Terms

sary pages 651–657

nay wish to preteach some of the key
s used in this chapter. Particularly for
sh Language Learners (ELL),
enting the vocabulary before the
ter or lesson begins gives students a
start into understanding the new
rial. Writing new words on poster
r, pointing to the words as you say
, then displaying the poster for a
d of time is a useful technique.

olete the square (p. 586)
iminant (p. 591)
ratic equation (p. 576)
ratic formula (p. 589)
dard form of a quadratic equation
. 576)

CHAPTER 13

What You'll Learn in Chapter 13

- How to solve a quadratic equation
- How to use the quadratic formula and the discriminant
- How to solve problems using quadratic equations
- How to solve rational and radical equations

Skills & Concepts You Need for Chapter 13

5-10 Multiply.

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

6-8 Solve.

3. $x^2 - 6x = 0$ **4.** $x^2 - 5x + 6 = 0$

10-6 Solve.

5. $2x + \frac{8}{x} = 8$ **6.** $\frac{x-2}{x+2} = \frac{1}{4}$

11-3 Simplify.

7. $\sqrt{88}$ **8.** $\sqrt{20}$ **9.** $\sqrt{44}$ **10.** $\sqrt{32}$

11-5 Rationalize the denominator.

11. $\sqrt{\frac{7}{3}}$ **12.** $\sqrt{\frac{5}{2}}$ **13.** $\sqrt{\frac{1}{5}}$ **14.** $\sqrt{\frac{7}{8}}$

12-7 Graph the following quadratic functions.

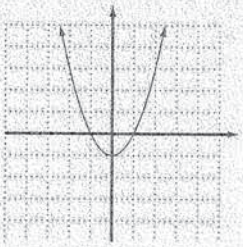
15. $f(x) = x^2 - 1$ **16.** $y = -x^2 + 2$

574

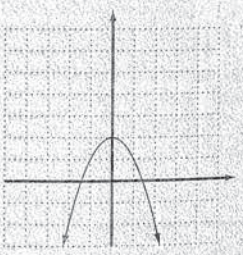
$x^2 - 10x + 25$
$9x^2 + 6x + 1$
0, 6
2, 3
2
$\frac{10}{3}$
$2\sqrt{22}$
$2\sqrt{5}$

9. $2\sqrt{11}$
10. $4\sqrt{2}$
11. $\frac{\sqrt{21}}{3}$
12. $\frac{\sqrt{10}}{2}$
13. $\frac{\sqrt{5}}{5}$
14. $\frac{\sqrt{14}}{4}$

15.



16.



Teach the Mathematics (continued)

ıtions of the Form
$+ bx + c = 0$

rd Example
$x^2 - 4x = x - 6.$
$- 5x + 6 = 0$
$)(x - 3) = 0$
$=$ or $x = 3$

CTICE/ASSESS

QUIZ
in standard form and determine
nd c for
$9x + 3.$
$9x - 3 = 0$
$, b = -9, c = -3$
$3x^2 - 2x = 0.$
or $x = \frac{2}{3}$
$x^2 = 7x - 10.$
or $x = 5$

ıment Guide
ɔvide flexible scheduling, this
ı can be split into parts.
re 1–9, 49–58 (writing
ndard form only)
ension 65
re 10–24
ension 59–64, 66
re 25–52
ension 53–58, 67–70

Mixed Review to maintain skills.

$x^2-3x+2=0; a=1, b=-3, c=2$
$)x^2-8x-5;$
$a=1, b=-8, c=-5$
$)2x^2-3=0; a=2, b=0, c=-3$
$)5x^2-9=0; a=5, b=0, c=-9$
$)7x^2-4x+3=0;$
$a=7, b=-4, c=3$

Quick Review

To factor $ax^2 + bx + c$, see Lesson 6-5.

Extra Help On the Web

Look for worked-out examples at the Prentice Hall Web site.
www.phschool.com

PART 3 Equations of the Form $ax^2 + bx + c = 0$

Objective: Solve an equation of the form $ax^2 + bx + c = 0$.

We can also use the principle of zero products to solve equations of the form $ax^2 + bx + c = 0$, if $ax^2 + bx + c$ can be factored.

EXAMPLE 4 Solve.

$$\begin{aligned} y^2 - 5y + 6 &= 6y - 18 \\ y^2 - 11y + 24 &= 0 && \text{Standard form} \\ (y - 8)(y - 3) &= 0 && \text{Factoring} \\ y - 8 = 0 \quad &\text{or} \quad y - 3 = 0 \\ y = 8 \quad &\text{or} \quad y = 3 \end{aligned}$$

Substitution will show that 8 and 3 check. The solutions are 8 and 3.

Try This Solve.

f. $3x^2 + x - 2 = 0$ **g.** $x^2 + 4x + 8 = 8x + 29$

13-1 Exercises

A

Write each equation in standard form and determine a, b, and c.

1. $x^2 - 3x + 2 = 0$ **2.** $x^2 - 8x - 5 = 0$ **3.** $2x^2 = 3$
4. $5x^2 = 9$ **5.** $7x^2 = 4x - 3$ **6.** $9x^2 = x + 5$
7. $5 = -2x^2 + 3x$ **8.** $2x = x^2 - 5$ **9.** $2x - 1 = 3x^2 + 7$

Solve.

