CHAPTER 5

Think & Discuss *(p. 247)*

1. about 1900 ft
2. about 22 sec; *Sample answer:* The graph charts the lava fragment in the air from its initial point at zero until there are no longer fragments in the air at 22 sec.

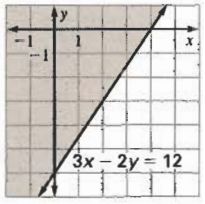
Skill Review *(p. 248)*

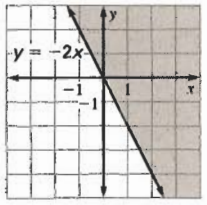
1. $3x - 5 = 0$
   $3x = 5$
   $x = \frac{5}{3}$

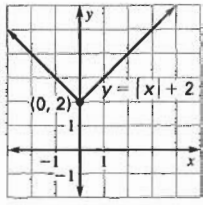
2. $4x + 24 = 12$
   $4x = -12$
   $x = -3$

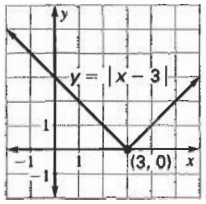
3. $2x + 1 = -x + 7$
   $3x = 6$
   $x = 2$

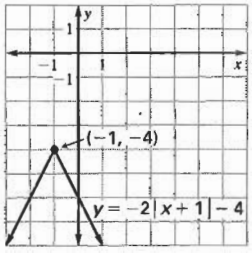
4. 

5. 

6. 

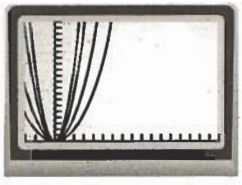
7. 

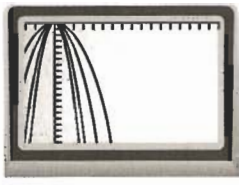
8. 

9. 

Lesson 5.1

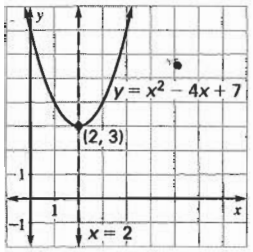
Activity (p. 29)

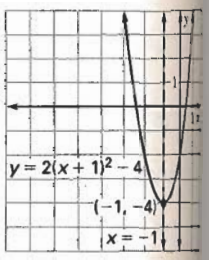
1. 

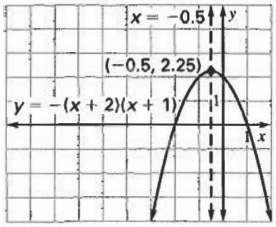
2. 

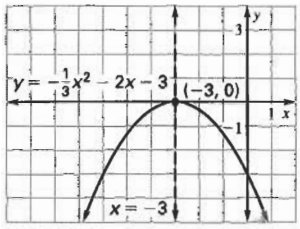
3. $(0, 0)$; $x = 0$
4. The graph opens up if $a > 0$, the graph opens down if $a < 0$.

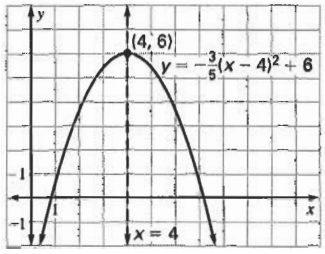
5.1 Guided Practice (p. 253)

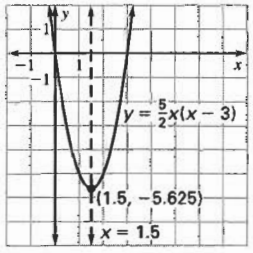
1. parabola
2. Up; since $a = 3$ and is greater than 0, the parabola opens up.
3. intercept form
4. 

5. 

6. 

7. 

8. 

9. 

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10. $y = (x + 1)(x + 2)$

$y = x^2 + 3x + 2$

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

$y = -2(x^2 + x - 12)$

$y = -2x^2 - 2x + 24$

12. $y = 4(x - 1)^2 + 5$

$y = 4(x^2 - 2x + 1) + 5$

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

13. $y = -(x + 2)^2 - 7$

$y = -(x^2 + 4x + 4) - 7$

$y = -x^2 - 4x - 11$

14. $y = -\frac{1}{2}(x - 6)(x - 8)$

$y = -\frac{1}{2}(x^2 - 14x + 48)$

$y = -\frac{1}{2}x^2 + 7x - 24$

15. $y = \frac{2}{3}(x - 9)^2 - 4$

$y = \frac{2}{3}(x^2 - 18x + 81) - 4$

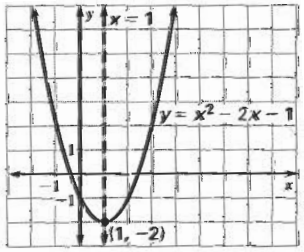
$y = \frac{2}{3}x^2 - 12x + 50$

16. males: $x = \frac{612.6}{8.58} = 71.4$°F; females: $x = \frac{908.9}{12.448} = 73$°F

5.1 Practice and Applications (pp. 253–255)

17. C **18.** A **19.** B

20.



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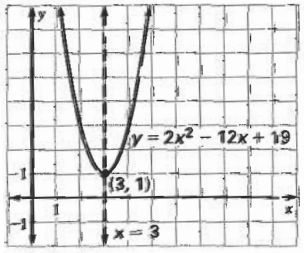

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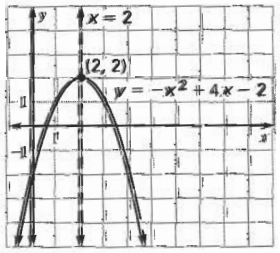

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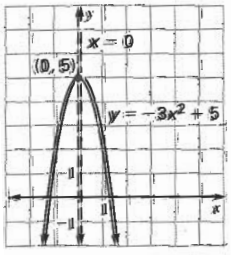

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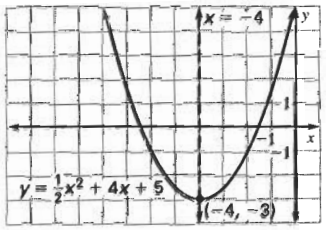

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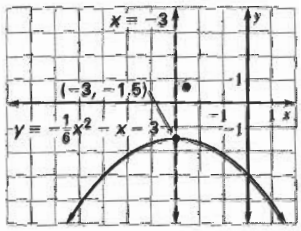

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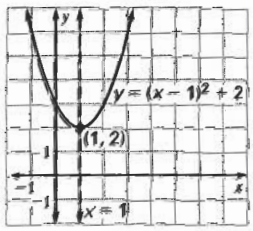

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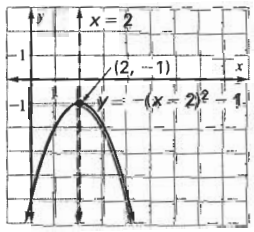

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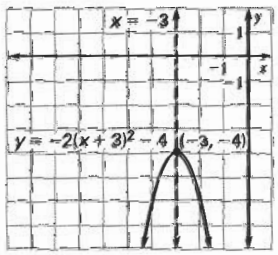

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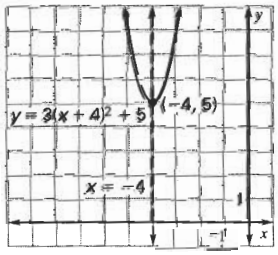

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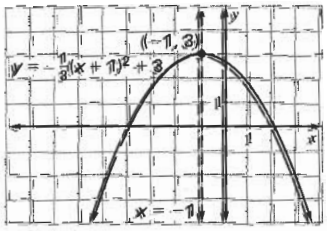

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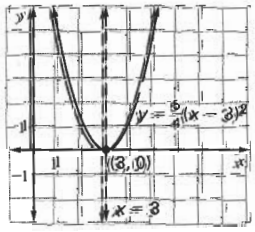

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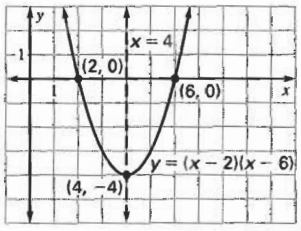
32.



