4=-\frac{1}{2}+4$$
$$(x-2)^2=\frac{7}{2}$$
$$x-2=\pm\sqrt{\frac{7}{2}}=\pm\frac{\sqrt{14}}{2}$$
$$x=2\pm\frac{\sqrt{14}}{2}=\frac{4\pm\sqrt{14}}{2}$$

The solutions are $\frac{4-\sqrt{14}}{2}$ and $\frac{4+\sqrt{14}}{2}$.

6. Solve using quadratic formula. [1.3]

$$x^2+13=4x$$
$$x^2-4x+13=0$$
$$a=1,\ b=-4,\ c=13$$
$$x=\frac{-(-4)\pm\sqrt{(-4)^2-4(1)(13)}}{2(1)}$$
$$x=\frac{4\pm\sqrt{-36}}{2}=\frac{4\pm6i}{2}=2\pm3i$$

The solutions are $2-3i$ and $2+3i$.

7. Find the discriminant and number of solutions. [1.3]

$$2x^2+3x+1=0$$
$$a=2,\ b=3,\ c=1$$
$$b^2-4ac=(3)^2-4(2)(1)=9-8=1$$

The discriminant, 1, is a positive number. Therefore, there are two real solutions

8. Solve. [1.4]

$$\sqrt{x-2}-1=\sqrt{3-x}$$
$$\left(\sqrt{x-2}-1\right)^2=\left(\sqrt{3-x}\right)^2$$
$$x-2-2\sqrt{x-2}+1=3-x$$
$$2x-4=2\sqrt{x-2}$$
$$x-2=\sqrt{x-2}$$
$$(x-2)^2=\left(\sqrt{x-2}\right)^2$$
$$x^2-4x+4=x-2$$
$$x^2-5x+6=0$$
$$(x-3)(x-2)=0$$

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

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

Check $\sqrt{2-2}-1=\sqrt{3-2}$

$-1=1$ (No)

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

$1-1=0$

$0=0$

The solution is 3.

9. Solve. [1.4]

$\sqrt{3x+1}-\sqrt{x-1}=2$

$\sqrt{3x+1}=\sqrt{x-1}+2$

$\left(\sqrt{3x+1}\right)^2=\left(\sqrt{x-1}+2\right)^2$

$3x+1=x-1+4\sqrt{x-1}+4$

$2x-2=4\sqrt{x-1}$

$x-1=2\sqrt{x-1}$ Remove factor of 2.

$(x-1)^2=\left(2\sqrt{x-1}\right)^2$

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

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

$x^2-6x+5=0$

$(x-1)(x-5)=0$

$x=1$ or $x=5$

Check $\sqrt{3(1)+1}-\sqrt{1-1}=2$

$\sqrt{4}-\sqrt{0}=2$

$2=2$

$\sqrt{3(5)+1}-\sqrt{5-1}=2$

$\sqrt{16}-\sqrt{4}=2$

$4-2=2$

$2=2$

1 and 5 check as solutions.

10. Solve. [1.4]

$3x^{4/5}-7=41$

$3x^{4/5}=48$

$x^{4/5}=16$

$\left(x^{4/5}\right)^{5/4}=(16)^{5/4}$

$|x|=32$

$x=-32,\ 32$

11. Solve. [1.4]

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

$4(x+2)\left(\frac{3}{x+2}-\frac{3}{4}\right)=4(x+2)\left(\frac{5}{x+2}\right)$

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

$12-3x-6=20$

$-3x=14$

$x=-\frac{14}{3}$

12. Solve. [1.4]

$2x^3+x^2-8x-4=0$

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

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

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

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

13. Solve. [1.4]

$x^3-64=0$

$(x-4)\left(x^2+4x+16\right)=0$

$x-4=0$ or $x^2+4x+16=0$

$x=4$

$x=\frac{-4\pm\sqrt{4^2-4(1)(16)}}{2(1)}$

$x=\frac{-4\pm\sqrt{-48}}{2}=\frac{-4\pm4i\sqrt{3}}{2}=-2\pm2i\sqrt{3}$

The solutions are $4,\ -2-2i\sqrt{3},\ -2+2i\sqrt{3}$.