10. $x^2 + 7x = 0$ **11.** $x^2 + 5x = 0$ **12.** $3x^2 + 6x = 0$
13. $4p^2 + 8p = 0$ **14.** $5x^2 - 2x = 0$ **15.** $3n^2 - 7n = 0$
16. $4x^2 + 4x = 0$ **17.** $2t^2 - 2t = 0$ **18.** $10x^2 - 30x = 0$
19. $10x^2 - 50x = 0$ **20.** $55x^2 - 11x = 0$ **21.** $33x^2 + 11x = 0$
22. $14x^2 - 3x = 0$ **23.** $17x^2 - 8x = 0$ **24.** $3x^2 - 81x = 0$

Solve.

25. $p^2 - 16p + 48 = 0$ **26.** $x^2 + 8x - 48 = 0$
27. $x^2 + 7x + 6 = 0$ **28.** $x^2 + 6x + 5 = 0$
29. $m^2 + 4m - 21 = 0$ **30.** $x^2 + 7x - 18 = 0$
31. $t^2 - 9t + 14 = 0$ **32.** $x^2 - 8x + 15 = 0$

6. $9x^2 - x - 5 = 0$; $a = 9, b = -1, c = -5$
7. $2x^2 - 3x + 5 = 0$; $a = 2, b = -3, c = 5$
8. $x^2 - 2x - 5 = 0$; $a = 1, b = -2, c = -5$
9. $3x^2 - 2x + 8 = 0$; $a = 3, b = -2, c = 8$
10. 0, −7
11. 0, −5
12. 0, −2
13. 0, −2
14. $0, \frac{2}{5}$
15. $0, \frac{7}{3}$
16. 0, −1
17. 0, 1
18. 0, 3
19. 0, 5
20. $0, \frac{1}{5}$
21. $0, -\frac{1}{3}$
22. $0, \frac{3}{14}$
23. $0, \frac{8}{17}$
24. 0, 27
25. 4, 12
26. 4, −12
27. −1, −6
28. −1, −5
29. 3, −7
30. 2, −9
31. 2, 7
32. 3, 5

33. $x^2 + 10x + 25 = 0$
34. $x^2 + 6x + 9 = 0$
35. $x^2 - 2x + 1 = 0$
36. $x^2 - 8x + 16 = 0$
37. $2x^2 - 13x + 15 = 0$
38. $6x^2 + x - 2 = 0$
39. $3a^2 - 10a - 8 = 0$
40. $9b^2 - 15b + 4 = 0$
41. $3x^2 - 7x = 20$
42. $6x^2 - 4x = 10$
43. $2x^2 + 12x = -10$
44. $12x^2 - 5x = 2$
45. $6x^2 + x - 1 = 0$
46. $6x^2 + 13x + 6 = 0$
47. $2x^2 + 3x = 35$
48. $12x^2 + 7x - 12 = 0$

B

Solve.

49. $t(t - 5) = 14$
50. $m(3m + 1) = 2$
51. $3y^2 + 8y = 12y + 15$
52. $18 + 2z = z^2 - 5z$
53. $t(9 + t) = 4(2t + 5)$
54. $16(p - 1) = p(p + 8)$
55. $(2x - 3)(x + 1) = 4(2x - 3)$
56. $(3x - 1)(2x + 1) = 3(2x + 1)$
57. $(2m - 1)(m + 3) = -2(m + 4)$
58. $(m + 2)(2m + 3) = (m + 2)^2$
59. $1 = \frac{1}{3}x^2$
60. $x^2 + \sqrt{3}x = 0$
61. $\sqrt{5}y^2 - y = 0$
62. $\sqrt{7}x^2 + \sqrt{3}x = 0$
63. $\sqrt{5}y^2 + y = 0$
64. $\sqrt{3}x^2 - \sqrt{8}x = 0$

65. ***Critical Thinking*** Find a quadratic function, $f(x) = ax^2 + bx + c$, with $x = -\frac{3}{8}$ as its axis of symmetry and whose value for c is 7.

Challenge

Find an equation of the indicated form having the solutions shown.

	Equation form	Solutions		Equation form	Solutions
66.	$ax^2 + bx = 0$	$0, -6$	**67.**	$ax^2 + bx + c = 0$;	$4, \frac{3}{4}$
68.	$ax^2 + bx + c = 0$	$\frac{2}{5}, -5$	**69.**	$ax^3 + bx^2 + cx = 0$;	$0, \frac{1}{2}, -3$

70. ***Write a Convincing Argument*** How many equations have the form $ax^2 + bx + c = 0$ and solutions 2 and 5?

Mixed Review

Determine the replacements for the variables that give real numbers.