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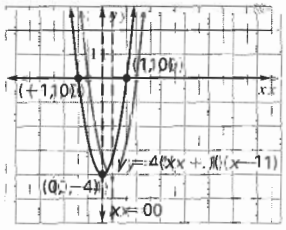

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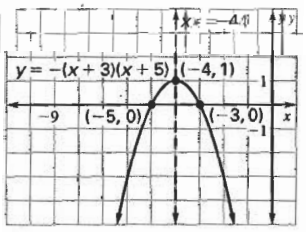

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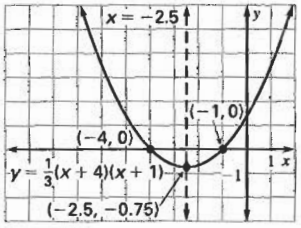

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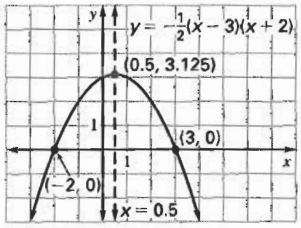

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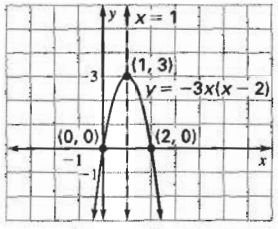


38. $y = (x + 5)(x + 2)$

$y = x^2 + 5x + 2x + 10$

$y = x^2 + 7x + 10$

39. $y = -(x + 3)(x - 4)$

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

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

40. $y = 2(x - 1)(x - 6)$

$y = 2(x^2 - x - 6x + 6)$

$y = 2x^2 - 14x + 12$

41. $y = -3(x - 7)(x + 4)$

$y = -3(x^2 - 7x + 4x - 28)$

$y = -3x^2 + 9x + 84$

42. $y = (5x + 8)(4x + 1)$

$y = 20x^2 + 32x + 5x + 8$

$y = 20x^2 + 37x + 8$

43. $y = (x + 3)^2 + 2$

$y = (x^2 + 6x + 9) + 2$

$y = x^2 + 6x + 11$

44. $y = -(x - 5)^2 + 11$

$y = -(x^2 - 10x + 25) + 11$

$y = -x^2 + 10x - 14$

45. $y = -6(x - 2)^2 - 9$

$y = -6(x^2 - 4x + 4) - 9$

$y = -6x^2 + 24x - 33$

46. $y = 8(x + 7)^2 - 20$

$y = 8(x^2 + 14x + 49) - 20$

$y = 8x^2 + 112x + 372$

47. $y = -(9x + 2)^2 + 4x$

$y = -(81x^2 + 36x + 4) + 4x$

$y = -81x^2 - 32x - 4$

48. $y = -\frac{7}{3}(x + 6)(x + 3)$

$y = -\frac{7}{3}(x^2 + 9x + 18)$

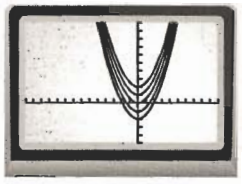
$y = -\frac{7}{3}x^2 - 21x - 42$

49. $y = \frac{1}{2}(8x - 1)^2 - \frac{3}{2}$

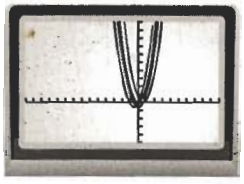
$y = \frac{1}{2}(64x^2 - 16x + 1) - \frac{3}{2}$

$y = 32x^2 - 8x - 1$

50. a.

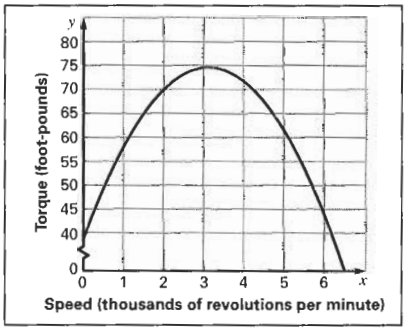


b.



As c increases, the graph moves upward. The graph moves left as b increases.

51.



About 3093 rev per min; 74.68 foot-pounds

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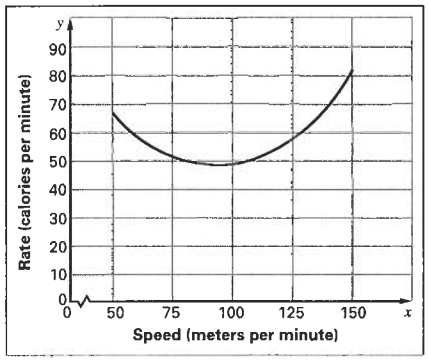
52. width = 160 ft

height = 1.5 ft

53.



Sample answer: The energy use decreases until about 90 meters per minute and then increases.

54. width = 6 ft

height = 2 ft

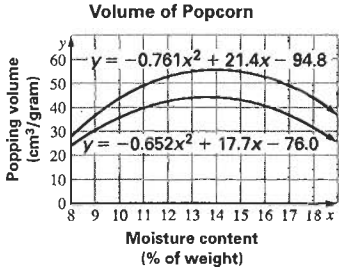
55. **a.** $x = \dfrac{-21.4}{-1.522} \approx 14\%$

$y = -0.761(14)^2 + 21.4(14) - 94.8 \approx 56$ cm^3 per gram

b. $x = \dfrac{-17.7}{-1.304} \approx 13.6\%$

$y = -0.652(13.6)^2 + 17.7(13.6) - 76.0 \approx 44$ cm^3 per gram

c.



d. *Sample answer:* Hot-air popping produces a greater volume than hot-oil popping.

56. $y = a(x - h)^2 + k$ $\qquad y = a(x - p)(x - q)$

$y = a(x^2 - 2xh + h^2) + k$ $\qquad y = a(x^2 - xp - xq + pq)$

$y = ax^2 - 2axh + ah^2 + k$ $\qquad y = ax^2 - ax(p + q) + apq$

For $y = ax^2 - 2axh + ah^2 + k$, $a = a$ and $b = -2ah$.

Then $x = -\dfrac{b}{2a}$ (the x-coordinate of the vertex) $= \dfrac{2ah}{2a} = h$. For $y = ax^2 - aqx + apq$, $a = a$ and $b = -a(p + q)$. Then $x = -\dfrac{b}{2a}$ (then x-coordinate of the vertex) $= -\dfrac{-a(p + q)}{2a} = \dfrac{p + q}{2}$.