14. a. Solve and write in set builder notation. [1.5]

$2x-5\le11$ or $-3x+2>14$

$2x\le16$ $\quad -3x>12$

$x\le8$ $\quad x<-4$

$\{x\,|\,x\le8\}\cup\{x\,|\,x<-4\}=\{x\,|\,x\le8\}$

b. Solve and write in interval notation. [1.5]

$2x-1<9$ and $-3x+1\le7$

$2x<10$ $\quad -3x\le6$

$x<5$ $\quad x\ge-2$

$\{x\,|\,x<5\}\cap\{x\,|\,x\ge-2\}=[-2,\ 5)$

15. Solve and write in interval notation. [1.5]

$|3x-4|>5$

$3x-4>5 \quad \text{or} \quad 3x-4<-5$

$3x>9 \qquad\qquad 3x<-1$

$x>3 \qquad\qquad x<-\frac{1}{3}$

$\left(-\infty,-\frac{1}{3}\right)\cup(3,\ \infty)$

16. Solve and write in interval notation. [1.5]

$x^2-5x-6<0$

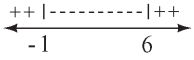
$(x+1)(x-6)<0$

The product is negative.

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

$x-6=0 \Rightarrow x=6$

Critical values are –1 and 6.

$(x+1)(x-6)$ 

(–1, 6)

17. Solve and write in interval notation. [1.5]

$\frac{x^2+x-12}{x+1}\geq 0$

$\frac{(x+4)(x-3)}{x+1}\geq 0$

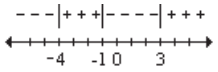
The quotient is positive or zero.

$x+4=0 \Rightarrow x=-4$

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

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

Critical values are –4, 3, and –1.

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

Denominator $\neq 0 \Rightarrow x\neq -1$.

$[-4,\ -1)\cup[3,\ \infty)$

18. Find the amount to be drained and replaced. [1.2]

x	0.20	Remove x amount of 20%
x	1.00	Add x amount of 100%

$6(0.20)-x(0.20)+x(1.00)=6(0.50)$

$1.2+0.8x=3$

$0.8x=1.8$

$x=2.25$ liters

19. Find the time for the assistant working alone. [1.2]

Let x = number of hours the assistant needs to cover the parking lot.

$6\left[\frac{1}{10}+\frac{1}{x}\right]=1$

$10x(6)\left[\frac{1}{10}+\frac{1}{x}\right]=10x(1)$

$6x+60=10x$

$-4x=-60$

$x=15$

The assistant takes 15 hours to cover the parking lot.

20. Find the length of the shadow. [1.2]

Let x = the length of the shadow

$\frac{10+x}{20}=\frac{x}{6}$

$20x=60+6x$

$14x=60$

$x=\frac{30}{7}\approx 4.3$

The shadow is about 4.3 feet.

21. Find the amount of each. [1.2]

\$3.45	x
\$2.70	$50-x$
\$3.15	50

$3.45x+2.7(50-x)=3.15(50)$

$3.45x+135-2.70x=157.50$

$0.75x=22.5$

$x=30$

$50-x=20$

30 lb of ground beef and 20 lb of sausage.

22. Find the time. [1.3]

$h=-16t^2+160t+4$

$100=-16t^2+160t+4$

$16t^2-160t+96=0$

$t=\frac{-(-160)\pm\sqrt{(-160)^2-4(16)(96)}}{2(16)}$

$t=\frac{160\pm\sqrt{19,456}}{32}$

$t\approx 0.6$ or $t\approx 9.4$

The rocket will be 100 feet above the ground at about 0.6 seconds or 9.4 second.

23. Find Zoey's speed. [1.4]

Let x +4 = Zoey's speed.

$$\frac{15}{x}-\frac{15}{x+4}=1$$
$$x(x+4)\left(\frac{15}{x}-\frac{15}{x+4}\right)=x(x+4)(1)$$
$$15(x+4)-15x=x(x+4)$$
$$15x+60-15x=x^2+4x$$
$$0=x^2+4x-60$$
$$0=(x+10)(x-6)$$
$$x=-10 \text{ (No) or } x=6$$

$x + 4 = 10$

Zoey's speed is 10 mph.