71. $\sqrt{5x^2}$ **72.** $\sqrt{x - 3}$ **73.** $\sqrt{x + 5}$ **74.** $\sqrt{3x - 2}$ *11-1*

Factor. **75.** $4m^2 - 10m - 6$ **76.** $c^2 - c - 90$ **77.** $y^2 - 121$

78. $9x^2 + 63x + 54$ **79.** $x^2y + 4xy + 4y$

80. $2ab + 2bc + 3ad + 3dc$ *6-2, 6-4, 6-5, 6-7*

Write roster notation for each set. **81.** $G = \{x | x \text{ is a positive factor of } 6\}$

82. $H = \{y | y \text{ is a perfect square and } 20 < y < 50\}$ *9-1*

Quick Review

The graph of a quadratic function is a parabola. The axis of symmetry contains the vertex of the parabola. See Lesson 12-4.

33. -5
34. -3
35. 1
36. 4
37. $\frac{3}{2}, 5$
38. $-\frac{2}{3}, \frac{1}{2}$
39. $4, -\frac{2}{3}$
40. $\frac{4}{3}, \frac{1}{3}$
41. $4, -\frac{5}{3}$
42. $\frac{5}{3}, -1$
43. $-1, -5$
44. $\frac{2}{3}, -\frac{1}{4}$
45. $\frac{1}{3}, -\frac{1}{2}$
46. $-\frac{3}{2}, -\frac{2}{3}$
47. $-5, \frac{7}{2}$
48. $\frac{3}{4}, -\frac{4}{3}$
49. $-2, 7$
50. $\frac{2}{3}, -1$
51. $3, -\frac{5}{3}$
52. $-2, 9$
53. $4, -5$
54. 4
55. $\frac{3}{2}, 3$
56. $\frac{4}{3}, -\frac{1}{2}$
57. $-1, -\frac{5}{2}$
58. $-2, -1$
59. $\pm\sqrt{3}$
60. $-\sqrt{3}, 0$
61. $\frac{\sqrt{5}}{5}, 0$
62. $-\frac{\sqrt{21}}{7}, 0$
63. $-\frac{\sqrt{5}}{5}, 0$
64. $\frac{2\sqrt{6}}{3}, 0$

65–69. Answers may vary. Samp answers are given.

65. $f(x) = 4x^2 + 3x + 7$
66. $x^2 + 6x = 0$
67. $4x^2 - 19x + 12 = 0$
68. $5x^2 + 23x - 10 = 0$
69. $2x^3 + 5x^2 - 3x = 0$
70. infinitely many

Mixed Review

71. Any value
72. $x \geq 3$
73. $x \geq -5$
74. $x \geq \frac{2}{3}$
75. $2(2m + 1)(m - 3)$
76. $(c + 9)(c - 10)$
77. $(y - 11)(y + 11)$
78. $9(x + 1)(x + 6)$
79. $y(x + 2)^2$
80. $(2b + 3d)(a + c)$
81. {1, 2, 3, 6}
82. {25, 36, 49}

Try This

k. Suppose \$400 is invested at interest rate r compounded annually and grows to \$529 in two years. What is the interest rate?

13-2 Exercises

Extra Help On the Web

Look for worked-out examples at the Prentice Hall Web site.
www.phschool.com

A

Mental Math Solve.

1. $x^2 = 121$ **2.** $x^2 = 10$ **3.** $5x^2 = 35$

4. $3x^2 = 30$ **5.** $5a^2 = 3$ **6.** $2x^2 = 5$

Solve.

7. $4t^2 - 25 = 0$ **8.** $9x^2 - 4 = 0$ **9.** $3x^2 - 49 = 0$

10. $5x^2 - 16 = 0$ **11.** $4y^2 - 3 = 9$ **12.** $49m^2 - 16 = 0$

13. $25n^2 - 36 = 0$ **14.** $5d^2 - 100 = 0$ **15.** $100x^2 - 5 = 0$

Solve.

16. $(x - 2)^2 = 49$ **17.** $(x + 1)^2 = 6$ **18.** $(d + 3)^2 = 21$

19. $(b - 3)^2 = 6$ **20.** $(x + 13)^2 = 8$ **21.** $(x - 13)^2 = 64$

22. $(x - 7)^2 = 12$ **23.** $(n + 1)^2 = 14$ **24.** $(x + 9)^2 = 34$

25. $(y + 4)^2 = 36$ **26.** $(m + 10)^2 = 15$ **27.** $(y - 5)^2 = 20$

Solve.

28. $x^2 + 2x + 1 = 81$ **29.** $x^2 - 2x + 1 = 16$

30. $y^2 + 10y + 25 = 121$ **31.** $y^2 - 12y + 36 = 49$

32. $m^2 + 4m + 4 = 29$ **33.** $c^2 + 16c + 64 = 15$

34. $x^2 - 6x + 9 = 91$ **35.** $x^2 - 14x + 49 = 19$

36. $n^2 - 8n + 16 = 15$ **37.** $d^2 + 24d + 144 = 8$

For Exercises 38–41, use the formula $-5t^2 + v_0t + c = h$.

38. A ball is thrown upwards from a height of 20 m with an initial velocity of 15 m/s. In about how many seconds will it hit the ground?

39. Eddie threw a stone into the lake from the end of a pier that was 4 m above the lake surface. He released the stone with an upward velocity of 19 m/s. About how long did it take for the stone to hit the water?