5.1 Mixed Review (p. 255)

57. $x - 2 = 0$

$x = 2$

58. $2x = -5$

$x = -2.5$

59. $-4x = 28$

$x = -7$

60. $4x = -8$

$x = -2$

61. $6x = 18 - 48$

$6x = -30$

$x = -5$

62. $20x - 5 = 2x + 6$

$18x = 11$

$x = \frac{11}{18}$

63. $0.6x = 0.2x + 2.8$

$0.4x = 2.8$

$x = 7$

64. $\dfrac{35x - 24x}{40} = \dfrac{11}{2}$

$\dfrac{11x}{40} = \dfrac{11}{2}$

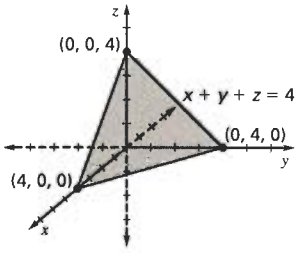
$x = 20$

65. $\dfrac{5x}{12} - \dfrac{x}{6} = -\dfrac{1}{4} - \dfrac{1}{2}$

$\dfrac{3x}{12} = -\dfrac{3}{4}$

$x = -3$

66.



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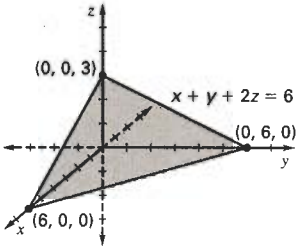

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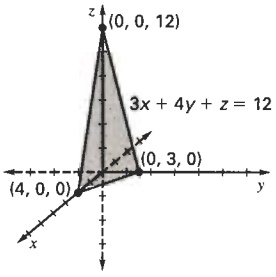

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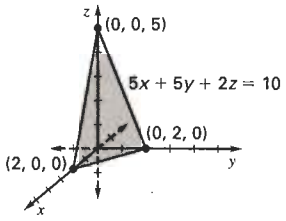

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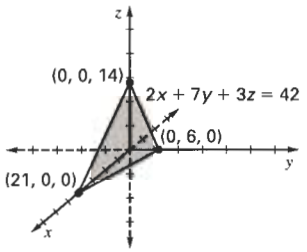
70.



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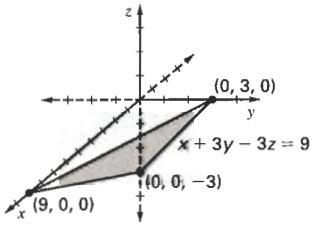

72. $A = \begin{bmatrix} 1 & 1 \\ -5 & 1 \end{bmatrix}$; $\det A = 1 + 5 = 6$

$$x = \frac{\begin{vmatrix} 1 & 1 \\ 19 & 1 \end{vmatrix}}{6} = \frac{1 - 19}{6} = -3$$

$$y = \frac{\begin{vmatrix} 1 & 1 \\ -5 & 19 \end{vmatrix}}{6} = \frac{19 + 5}{6} = 4$$

$(-3, 4)$

73. $A = \begin{bmatrix} 2 & 1 \\ 3 & -4 \end{bmatrix}$; $\det A = -8 - 3 = -11$

$$x = \frac{\begin{vmatrix} 5 & 1 \\ 2 & -4 \end{vmatrix}}{-11} = \frac{-20 - 2}{-11} = 2$$

$$y = \frac{\begin{vmatrix} 2 & 5 \\ 3 & 2 \end{vmatrix}}{-11} = \frac{4 - 15}{-11} = 1$$

$(2, 1)$

74. $A = \begin{bmatrix} 7 & -10 \\ 1 & 2 \end{bmatrix}$; $\det A = 14 + 10 = 24$

$$x = \frac{\begin{vmatrix} -15 & -10 \\ -9 & 2 \end{vmatrix}}{24} = \frac{-30 - 90}{24} = -5$$

$$y = \frac{\begin{vmatrix} 7 & -15 \\ 1 & -9 \end{vmatrix}}{24} = \frac{-63 + 15}{24} = -2$$

$(-5, -2)$

75. $A = \begin{bmatrix} 5 & 2 & 2 \\ 3 & 1 & -6 \\ -1 & -1 & -1 \end{bmatrix}$;

$\det A = (-5 + 12 - 6) - (-2 + 30 - 6) = -21$

$$x = \frac{\begin{vmatrix} 4 & 2 & 2 \\ -4 & 1 & -6 \\ 1 & -1 & -1 \end{vmatrix}}{-21}$$

$$= \frac{(-4 - 12 + 8) - (2 + 24 + 8)}{-21} = \frac{-8 - 34}{-21} = 2$$

$$y = \frac{\begin{vmatrix} 5 & 4 & 2 \\ 3 & -4 & -6 \\ -1 & 1 & -1 \end{vmatrix}}{-21}$$

$$= \frac{(20 + 24 + 6) - (8 - 30 - 12)}{-21} = \frac{50 + 34}{-21} = -4$$

$$z = \frac{\begin{vmatrix} 5 & 2 & 4 \\ 3 & 1 & -4 \\ -1 & -1 & 1 \end{vmatrix}}{-21}$$

$$= \frac{(5 + 8 - 12) - (-4 + 20 + 6)}{-21} = \frac{1 - 22}{-21} = 1$$

$(2, -4, 1)$

76. $A = \begin{bmatrix} 1 & 3 & 1 \\ -1 & 1 & 1 \\ 2 & -7 & 5 \end{bmatrix}$;

$\det A = (5 + 6 + 7) - (2 - 7 - 15) = 18 + 20 = 38$

$$x = \frac{\begin{vmatrix} 5 & 3 & 1 \\ 7 & 1 & 1 \\ 28 & -7 & 5 \end{vmatrix}}{38}$$

$$= \frac{(25 + 84 - 49) - (28 - 35 + 105)}{38} = \frac{60 - 98}{38} = -1$$

$$y = \frac{\begin{vmatrix} 1 & 5 & 1 \\ -1 & 7 & 1 \\ 2 & 28 & 5 \end{vmatrix}}{38}$$

$$= \frac{(35 + 10 - 28) - (14 + 28 - 25)}{38} = \frac{17 - 17}{38} = 0$$

$$z = \frac{\begin{vmatrix} 1 & 3 & 5 \\ -1 & 1 & 7 \\ 2 & -7 & 28 \end{vmatrix}}{38}$$

$$= \frac{(28 + 42 + 35) - (10 - 49 - 84)}{38} = \frac{105 + 123}{38} = 6$$

$(-1, 0, 6)$

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77. $A = \begin{bmatrix} 2 & -3 & -9 \\ 6 & 1 & -1 \\ 9 & -2 & 4 \end{bmatrix}$;