24. Find the range of p. [1.5]

$$0<0.05p-1.5<2.375$$
$$1.50<0.05p<3.875$$
$$30.0<p<77.5$$

25. Find the velocity of the meteorite. [1.6]

$$v=\frac{k}{\sqrt{d}}$$
$$4=\frac{k}{\sqrt{3000}}$$
$$k=4\sqrt{3000}=40\sqrt{30}$$
$$v=\frac{40\sqrt{30}}{\sqrt{2500}}=\frac{40\sqrt{30}}{50}$$
$$v=\frac{4\sqrt{30}}{5}\approx 4.4 \text{ miles/second}$$

Cumulative Review Exercises

1. Evaluate. [P.1]

$$4+3(-5)=4-15=-11$$

2. Write in scientific notation. [P.2]

$$0.00017=1.7\times10^{-4}$$

3. Perform the operations and simplify. [P.3]

$$(3x-5)^2-(x+4)(x-4)$$
$$=(9x^2-30x+25)-(x^2-16)$$
$$=9x^2-30x+25-x^2+16$$
$$=8x^2-30x+41$$

4. Factor. [P.4]

$$8x^2+19x-15=(8x-5)(x+3)$$

5. Simplify. [P.5]

$$\frac{7x-3}{x-4}-5=\frac{7x-3-5x+20}{x-4}=\frac{2x+17}{x-4}$$

6. Simplify. [P.2]

$$a^{2/3}\cdot a^{1/4}=a^{2/3\,+\,1/4}=a^{11/12}$$

7. Simplify. [P.6]

$$(2+5i)(2-5i)=4-25i^2=4+25=29$$

8. Solve. [1.1]

$$2(3x-4)+5=17$$
$$2(3x-4)=12$$
$$6x=20$$
$$x=\frac{10}{3}$$

9. Solve using the quadratic formula. [1.3]

$$2x^2-4x=3$$
$$2x^2-4x-3=0$$
$$x=\frac{-(-4)\pm\sqrt{(-4)^2-4(2)(-3)}}{2(2)}=\frac{4\pm2\sqrt{10}}{4}$$
$$=\frac{2\pm\sqrt{10}}{2}$$

10. Solve. [1.1]

$$|2x-6|=4$$
$$2x-6=4 \quad \text{or} \quad 2x-6=-4$$
$$2x=10 \quad\quad 2x=2$$
$$x=5 \quad\quad x=1$$

11. Solve. [1.4]

$$x=3+\sqrt{9-x}$$
$$x-3=\sqrt{9-x}$$
$$(x-3)^2=\left(\sqrt{9-x}\right)^2$$
$$x^2-6x+9=9-x$$
$$x^2-5x=0$$
$$x(x-5)=0$$
$$x=0 \text{ or } x=5$$

Check 0: Check 5:

$0 = 3 + \sqrt{9-0}$ $5 = 3 + \sqrt{9-5}$

$0 = 3 + \sqrt{9}$ $5 = 3 + \sqrt{4}$

$0 = 3 + 3$ $5 = 3 + 2$

$0 = 6$ No $5 = 5$

The solution is 5.

12. Solve. [1.4]

$$x^3 - 36x = 0$$
$$x(x^2 - 36) = 0$$
$$x(x+6)(x-6) = 0$$

The solutions are 0, –6, 6.

13. Solve. [1.4]

$2x^4 - 11x^2 + 15 = 0$ Let $u = x^2$.

$2u^2 - 11u + 15 = 0$

$(2u-5)(u-3) = 0$

$2u - 5 = 0$ or $u - 3 = 0$

$u = x^2 = \frac{5}{2}$ $u = 3$

$x^2 = 3$

$x = \pm\sqrt{\frac{5}{2}} = \pm\frac{\sqrt{10}}{2}$ $x = \pm\sqrt{3}$

The solutions are $-\frac{\sqrt{10}}{2}, \frac{\sqrt{10}}{2}, -\sqrt{3}, \sqrt{3}$.

14. Solve. Write the solution in set-builder notation. [1.5]

$3x - 1 > 2$ or $-3x + 5 \geq 8$

$3x > 3$ $-3x \geq 3$

$x > 1$ $x \leq -1$

The solution is $\{x \mid x \leq -1 \text{ or } x > 1\}$.

15. Solve. Write the solution in interval notation. [1.5]

$|x-6| \geq 2$

$x - 6 \geq 2$ or $x - 6 \leq -2$

$x \geq 8$ $x \leq 4$

The solution is $(-\infty, 4] \cup [8, \infty)$.