40. A rock 80 m up the face of a cliff breaks loose. About how long does it take the rock to fall to the ground?

41. While cleaning a squirrel nest from a gutter on her house, Mrs. Daugherty threw an acorn downwards with a speed of 1 m/s ($v_0 = -1$). About how long did it take the acorn to fall 4 m to the ground?

3. PRACTICE/ASSESS

LESSON QUIZ

Solve.

1. $25x^2 = 4$
   $x = \pm\frac{2}{5}$
2. $(x - 5)^2 = 64$
   $x = 13$ or $x = -3$
3. $x^2 - 6x + 9 = 4$
   $x = 1$ or $x = 5$

Assignment Guide

To provide flexible scheduling lesson can be split into parts.

- Core 1–15, 17–27 odd, 43–4
  Extension 50–53
- Core 16–26 even, 28–37, 4
  even
  Extension 54–57, 63, 68
- Core 38–41, 58–62, 64, 65
  Extension 66, 67, 69, 70

Use Mixed Review to maintai

Try This

k. 15%

Exercises

1. ± 11
2. $\pm\sqrt{10}$
3. $\pm\sqrt{7}$
4. $\pm\sqrt{10}$
5. $\pm\frac{\sqrt{15}}{5}$
6. $\pm\frac{\sqrt{10}}{2}$
7. $\pm\frac{5}{2}$
8. $\pm\frac{2}{3}$
9. $\pm\frac{7\sqrt{3}}{3}$
10. $\pm\frac{4\sqrt{5}}{5}$
11. $\pm\sqrt{3}$
12. $\pm\frac{4}{7}$
13. $\pm\frac{6}{5}$
14. $\pm 2\sqrt{5}$
15. $\pm\frac{\sqrt{5}}{10}$
16. 9, −5
17. $-1 \pm \sqrt{6}$
18. $-3 \pm \sqrt{21}$
19. $3 \pm \sqrt{6}$
20. $-13 \pm 2\sqrt{2}$
21. 21, 5
22. $7 \pm 2\sqrt{3}$
23. $-1 \pm \sqrt{14}$
24. $-9 \pm \sqrt{34}$
25. 2, −10
26. $-10 \pm \sqrt{15}$
27. $5 \pm 2\sqrt{5}$
28. −10, 8
29. −3, 5
30. 6, −16
31. 13, −1
32. $-2 \pm \sqrt{29}$
33. $-8 \pm \sqrt{15}$
34. $3 \pm \sqrt{91}$
35. $7 \pm \sqrt{19}$
36. $4 \pm \sqrt{15}$
37. $-12 \pm 2\sqrt{2}$
38. 4
39. 4 s
40. 4 s
41. $\frac{4}{5}$ s

The amount P is invested at interest rate r compounded annually and grows to the amount A in two years. Find the interest rate. Use $A = P(1 + r)^t$.

42. $P = \$100, A = \$121$
43. $P = \$2560, A = \$3610$
44. $P = \$6250, A = \$7290$
45. $P = \$400, A = \$453.69$
46. $P = \$1000, A = \$1267.88$
47. $P = \$4000, A = \$5267.03$
48. $P = \$1600, A = \$1772.41$
49. $P = \$1000, A = \$1232.10$

B

Solve for x.

50. $4x^2 - (x + 1)^2 = 0$
51. $(x - b)^2 = 4b^2$
52. $2(3x + 1)^2 = 8$
53. $5(5x - 2)^2 - 7 = 13$
54. $9x^2 - 24x + 16 = 2$
55. $64x^2 + 48x + 9 = 100$
56. $\frac{x - 1}{9} = \frac{1}{x - 1}$
57. $\frac{5}{x + 4} - \frac{3}{x - 2} = 4$

58. A diver springs upward from a 10-m diving board with a velocity of $\frac{7}{4}$ m/s. In about how many seconds will she enter the water?

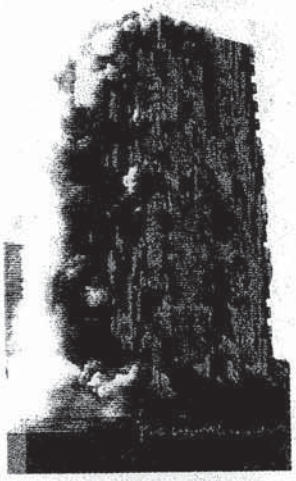
When an object is dropped, or thrown downward with an initial downward velocity v_0, the approximate distance (d) in meters the object travels in t seconds is given by the formula $d = 5t^2 + v_0t$.

59. A 134-m tall Detroit department store building was destroyed by controlled implosion in 1998. Use the formula above to estimate how long it took for a piece that broke away from the roof to reach the ground.

60. When a tall concrete chimney was imploded at a copper smelter in McGill, Nevada, in 1993, a piece of concrete from the top took 6.75 s to reach the ground. About how tall was the chimney?