$\det A = (8 + 27 + 108) - (-81 + 4 - 72)$

$= 143 + 149 = 292$

$$x = \frac{\begin{vmatrix} 11 & -3 & -9 \\ 45 & 1 & -1 \\ 56 & -2 & 4 \end{vmatrix}}{292}$$

$$= \frac{(44 + 168 + 810) - (-504 + 22 - 540)}{292}$$

$$= \frac{1022 + 1022}{292} = 7$$

$$y = \frac{\begin{vmatrix} 2 & 11 & -9 \\ 6 & 45 & -1 \\ 9 & 56 & 4 \end{vmatrix}}{292}$$

$$= \frac{(360 - 99 - 3024) - (-3645 - 112 + 264)}{292}$$

$$= \frac{-2763 + 3493}{292} = 2.5$$

$$z = \frac{\begin{vmatrix} 2 & -3 & 11 \\ 6 & 1 & 45 \\ 9 & -2 & 56 \end{vmatrix}}{292}$$

$$= \frac{(112 - 1215 - 132) - (99 - 180 - 1008)}{292}$$

$$= \frac{-1235 + 1089}{292} = \frac{-146}{292} = -0.5$$

$(7, 2.5, -0.5)$

78. $\frac{22 - 7}{14} = \frac{15}{14} = 1\frac{1}{14}$ ft per hr

Lesson 5.2

5.2 Guided Practice (p. 260)

1. *Sample answer:* numbers where the value of the function is zero

2. The x-term is negative and its absolute value is greater than the absolute value of the constant term.

3. The student did not set the factors equal to zero.

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

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

$(x - 1)(x + 5) = 0$

$x - 1 = 0 \quad x + 5 = 0$

$x = 1 \quad x = -5$

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

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

6. $x^2 - 16 = (x - 4)(x + 4)$

7. $y^2 + 2y + 1 = (y + 1)(y + 1)$

8. $p^2 - 4p + 4 = (p - 2)(p - 2)$

9. $q^2 + q = q(q + 1)$

10. $x = -3 \quad x = 1$

11. $(x - 4)(x + 2) = 0$

$x - 4 = 0 \quad x + 2 = 0$

$x = 4 \quad x = -2$

12. $(3x + 1)(x + 3) = 0$

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

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

13. $4u^2 - 1 = 0$

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

$2u = 1 \quad 2u = -1$

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

14. $v^2 - 14v + 49 = 0$

$(v - 7)(v - 7) = 0$

$v = 7$

15. $5w^2 - 30w = 0$

$5w(w - 6) = 0$

$w = 0 \quad w = 6$

16. $y = (x - 1)(x - 5)$; 1, 5

17. $y = (x + 2)(x + 4)$; $-2, -4$

18. $y = (x - 1)(x + 1)$; 1, -1

19. $y = (x + 5)^2$; -5

20. $y = 2(x - 4)(x + 3)$; 4, -3

21. $y = (3x - 2)(x - 2)$; $\frac{2}{3}, 2$

22. $(2x + 12)(2x + 8) - 96 = 96$

$4x^2 + 40x = 96$

$4(x^2 + 10x - 24) = 0$

$4(x + 12)(x - 2) = 0$

The width of the border is 2 ft.

5.2 Practice and Applications (pp. 260–263)

23. $x^2 + 5x + 4 = (x + 4)(x + 1)$

24. $x^2 + 9x + 14 = (x + 7)(x + 2)$

25. $x^2 + 13x + 40 = (x + 5)(x + 8)$

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

27. $x^2 - 8x + 12 = (x - 6)(x - 2)$

28. $x^2 - 16x + 51$ cannot be factored

29. $a^2 + 3a - 10 = (a + 5)(a - 2)$

30. $b^2 + 6b - 27 = (b + 9)(b - 3)$

31. $c^2 + 2c - 80 = (c + 10)(c - 8)$

32. $p^2 - 5p - 6 = (p - 6)(p + 1)$

33. $q^2 - 7q - 10$ cannot be factored

34. $r^2 - 14r - 72 = (r - 18)(r + 4)$

35. $2x^2 + 7x + 3 = (2x + 1)(x + 3)$

36. $3x^2 + 17x + 10 = (3x + 2)(x + 5)$

37. $8x^2 + 18x + 9 = (4x + 3)(2x + 3)$

38. $5x^2 - 7x + 2 = (5x - 2)(x - 1)$

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39. $6x^2 - 9x + 5$ cannot be factored

40. $10x^2 - 19x + 6 = (5x - 2)(2x - 3)$

41. $3k^2 + 32k - 11 = (3k - 1)(k + 11)$

42. $11m^2 + 14m - 16 = (11m - 8)(m + 2)$

43. $18n^2 + 9n - 14 = (3n - 2)(6n + 7)$

44. $7u^2 - 4u - 3 = (7u + 3)(u - 1)$

45. $12v^2 - 25v - 7 = (3v - 7)(4v + 1)$

46. $4w^2 - 13w - 27$ cannot be factored

47. $x^2 - 25 = (x - 5)(x + 5)$

48. $x^2 + 4x + 4 = (x + 2)^2$

49. $x^2 - 6x + 9 = (x - 3)^2$

50. $4r^2 - 4r + 1 = (2r - 1)^2$

51. $9s^2 + 12s + 4 = (3s + 2)^2$

52. $16t^2 - 9 = (4t - 3)(4t + 3)$

53. $49 - 100a^2 = (7 - 10a)(7 + 10a)$

54. $25b^2 - 60b + 36 = (5b - 6)^2$

55. $81c^2 + 198c + 121 = (9c + 11)^2$

56. $5(x^2 + x - 2) = 5(x + 2)(x - 1)$

57. $2(9x^2 - 1) = 2(3x - 1)(3x + 1)$

58. $3(x^2 + 18x + 81) = 3(x + 9)^2$

59. $4(2y^2 - 7y - 15) = 4(2y + 3)(y - 5)$

60. $7(16a^2 - 24a + 9) = 7(4a - 3)^2$

61. $u(u + 7)$

62. $6t(t - 6)$

63. $-v^2 + 2v - 1 = -(v - 1)^2$

64. $2(d^2 + 6d - 8)$

65. $(x - 4)(x + 1) = 0$
$x = 4 \quad x = -1$

66. $(x + 11)(x + 8) = 0$
$x = -11 \quad x = -8$

67. $(5x - 3)(x - 2) = 0$
$x = \frac{3}{5} \quad x = 2$

68. $(4x - 5)(2x + 1) = 0$
$x = \frac{5}{4} \quad x = -\frac{1}{2}$

69. $(k + 12)^2 = 0$
$k = -12$

70. $(3m - 5)^2 = 0$
$m = \frac{5}{3}$

71. $(9n - 4)(9n + 4) = 0$
$n = \frac{4}{9} \quad n = -\frac{4}{9}$

72. $4a(10a + 1) = 0$
$a = 0 \quad a = -\frac{1}{10}$

73. $-3(b + 5)(b - 6) = 0$
$b = -5 \quad b = 6$

74. $x^2 + 9x + 20 = 0$
$(x + 4)(x + 5) = 0$
$x = -4 \quad x = -5$

75. $16x^2 - 8x + 1 = 0$
$(4x - 1)^2 = 0$
$x = \frac{1}{4}$

76. $p^2 - 49 = 0$
$(p - 7)(p + 7) = 0$
$p = 7 \quad p = -7$

77. $3y^2 - 5y - 8 = 0$
$(3y - 8)(y + 1) = 0$
$y = \frac{8}{3} \quad y = -1$

78. $-5q^2 + 11q - 2 = 0$
$-(5q - 1)(q - 2) = 0$
$q = \frac{1}{5} \quad q = 2$

79. $w^2 + 12w + 36 - 3w - 36 + w^2 = 0$
$2w^2 + 9w = 0$
$w(2w + 9) = 0$
$w = 0 \quad w = -\frac{9}{2}$

80. $y = (x - 2)(x - 1)$; 2, 1

81. $y = (x + 4)(x + 3)$; $-4, -3$

82. $y = (x + 7)(x - 5)$; $-7, 5$

83. $y = (x - 2)(x + 2)$; $2, -2$

84. $y = (x + 10)^2$; -10

85. $y = x(x - 3)$; $0, 3$

86. $y = 3(x^2 - 4x - 5)$
$y = 3(x - 5)(x + 1)$;
$5, -1$

87. $y = -(x - 8)^2$; 8

88. $y = (2x - 1)(x - 4)$;
$\frac{1}{2}, 4$

89. **a.** $m + n = 0$
$mn = 9$

b. If $m + n = 0$, then $m = -n$. Substituting in $mn = 9$, $(-n)(n) = 9$, $-n^2 = 9$, and $n^2 = -9$. There is no such number such that $n^2 = -9$. Therefore, $x^2 + 9$ is not factorable.