16. Solve. Write the solution in set-builder notation. [1.5]

$$\frac{x-2}{2x-3} \geq 4$$
$$\frac{x-2}{2x-3} - 4 \geq 0$$
$$\frac{x-2}{2x-3} - \frac{4(2x-3)}{2x-3} \geq 0$$
$$\frac{x-2-8x+12}{2x-3} \geq 0$$
$$\frac{-7x+10}{2x-3} \geq 0$$

Solve $-7x + 10 = 0$ and $2x - 3 - 0$ to find the critical values.

$-7x + 10 = 0$ $2x - 3 = 0$

$x = \frac{10}{7}$ $x = \frac{3}{2}$

The critical values are $\frac{10}{7}$ and $\frac{3}{2}$. The intervals are

$\left(-\infty, \frac{10}{7}\right), \left(\frac{10}{7}, \frac{3}{2}\right)$ and $\left(\frac{3}{2}, \infty\right)$

Test 0, in the interval $\left(-\infty, \frac{10}{7}\right)$:

$\frac{0-2}{2(0)-3} \geq 4 \Rightarrow \frac{-2}{-3} \geq 4 \Rightarrow \frac{2}{3} \geq 4$, which is false.

Test 1.45, in the interval $\left(\frac{10}{7}, \frac{3}{2}\right)$:

$\frac{1.45-2}{2(1.45)-3} \geq 4 \Rightarrow \frac{-0.55}{-0.1} \geq 4 \Rightarrow 5.5 \geq 4$, which is true.

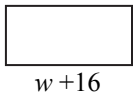
Test 2, in the interval $\left(\frac{3}{2}, \infty\right)$:

$\frac{2-2}{2(2)-3} \geq 4 \Rightarrow \frac{0}{1} \geq 4 \Rightarrow 0 \geq 4$, which is false.

The denominator cannot equal zero $\Rightarrow x \neq \frac{3}{2}$.

The solution is $\left\{x \middle| \frac{10}{7} \leq x < \frac{3}{2}\right\}$.

17. Find the dimensions of the fence. [1.2]



$$\begin{aligned}\text{Perimeter} &= 2(\text{Length}) + 2(\text{Width})\\ 200 &= 2(w+16) + 2w\\ 200 &= 2w + 32 + 2w\\ 168 &= 4w\\ 42 &= w\\ w &= 42\\ w+16 &= 58\end{aligned}$$

The width is 42 feet; the length is 58 feet.

18. Find the number of printers. [1.5]

$$\begin{aligned}P &= R - C\\ &= 200x - 0.004x^2 - (65x + 320{,}000)\\ &= -0.004x^2 + 135x - 320{,}000\end{aligned}$$

Profits must be greater than or equal to 600,000.

$$-0.004x^2 + 135x - 320{,}000 \ge 600{,}000$$
$$-0.004x^2 + 135x - 920{,}000 \ge 0$$

$$x = \frac{-135 \pm \sqrt{(135)^2 - 4(-0.004)(-920{,}000)}}{2(-0.004)}$$
$$= \frac{-135 \pm \sqrt{3505}}{-0.008}$$
$$= 9475 \text{ or } 24{,}275$$

9475 to 24,275 printers should be manufactured.

19. Find the range of scores. [1.5]

Let x = the score on the fourth test.

$$80 \le \frac{86+72+94+x}{4} < 90 \quad \text{and} \quad 0 \le x \le 100$$
$$80 \le \frac{252+x}{4} < 90$$
$$320 \le 252 + x < 360$$
$$68 \le x < 108$$
$$[68,\ 108) \cap [0,\ 100] = [68,\ 100]$$

The fourth test score must be from 68 to 100.

20. Find the percent of speeders.

$$\frac{600p}{100-p} \ge 100 \quad \text{and} \quad \frac{600p}{100-p} \le 180$$
$$600p \ge 100(100-p) \qquad 600p \le 180(100-p)$$
$$600p \ge 10{,}000 - 100p \qquad 600p \le 18{,}000 - 180p$$
$$700p \ge 10{,}000 \qquad 780p \le 18{,}000$$
$$p \ge 14.3 \qquad p \le 23.1$$

They can expect to ticket from 14.3% to 23.1% of the speeders.