61. a. ***Multi-Step Problem*** Three of the most striking vertical geological features in the American West are Chimney Rock in Nebraska, Devils Tower in Wyoming, and El Capitan in California. They rise to heights of 136 m, 386 m, and 1095 m, respectively, above the surrounding land. For each of these natural landforms, how long (to the nearest tenth of a second) would it take a dropped object to fall a distance equal to the height?

b. An object is thrown downward from the top of El Capitan. What initial velocity must it have in order to fall 1095 m in the same time it takes a dropped object to fall 386 m? 136 m?



When a 100-m tall building is imploded, about how long does it take for a piece that breaks off from the roof to fall to the ground?

62. An object is dropped, in turn, from the tops of two of San Francisco's tallest buildings, one 260 m tall and the other 237 m tall.

a. What is the difference in the times it takes to reach the ground?

b. ***Write a Convincing Argument*** The difference in the heights of the buildings is 23 m. Is the time difference in part a equal to the time it takes the object dropped from the taller building to travel the first 23 m, the last 23 m, or neither?

Exercises

42. 10%
43. 18.75%
44. 8%
45. 6.5%
46. 12.6%
47. 14.75%
48. 5.25%
49. 11%
50. $1, -\frac{1}{3}$
51. $3b, -b$
52. $\frac{1}{3}, -1$
53. $\frac{4}{5}, 0$
54. $\frac{1}{3}(4 \pm \sqrt{2})$
55. $-\frac{13}{8}, \frac{7}{8}$
56. $4, -2$
57. $1, -\frac{5}{2}$
58. $\frac{8}{5}$ or $1\frac{3}{5}$
59. About 5 s
60. 228 m

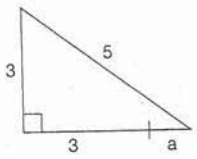
Photo caption: 4.5 s

61. a. 5.2 s, 8.8 s, 14.8 s
    b. About 81 m/s; about 184 m/s
62. a. About 0.3 s
    b. The last 23 m

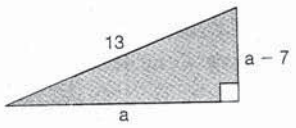
63. ***Critical Thinking*** Solve the quadratic equation $x^2 + 4x + 4 = 9$. Check each solution by substituting it for x in $x^2 + 4x + 4$ and simplifying. Then solve the quadratic equation $x^2 + 4x + 4 = 8$. Check its solutions by the same method.

The triangles shown are right triangles. Use the Pythagorean theorem to find the value of a.

64.



65.



Challenge

In Exercises 66 and 67 the interest is compounded annually and the interest rates are annual rates.

66. a. For an investment of \$2000 to double in value in two years, what would the interest rate have to be?

b. ***Mathematical Reasoning*** Will an interest rate of 30% double the value of an investment P in 2 years for some, all, or no values of P? Explain.

67. In two years you want to have \$3000. How much do you need to invest now if you can get an interest rate of 5.75%?

68. ***Multi-Step Problem*** Solve $y^4 - 4y^2 + 4 = 0$. (Hint: Let $x = y^2$. Solve for x, then solve for y after finding x.)

69. The amount of \$1000 is invested at a quarterly interest rate of 2% compounded quarterly. What is the total amount in the account at the end of two years?

70. The amount of \$2000 is invested at an annual interest rate of 12% compounded quarterly. What is the total amount in the account at the end of two years? (Hint: First calculate the quarterly interest rate.)

Mixed Review

Graph each function. **71.** $f(x) = x^2 - 3$ **72.** $g(x) = 3 - x^2$ *12-4*

Divide and simplify. **73.** $\frac{\sqrt{10}}{\sqrt{5}}$ **74.** $\frac{\sqrt{45y^3}}{\sqrt{5y}}$ **75.** $\frac{\sqrt{27a^2}}{\sqrt{9a^2}}$ **76.** $\frac{\sqrt{16}}{\sqrt{3}}$ *11-5*

Find the indicated outputs for these functions.

77. $f(t) = 2t^2 - 4t + 1$; find $f(-2)$, $f(1)$, and $f(3)$.

78. $g(x) = |x| - 5$; find $g(-7)$, $g(-2)$, and $g(1)$.

79. $h(s) = s^3 - 5$; find $h(-3)$, $h(1)$, and $h(3)$.

80. $f(x) = x^4 + 2$; find $f(-2)$, $f(0)$, and $f(3)$. *12-1*

Practice Multiple Choice

Choose the best answer.

1. Find (a) the set of solutions of the quadratic equation $x^2 + 2x - 15 = 0$ and (b) the axis of symmetry of the graph of the related quadratic function $f(x) = x^2 + 2x - 15$.