90. $(4 + 2x)(5 + 2x) - 20 = 10$
$20 + 8x + 4x^2 - 20 - 10 = 0$
$4x^2 + 18x - 10 = 0$
$(2x + 10)(2x - 1) = 0$
$x = \frac{1}{2}$
0.5 ft

91. $(375 + x)(240 + x) - 90{,}000 = 40{,}500$
$x^2 + 615x - 40{,}500 = 0$
$(x - 60)(x + 675) = 0$
$x = 60$
60 ft

92. $x^2 + 3x = 40$
$x^2 + 3x - 40 = 0$
$(x - 5)(x + 8) = 0$
$x = 5$

93. $2x^2 + x = 105$
$2x^2 + x - 105 = 0$
$(2x + 15)(x - 7) = 0$
$x = 7$

94. $\frac{1}{2}(3x^2 - x) = 22$
$3x^2 - x - 44 = 0$
$(3x + 11)(x - 4) = 0$
$x = 4$

95. $\frac{1}{2}(6x + 2)(x) = 114$
$3x^2 + x - 114 = 0$
$(3x + 19)(x - 6) = 0$
$x = 6$

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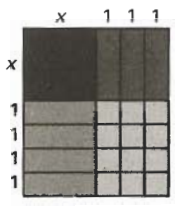
96. **a.** *Sample answer:* The area of the rectangle in the diagram equals the sum of the areas of its parts. The area of the rectangle also equals the product of the lengths of its sides. So, $x^2 + 5x + 6 = (x + 2)(x + 3)$.

b.



$x^2 + 7x + 12 = (x + 3)(x + 4)$

97. $1500 - (30 - 2x)(50 - 2x) = 375$

$1500 - (1500 - 160x + 4x^2) - 375 = 0$

$-4x^2 + 160x - 375 = 0$

$-(2x - 5)(2x - 75) = 0$

$x = 2.5$

The border width is 2.5 ft.

98. $60x - x^2 = 800$

$-(x^2 - 60x + 800) = 0$

$-(x - 20)(x - 40) = 0$

$x = 20$

20 ft by 40 ft

99. $R = (200 - 2x)(60 + x)$

$R = -2(x - 100)(60 + x)$

$100, -60$

$\frac{100 - 60}{2} = 20$

To maximize revenue, charge \$80. Maximum revenue is \$12,800.

100. $(70 + 5x)(680 - 20x) = R$

$-100(x - 34)(x + 14) = R$

$34, -14$

$\frac{34 - 14}{2} = 10$

$-100(-24)(24) = R$

$\$57{,}600 = R$

Price for each camera should be \$480 and the maximum revenue is \$57,600.

101. $y = -0.0196x^2 + 1.37x$

$x = \frac{-1.37}{(2)(-0.0196)} \approx 35$

$y = -0.0196(35)^2 + 1.37(35)$

$y \approx 24$

Big Bertha could fire a shell about 70 miles with a maximum height of about 24 miles.

102. C

$(x - 2)(x - 2) = x^2 - 4x + 4 \neq x^2 + 4x + c$

103. $2x^2 - 11x + 16 = x^2 - 3x$

$x^2 - 8x + 16 = 0$

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

$x = 4$ D

104. $0 = 3(4)^2 + b(4) - 8$

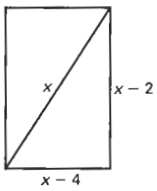
$8 - 48 = 4b$

$-40 = 4b$

$-10 = b$

B

105.



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

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

$0 = x^2 - 12x + 20$

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

$x = 10$

The door is 8 ch ih by 6 ch ih.

5.2 Mixed Review (p. 263)

106. $|x| = 3$

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

107. $|x - 2| = 6$

$x - 2 = -6$ or $x - 2 = 6$

$x = -4$ or $x = 8$

108. $|4x - 9| = 2$

$4x - 9 = -2$ or $4x - 9 = 2$

$4x = 7$ or $4x = 11$

$x = 1.75$ or $x = 2.75$

109. $|-5x + 4| = 14$

$-5x + 4 = -14$ or $-5x + 4 = 14$

$-5x = -18$ or $-5x = 10$

$x = 3.6$ or $x = -2$

110. $|7 - 3x| \neq -8$; no solution

111. $|x + 1| < 3$

$-3 < x + 1 < 3$

$-4 < x < 2$

112. $|2x - 5| \leq 1$

$-1 \leq 2x - 5 \leq 1$

$4 \leq 2x \leq 6$

$2 \leq x \leq 3$

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113. $|x - 4| > 7$

$x - 4 < -7$ or $x - 4 > 7$

$x < -3$ or $x > 11$

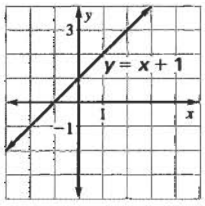
114. $\left|\frac{1}{3}x + 1\right| \geq 2$

$\frac{1}{3}x + 1 \leq -2$ or $\frac{1}{3}x + 1 \geq 2$

$\frac{1}{3}x \leq -3$ or $\frac{1}{3}x \geq 1$

$x \leq -9$ or $x \geq 3$

115.



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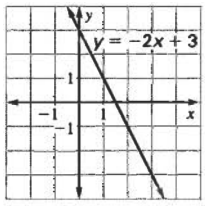

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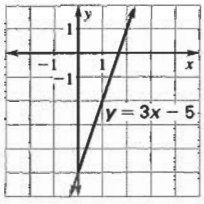

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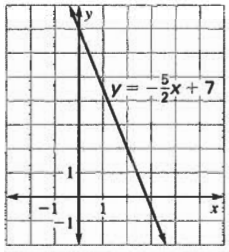

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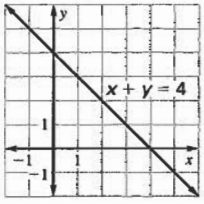

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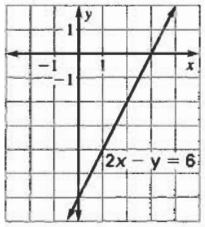

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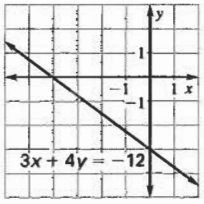

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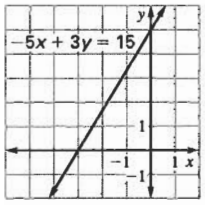

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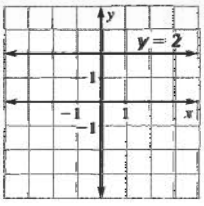

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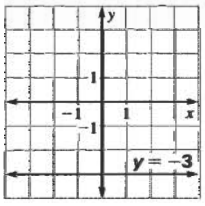

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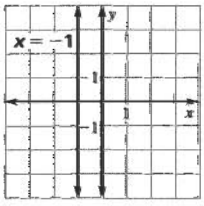

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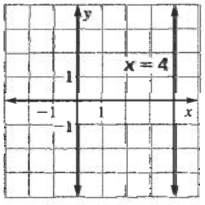