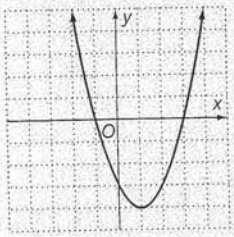
A a. $\{3, -5\}$
b. $x = 1$

B a. $\{3, -5\}$
b. $x = -1$

C a. $\{-3, 5\}$
b. $x = 1$

D a. $\{-3, 5\}$
b. $x = -1$

2. Estimate the x-intercepts of the quadratic function graphed below.



F −2 and 3
G −1 and −3
H −1 and 3
J −3 and 1

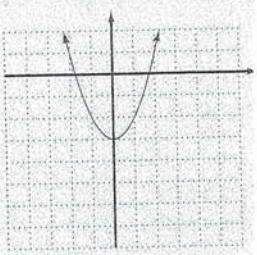
1. B; Algebra 14.0
2. H; Algebra 21.0

Exercises

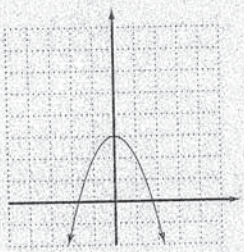
63. $x = 1$, $x = -5$; check students' work.
$x = -2 \pm \sqrt{2}$; check students' work.
64. $a = 1$
65. $a = 12$
66. a. About 41.5%; see answer for part b.
b. No values of P; for P to double, $2P = P(1 + r)^2$, $(1 + r)^2 = 2$, $r = \sqrt{2} - 1 \approx 0.4142 \approx 41.5\%$ (rounded up). An interest rate of about 41.5% is needed to double any value of P in 2 years.
67. \$2682.63
68. $x = 2$, $y = \pm\sqrt{2}$
69. \$1171.66
70. \$2533.54

Mixed Review

71.



72.



73. $\sqrt{2}$
74. $3y\ (y > 0)$
75. $\sqrt{3}$
76. $\frac{4\sqrt{3}}{3}$
77. 17, −1, 7
78. 2, −3, −4
79. −32, −4, 22
80. 18, 2, 83

TICE/ASSESS

z

pleting the square.
= 3
$\sqrt{19}$
+ 1 = 0
$\frac{\sqrt{2}}{2}$

ent Guide

le flexible scheduling, this n be split into parts.
–9, 10–23 (completing the e for the first two terms

sion 30–35
10–29
sion 36–42

ed Review to maintain skills.

1) x^2-6x+9
2) $y^2+8y+16$
3) $m^2+7m+\frac{49}{4}$
4) $t^2-5t+\frac{25}{4}$
5) x^2+4x+4
6) $n^2-12n+36$
7) $z^2-20z+100$
8) $y^2+9y+\frac{81}{4}$
9) $x^2+15x+\frac{225}{4}$
10) $-2, 8$

Extra Help On the Web

Look for worked-out examples at the Prentice Hall Web site.
www.phschool.com

13-3 Exercises

A

Complete the square.

1. $x^2 - 6x$
2. $y^2 + 8y$
3. $m^2 + 7m$
4. $t^2 - 5t$
5. $x^2 + 4x$
6. $n^2 - 12n$
7. $z^2 - 20z$
8. $y^2 + 9y$
9. $x^2 + 15x$

Solve by completing the square.

10. $x^2 - 6x - 16 = 0$
11. $m^2 + 8m + 15 = 0$
12. $x^2 + 22x + 21 = 0$
13. $x^2 + 14x - 15 = 0$
14. $x^2 - 2x - 5 = 0$
15. $x^2 - 4x - 11 = 0$
16. $n^2 - 22n + 102 = 0$
17. $x^2 - 18x + 74 = 0$
18. $x^2 + 10x - 4 = 0$
19. $x^2 - 10x - 4 = 0$
20. $n^2 - 7n - 2 = 0$
21. $t^2 + 7t - 2 = 0$
22. $x^2 + 3x - 28 = 0$
23. $x^2 - 3x - 28 = 0$
24. $2x^2 + 3x - 17 = 0$
25. $2r^2 - 3r - 1 = 0$
26. $3x^2 + 4x - 1 = 0$
27. $3x^2 - 4x - 3 = 0$
28. $2x^2 - 9x - 5 = 0$
29. $2x^2 - 5x - 12 = 0$

B

Complete the square.

30. $x^2 + ? + 36$
31. $x^2 + ? + 55$
32. $4x^2 + 20x + ?$
33. $4x^2 + ? + 16$
34. $x^2 + ? + c$
35. $ax^2 + ? + c$
36. ***Critical Thinking*** Solve $ax^2 + bx + c = 0$ by completing the square. Express your answer in terms of a, b, and c. If the equation has real-number solutions, what restrictions must there be on a, b, and c?

Challenge

Solve for x by completing the square.

37. $x^2 - ax - 6a^2 = 0$
38. $x^2 + 4bx + 2b = 0$
39. $x^2 - x - c^2 - c = 0$
40. $3x^2 - bx + 1 = 0$
41. $kx^2 + mx + n = 0$
42. $b^2x^2 - 2bx + c^2 = 0$

Mixed Review

Find an equation of variation where y varies directly as x, and the following are true. 43. $y = 11$ when $x = 4$ 44. $y = 16$ when $x = 8$ *12-5*

Identify as rational or irrational. 45. $\sqrt{15}$ 46. $\sqrt{225}$ 47. $\sqrt{144}$ *11-1*

Solve. 48. $\sqrt{2x+3} = 5$ 49. $-\sqrt{4x} = 4$ *11-9*

11. $-5, -3$
12. $-21, -1$
13. $-15, 1$
14. $1 \pm \sqrt{6}$
15. $2 \pm \sqrt{15}$
16. $11 \pm \sqrt{19}$
17. $9 \pm \sqrt{7}$
18. $-5 \pm \sqrt{29}$
19. $5 \pm \sqrt{29}$
20. $\frac{7 \pm \sqrt{57}}{2}$
21. $\frac{-7 \pm \sqrt{57}}{2}$
22. $-7, 4$
23. $-4, 7$
24. $\frac{-3 \pm \sqrt{145}}{4}$
25. $\frac{3 \pm \sqrt{17}}{4}$
26. $\frac{-2 \pm \sqrt{7}}{3}$
27. $\frac{2 \pm \sqrt{13}}{3}$
28. $-\frac{1}{2}, 5$
29. $-\frac{3}{2}, 4$
30. $\pm 12x$
31. $\pm 2x\sqrt{55}$
32. 25
33. $\pm 16x$
34. $\pm 2x\sqrt{c}$
35. $\pm 2x\sqrt{ac}$
36. $\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$; $a \neq 0, b^2 \geq 4ac$
37. $3a, -2a$
38. $-2b \pm \sqrt{2b(2b-1)}$
39. $c + 1, -c$
40. $\frac{b \pm \sqrt{b^2 - 12}}{6}$
41. $\frac{-m \pm \sqrt{m^2 - 4nk}}{2k}$
42. $\frac{1 \pm \sqrt{1 - c^2}}{b}$

Mixed Review

43. $y = \frac{11}{4}x$
44. $y = 2x$
45. Irrational
46. Rational
47. Rational
48. 11
49. No real-number solution

13-4 Exercises

Extra Help On the Web

Look for worked-out examples at the Prentice Hall Web site.
www.phschool.com

A

Solve using the quadratic formula.

1. $x^2 - 4x = 21$
2. $x^2 + 7x = 18$
3. $x^2 = 6x - 9$
4. $x^2 = 8x - 16$
5. $3y^2 - 2y - 8 = 0$
6. $3y^2 - 7y + 4 = 0$
7. $4x^2 + 12x = 7$
8. $4x^2 + 4x = 15$
9. $x^2 - 9 = 0$
10. $x^2 - 4 = 0$
11. $x^2 - 2x + 1 = 0$
12. $x^2 - 4x - 7 = 0$
13. $y^2 - 10y + 22 = 0$
14. $y^2 + 6y - 9 = 0$
15. $x^2 + 4x + 4 = 7$
16. $x^2 - 2x + 1 = 5$
17. $3x^2 + 8x + 2 = 0$
18. $3x^2 - 4x - 2 = 0$

Use the quadratic formula to find the roots of each polynomial.

19. $4y^2 + 3y - 1$
20. $4y^2 + 4y + 1$
21. $3x^2 + 5x$
22. $5x^2 - 2x$
23. $4x^2 - 100$
24. $5t^2 - 80$
25. $2t^2 + 6t + 5$
26. $4y^2 + 3y + 2$
27. $3x^2 - 8x + 4$
28. The height of a drop of water at t seconds after being shot upward from the fireboat is $h = 20 + 76t - 16t^2$ feet. Assuming no air resistance, how long does it take for the drop to hit the river? (Hint: Let $h = 0$.)

Solve using the quadratic formula. Give solutions to the nearest tenth.

29. $x^2 - 4x - 7 = 0$
30. $x^2 + 2x - 2 = 0$
31. $y^2 - 6y - 1 = 0$
32. $4x^2 + 4x = 1$
33. $4x^2 = 4x + 1$
34. $3x^2 + 4x - 2 = 0$
35. $3x^2 - 8x + 2 = 0$
36. $2y^2 + 6y - 2 = 0$
37. $x^2 - 3x + 1 = 3$
38. $2x^2 - 10x + 9 = 0$
39. $5x^2 = 6 + 2x$
40. $7x^2 = 3$

Find the value of the discriminant to determine the number of real-number solutions for each quadratic equation.

41. $x^2 - 5x + 7 = 0$
42. $x^2 - 8x + 3 = 0$
43. $a^2 + 12a + 36 = 0$
44. $2m^2 - m - 6 = 0$

Use the discriminant to determine whether the graph of each quadratic function intersects the x-axis in zero, one, or two points.

45. $f(t) = 4t^2 - 3t + 3$
46. $y = 2x^2 - 4x - 6$
47. $f(x) = 3x^2 - 3x + 4$
48. $p = -3q^2 + 4q + 2$

Find the x-intercepts of the graph of each quadratic function.

49. $y = (x - 4)(x + 3)$
50. $y = (x - 5)^2$
51. $y = x^2 + 1$
52. $y = x(x + 10)$

A fireboat salutes by shooting water into the air. How high does the middle stream of water reach if water height is described by the function $h = 20 + 76t - 16t^2$?