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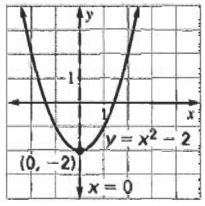

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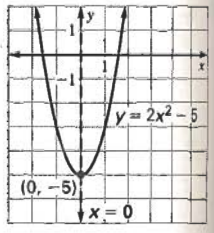

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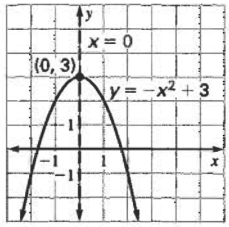

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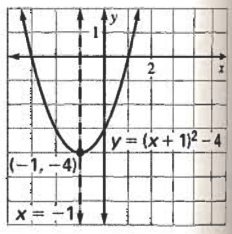

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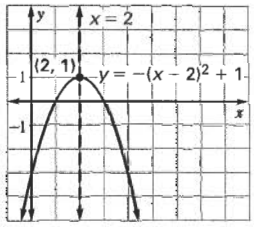

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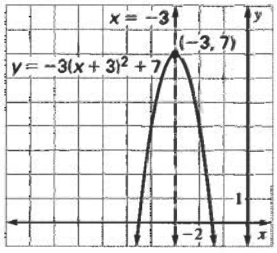

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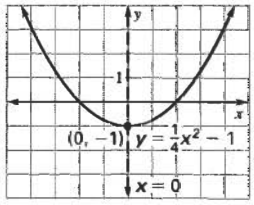

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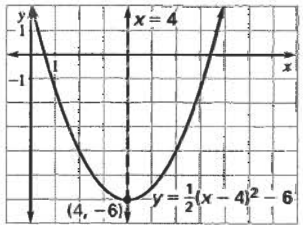
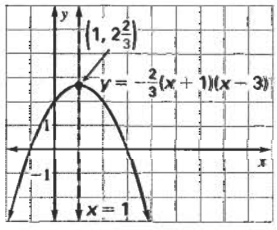


135.



136. $x + y = 22$

$2x + 3y = 50$

$2(22 - y) + 3y = 50$

$44 - 2y + 3y = 50$

$y = 6$

You can take the bus only 6 times.

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Lesson 5.3

Activity (p. 264)

1. a. $\sqrt{36} = 6$

$\sqrt{4} \cdot \sqrt{9} = 6$

b. $\sqrt{8} = 2\sqrt{2} \approx 2.8$

$\sqrt{2} \cdot \sqrt{4} = 2\sqrt{2} \approx 2.8$

c. $\sqrt{30} \approx 5.5$

$\sqrt{3} \cdot \sqrt{10} \approx 5.5$

1. a.–c. *Sample answer:* $\sqrt{ab} = \sqrt{a} \cdot \sqrt{b}$

2. a. $\sqrt{\frac{4}{9}} = \frac{2}{3}$

$\frac{\sqrt{4}}{\sqrt{9}} = \frac{2}{3}$

b. $\sqrt{\frac{25}{2}} \approx 3.5$

$\frac{\sqrt{25}}{\sqrt{2}} \approx 3.5$

c. $\sqrt{\frac{19}{7}} \approx 1.6$

$\frac{\sqrt{19}}{\sqrt{7}} \approx 1.6$

2. a.–c. *Sample answer:* $\sqrt{\frac{a}{b}} = \frac{\sqrt{a}}{\sqrt{b}}$

5.3 Guided Practice (p. 267)

1. *Sample answer:* to eliminate a radical from the denominator of a fraction

2. *Sample answer:* The product property says that the square root of a product equals the product of the square roots. The quotient property says that the square root of a quotient equals the quotient of the square roots.

3. 2; 1; 0 **4.** $\sqrt{7 \cdot 7} = 7$ **5.** $\sqrt{4 \cdot 3} = 2\sqrt{3}$

6. $\sqrt{5 \cdot 9} = 3\sqrt{5}$ **7.** $\sqrt{3} \cdot \sqrt{3 \cdot 9} = 9$

8. $\sqrt{\frac{16}{25}} = \frac{4}{5}$ **9.** $\frac{\sqrt{7}}{\sqrt{3 \cdot 3}} = \frac{\sqrt{7}}{3}$ **10.** $\frac{\sqrt{3}}{\sqrt{3} \cdot \sqrt{3}} = \frac{\sqrt{3}}{3}$

11. $\frac{\sqrt{5}\sqrt{2}}{\sqrt{2} \cdot \sqrt{2}} = \frac{\sqrt{10}}{2}$ **12.** $x^2 = 64$

$x = \pm 8$

13. $x^2 = 25$

$x = \pm 5$

14. $4x^2 = 16$

$x^2 = 4$

$x = \pm 2$

15. $x^2 = 12$

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

16. $(x - 1)^2 = 10$

$x - 1 = \pm\sqrt{10}$

$x = \pm\sqrt{10} + 1$

17. $(x + 8)^2 = 28$

$x + 8 = \pm 2\sqrt{7}$

$x = \pm 2\sqrt{7} - 8$

18. $h = -16t^2 + 50$

$0 = -16t^2 + 50$

$-50 = -16t^2$

$\frac{25}{8} = t^2$

$\sqrt{\frac{25}{8}} = t$

$1.8 \text{ sec} \approx t$

5.3 Practice and Applications (pp. 267–269)

19. $\sqrt{3 \cdot 3 \cdot 2} = 3\sqrt{2}$ **20.** $\sqrt{2 \cdot 2 \cdot 2 \cdot 2 \cdot 3} = 4\sqrt{3}$

21. $\sqrt{3 \cdot 3 \cdot 3} = 3\sqrt{3}$ **22.** $\sqrt{2 \cdot 2 \cdot 13} = 2\sqrt{13}$

23. $\sqrt{9 \cdot 2 \cdot 4} = 6\sqrt{2}$ **24.** $\sqrt{25 \cdot 7} = 5\sqrt{7}$

25. $\sqrt{49 \cdot 2} = 7\sqrt{2}$ **26.** $\sqrt{121 \cdot 5} = 11\sqrt{5}$

27. $2 \cdot 7 = 14$ **28.** $\sqrt{4 \cdot 2} \cdot \sqrt{2} = 4$

29. $\sqrt{3} \cdot \sqrt{3 \cdot 4} = 6$ **30.** $3\sqrt{4 \cdot 5} \cdot 6\sqrt{5} = 180$

31. $\sqrt{4 \cdot 3} \cdot \sqrt{2} = 2\sqrt{6}$ **32.** $\sqrt{2 \cdot 3} \cdot \sqrt{2 \cdot 5} = 2\sqrt{15}$

33. $4\sqrt{3} \cdot \sqrt{3 \cdot 7} = 12\sqrt{7}$

34. $\sqrt{2 \cdot 2 \cdot 2} \cdot \sqrt{2 \cdot 3} \cdot \sqrt{3} = 12$ **35.** $\frac{\sqrt{1}}{\sqrt{9}} = \frac{1}{3}$

36. $\frac{\sqrt{4}}{\sqrt{49}} = \frac{2}{7}$ **37.** $\frac{\sqrt{36}}{\sqrt{25}} = \frac{6}{5}$ **38.** $\frac{\sqrt{100}}{\sqrt{81}} = \frac{10}{9}$

39. $\frac{\sqrt{3}}{\sqrt{16}} = \frac{\sqrt{3}}{4}$ **40.** $\frac{\sqrt{11}}{\sqrt{64}} = \frac{\sqrt{11}}{8}$ **41.** $\frac{\sqrt{75}}{\sqrt{36}} = \frac{5\sqrt{3}}{6}$

42. $\frac{\sqrt{40}}{\sqrt{169}} = \frac{2\sqrt{10}}{13}$ **43.** $\frac{2\sqrt{3}}{\sqrt{3} \cdot \sqrt{3}} = \frac{2\sqrt{3}}{3}$

44. $\frac{5\sqrt{17}}{\sqrt{17} \cdot \sqrt{17}} = \frac{5\sqrt{17}}{17}$ **45.** $\frac{\sqrt{6} \cdot \sqrt{5}}{\sqrt{5} \cdot \sqrt{5}} = \frac{\sqrt{30}}{5}$

46. $\frac{\sqrt{144} \cdot \sqrt{11}}{\sqrt{11} \cdot \sqrt{11}} = \frac{12\sqrt{11}}{11}$ **47.** $\frac{\sqrt{7} \cdot \sqrt{2}}{\sqrt{8} \cdot \sqrt{2}} = \frac{\sqrt{14}}{4}$

48. $\frac{\sqrt{18} \cdot \sqrt{13}}{\sqrt{13} \cdot \sqrt{13}} = \frac{3\sqrt{26}}{13}$ **49.** $\frac{\sqrt{45} \cdot \sqrt{2}}{\sqrt{32} \cdot \sqrt{2}} = \frac{3\sqrt{10}}{8}$

50. $\frac{\sqrt{20}}{\sqrt{7}} = \frac{2\sqrt{35}}{7}$ **51.** $x^2 = 121$

$x = \pm 11$

52. $x^2 = 90$

$x = \pm 3\sqrt{10}$

53. $3x^2 = 108$

$x^2 = 36$

$x = \pm 6$

54. $2x^2 = 36$

$x^2 = 18$

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

55. $-x^2 = -75$

$x^2 = 75$

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

56. $10u^2 = 6$

$u^2 = \frac{6}{10}$

$u = \pm\frac{\sqrt{60}}{10} = \pm\frac{\sqrt{15}}{5}$

57. $\frac{v^2}{25} = 12$

$v^2 = 12 \cdot 25$

$v = \pm 10\sqrt{3}$

58. $\frac{p^2}{8} = 10$

$p^2 = 8 \cdot 10$

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

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59. $\frac{q^2}{2} = 72$

$q^2 = 144$

$q = \pm 12$

60. $2(x^2 - 6x + 9) - 8 = 0$

$2x^2 - 12x + 18 - 8 = 0$

$2x^2 - 12x + 10 = 0$

$2(x^2 - 6x + 5) = 0$

$2(x - 1)(x - 5) = 0$

$1, 5$

61. $4(x^2 + 2x + 1) - 100 = 0$

$4x^2 + 8x + 4 - 100 = 0$

$4x^2 + 8x - 96 = 0$

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

$4(x + 6)(x - 4) = 0$

$-6, 4$

62. $-3(x + 2)^2 = -18$

$(x + 2)^2 = 6$

$x + 2 = \pm\sqrt{6}$

$x = -2 \pm \sqrt{6}$

$-2 - \sqrt{6}, -2 + \sqrt{6}$

63. $5(x - 7)^2 = 135$

$(x - 7)^2 = 27$

$x - 7 = \pm 3\sqrt{3}$

$x = 7 \pm 3\sqrt{3};$

$7 + 3\sqrt{3}, 7 - 3\sqrt{3}$

64. $8(x + 4)^2 = 9$

$x + 4 = \pm\sqrt{\frac{9}{8}}$

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

$\frac{3\sqrt{2}}{4} - 4, -\frac{3\sqrt{2}}{4} - 4$

65. $2(a - 6)^2 = 98$

$(a - 6)^2 = 49$

$a - 6 = \pm 7$

$a = 6 \pm 7;$

$13, -1$

66. $(b - 8)^2 = 28$

$b - 8 = \pm 2\sqrt{7}$

$b = 8 \pm 2\sqrt{7};$

$8 + 2\sqrt{7}, 8 - 2\sqrt{7}$

67. $(2r - 5)^2 = 81$

$(2r - 5) = \pm 9$

$2r = 5 \pm 9$

$r = \frac{5 \pm 9}{2};$

$7, -2$

68. $(s + 1)^2 - 24 = 75$

$(s + 1)^2 = 99$

$s + 1 = \pm 3\sqrt{11}$

$s = -1 \pm 3\sqrt{11};$

$-1 + 3\sqrt{11}, -1 - 3\sqrt{11}$

69. $0 = -16t^2 + 177$

$16t^2 = 177$

$t = \frac{\sqrt{177}}{4}$

$t \approx 3.3$ sec

70. **a.** $h = -16t^2 + 20$

b.

t	0	0.1	0.2	0.3	0.4	0.5	0.6
h	20	19.84	19.36	18.56	17.44	16	14.24

t	0.7	0.8	0.9	1.0	1.1	1.2	1.3
h	12.16	9.76	7.04	4	0.64	−3.04	−7.04

t	1.4	1.5
h	−11.36	−16

$0 = -16t^2 + 20$

$16t^2 = 20$

$t^2 = \frac{20}{16} = \frac{5}{4}$

$t = \frac{\sqrt{5}}{2}$

$t \approx 1.1$ sec

71. Earth

$0 = -16t^2 + 200$

$16t^2 = 200$

$t = \frac{5\sqrt{2}}{2}$

$t \approx 3.5$ sec

Mars

$0 = -6t^2 + 200$

$6t^2 = 200$

$t = \frac{20\sqrt{3}}{6}$

$t \approx 5.8$ sec

Jupiter

$0 = -\frac{81}{2}t^2 + 200$

$81t^2 = 400$

$t = \sqrt{\frac{400}{81}}$

$t = \frac{20}{9}$

$t \approx 2.2$ sec

Neptune

$0 = -18t^2 + 200$

$18t^2 = 200$

$t = \sqrt{\frac{200}{18}}$

$t = \frac{20}{6}$

$t \approx 3.3$ sec

—CONTINUED—

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71. **—CONTINUED—**

Pluto

$0 = -\frac{2.1}{2}t^2 + 200$

$2.1t^2 = 400$

$t = \sqrt{\frac{400}{2.1}}$

$t = \frac{20\sqrt{2.1}}{2.1}$

$t \approx 13.8$ sec

72. $15 = 0.019s^2$

$\sqrt{\frac{15}{0.019}} = s$

28.1 knots $\approx s$

73. $27^2 = (4x)^2 + (3x)^2$

$27^2 = 16x^2 + 9x^2$

$27^2 = 25x^2$

$\frac{27^2}{5^2} = x^2$

$\frac{27}{5} = x$

21.6 in. by 16.2 in.

74. a. $20 = 0.00256s^2$

$\sqrt{\frac{20}{0.00256}} = s$

$88.4 \approx s$

about 88.4 mi/h

b. $40 = 0.00256s^2$

$\sqrt{\frac{40}{0.00256}} = s$

$125 = s$

No; *Sample answer:* When $P = 40$ lb/ft^2, speed is 125 mi/h which is not $2 \cdot 88.4$.

c. *Sample answer:* The wind speed value is squared in the formula and squaring increases the pressure value quickly.

75. a. $12.5 = \left(\sqrt{25} - \frac{2\pi(2)^2\sqrt{3}}{60 \times 30}t\right)^2$

$12.5 = \left(5 - \frac{8\pi\sqrt{3}}{1800}t\right)^2$

$\sqrt{12.5} = 5 - \frac{8\pi\sqrt{3}}{1800}t$

$6364 = 9000 - 8\pi\sqrt{3}t$

$-2636 = -8\pi\sqrt{3}t$

$\frac{-2636}{-8\pi\sqrt{3}} = t$

$60.6 \approx t$

about 60.6 sec

b. $0 = \left(\sqrt{12.5} - \frac{2\pi(2)^2\sqrt{3}t}{60 \times 30}\right)^2$

$0 = \sqrt{12.5} - \frac{8\pi\sqrt{3}t}{1800}$

$-1800\sqrt{12.5} = -8\pi\sqrt{3}t$

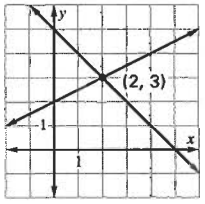
$\frac{-1800\sqrt{12.5}}{-8\pi\sqrt{3}} = t$

$146.2 \approx t$

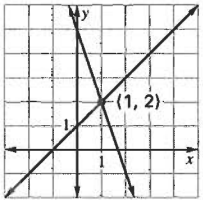
about 146.2 sec

c. *Sample answer:* The water drains more slowly as the time increases.

76.



77.



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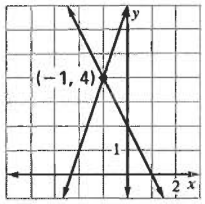
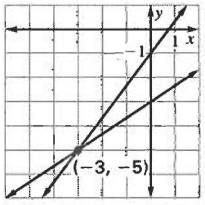
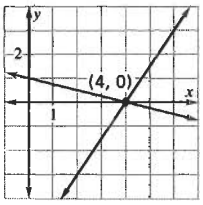


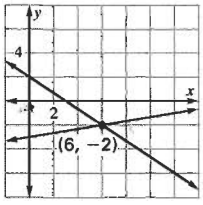
79.



80.



81.



82. $\begin{bmatrix} 1 & -5 \\ 18 & 0 \end{bmatrix}$

83. $\begin{bmatrix} 13 & -1 \\ -11 & 1 \end{bmatrix}$

84. $\begin{bmatrix} 12 & -20 & 4 \\ -16 & 16 & -32 \end{bmatrix}$

85. $\begin{bmatrix} -24 & -20 \\ -40 & 18 \end{bmatrix} + \begin{bmatrix} 105 & 77 \\ 0 & -49 \end{bmatrix} = \begin{bmatrix} 81 & 57 \\ -40 & -31 \end{bmatrix}$

86. $y = x^2 + 5x - 2x - 10$

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

87. $y = x^2 - x - 8x + 8$

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

88. $y = 2x^2 + 7x + 8x + 28$

$y = 2x^2 + 15x + 28$

89. $y = 16x^2 + 36x - 36x - 81$

$y = 16x^2 - 81$

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90. $y = x^2 - 3x - 3x + 9 + 1$

$y = x^2 - 6x + 10$

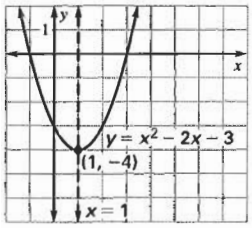
91. $y = 5(x^2 + 6x + 6x + 36) - 12$

$y = 5x^2 + 60x + 180 - 12$

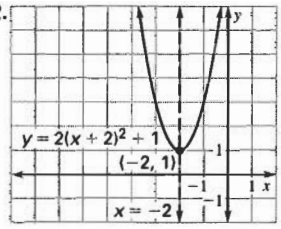
$y = 5x^2 + 60x + 168$

Quiz 1 (p. 270)

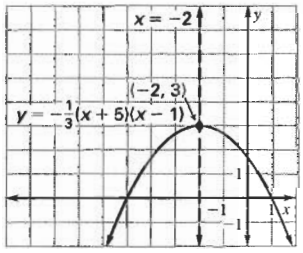
1.



2.



3.



4. $(x + 3)(x - 9) = 0$

$x + 3 = 0$ $\qquad$ $x - 9 = 0$

$x = -3$ $\qquad$ $x = 9$

5. $(4x + 5)(x + 4) = 0$

$4x + 5 = 0$ $\qquad$ $x + 4 = 0$

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

6. $4t^2 - 4t + 1 = 0$

$(2t - 1)(2t - 1) = 0;$

$2t - 1 = 0$

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

7. $\sqrt{54} = \sqrt{9 \cdot 6} = 3\sqrt{6}$

8. $7\sqrt{2} \cdot \sqrt{2 \cdot 5} = 14\sqrt{5}$

9. $\sqrt{\frac{36}{5}} = \sqrt{\frac{36 \cdot 5}{5 \cdot 5}} = \frac{6\sqrt{5}}{5}$

10. $\frac{4}{\sqrt{4 \cdot 3}} = \frac{4\sqrt{3}}{6} = \frac{2\sqrt{3}}{3}$

11. $10 = 1.35s^2$

$\sqrt{\frac{10}{1.35}} = s \approx 2.7$ mi/h

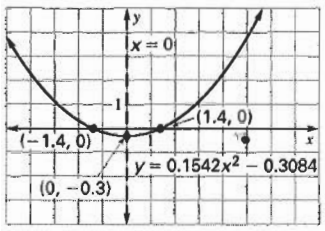
Math and History (p. 270)

1. $y = 0$; the x-axis lines up with the liquid's surface.

2. $y = \frac{\pi^2(0.5)^2}{16}x^2 - \frac{\pi^2(0.5)^2(2)^2}{32}$

$y = \frac{0.25\pi^2}{16}x^2 - \frac{0.25\pi^2}{8}$

$y = 0.1542x^2 - 0.3084$



3. $0 = (2\pi^2f^2x^2 - \pi^2f^2R^2)$

$0 = \left(\sqrt{2}\pi fx + \pi fR\right)\left(\sqrt{2}\pi xf - \pi fR\right)$

$-\sqrt{2}\pi fx = \pi fR$

$x = \frac{\pi fR}{-\sqrt{2}\pi f} = -\frac{R\sqrt{2}}{2}$

$\sqrt{2}\pi fx = \pi fR$

$x = \frac{\pi fR}{\sqrt{2}\pi f} = \frac{R\sqrt{2}}{2}$

No, the x-intercepts are in terms of the radius only.

Technology Activity 5.3 (p. 271)

1. $-1.53, 1.53$

2. $-1.73, 1.73$

3. $-2.45, 2.45$

4. $-2.87, 2.87$

5. $-2.73, 0.73$

6. $-0.90, 8.90$

7. $-3.65, 1.65$

8. $-0.85, 2.35$

9. $48\pi = 6\pi r^2$

$8 = r^2$

$2.8 \text{ in.} \approx r$

Lesson 5.4

5.4 Guided Practice (p. 277)

1. $3, -7i$

2. *Sample answer:* The real part should be the same and the imaginary part should be the opposite of the given imaginary part; $-5 - 2i$.

3. *Sample answer:* distance from origin

4. $x^2 = -9$

$x = \pm 3i$

5. $2x^2 = -16$

$x^2 = -8$

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

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