3. PRACTICE/ASSES

LESSON QUIZ

Solve using the quadratic form

1. $2x^2 - 5x + 2 = 0$
   $x = 2$ or $x = \frac{1}{2}$
2. $3x^2 + 4x + 1 = 0$
   $x = -1$ or $x = -\frac{1}{3}$
3. Find the discriminant and d the nature of the solutions following equation.
   $3x^2 - 4x + 8 = 0$
   −80, no real-number soluti

Assignment Guide

To provide flexible schedul lesson can be split into par

- Core 1–39 odd, 49–59 oc
  Extension 62–68 even, 6
- Core 2–40 even, 41–48, 5 even
  Extension 61–67 odd

Use Mixed Review to maint

Exercises

1. −3, 7
2. −9, 2
3. 3
4. 4
5. $-\frac{4}{3}$, 2
6. 1, $\frac{4}{3}$
7. $-\frac{7}{2}, \frac{1}{2}$
8. $-\frac{5}{2}, \frac{3}{2}$
9. −3, 3
10. −2, 2
11. 1
12. $2 \pm \sqrt{11}$
13. $5 \pm \sqrt{3}$
14. $-3 \pm 3\sqrt{2}$
15. $-2 \pm \sqrt{7}$
16. $1 \pm \sqrt{5}$
17. $\frac{-4 \pm \sqrt{10}}{3}$
18. $\frac{2 \pm \sqrt{10}}{3}$
19. $-1, \frac{1}{4}$
20. $-\frac{1}{2}$
21. $-\frac{5}{3}$, 0
22. $0, \frac{2}{5}$
23. −5, 5
24. −4, 4
25. No real-number roots
26. No real-number roots
27. $\frac{2}{3}$, 2
28. 5 s

Photo caption: 110.25 ft

29. −1.3, 5.3
30. −2.7, 0.7
31. −0.2, 6.2
32. −1.2, 0.2
33. −0.2, 1.2
34. −1.7, 0.4
35. 0.3, 2.4
36. −3.3, 0.3
37. −0.6, 3.6
38. 1.2, 3.8
39. −0.9, 1.3
40. 0.7, −0.7
41. −3, no real-number solut
42. 52, two real-number solut
43. 0, one real-number solutic
44. 49, two real-number solut
45. zero points
46. two points
47. zero points
48. two points
49. −3, 4
50. 5
51. None
52. −10, 0

53) 0, 2

54) $-\frac{4}{3}$, 0

55) $\frac{3 \pm \sqrt{5}}{2}$

56) $\frac{7 \pm \sqrt{69}}{10}$

57) $\frac{-7 \pm \sqrt{61}}{2}$

58) −8, 4

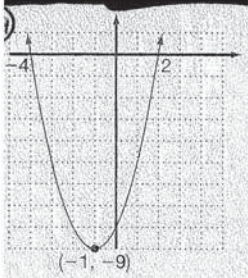
59) No real-number solutions

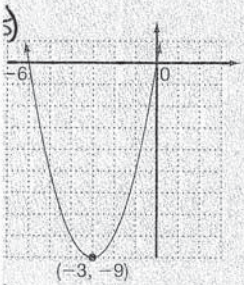
60) No real-number solutions

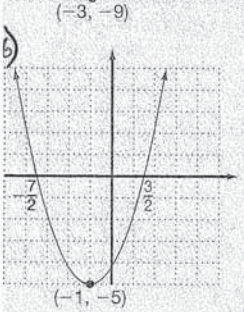
61) −4, 2

62) 4

63) no real roots







Practice Multiple Choice

Choose the best answer.

1. What term should be added to both sides of the equation to "complete the square"?

$x^2 + \frac{8x}{7} + ? = 2 + ?$

A $\frac{64}{49}$

B $\frac{8}{7}$

C 225

D $\frac{16}{49}$

2. Solve.

$2x^2 + 7x + 9 = 0$

F $x = \frac{-7 \pm \sqrt{-23}}{4}$; no real-number solutions

G $x = \frac{7 \pm \sqrt{-23}}{4}$; no real-number solutions.

H $x = -\frac{9}{2}, 1$

J $x = -1, \frac{9}{2}$

1. D; Algebra 19.0
2. F; Algebra 20.0

B

Solve.

53. $5x + x(x - 7) = 0$ **54.** $x(3x + 7) - 3x = 0$

55. $3 - x(x - 3) = 4$ **56.** $x(5x - 7) = 1$

57. $(y + 4)(y + 3) = 15$ **58.** $(y + 5)(y - 1) = 27$

59. $(x + 2)^2 + (x + 1)^2 = 0$ **60.** $(x + 3)^2 + (x + 1)^2 = 0$

Use a graph to find the roots of each polynomial.

61. $x^2 + 2x - 8$ **62.** $x^2 - 8x + 16$ **63.** $x^2 + 1$

Use roots and the vertex to "quick sketch" a graph of each quadratic function. (Hint: The graph has an axis of symmetry.)

64. $y = (x + 4)(x - 2)$ **65.** $y = x(x + 6)$ **66.** $y = \frac{1}{5}(2x - 3)(2x + 7)$

67. ***Critical Thinking*** For the given condition, will $ax^2 + bx + c = 0$ have two real-number solutions for some, all, or no values of b?

a. when $b^2 > 4ac$ **b.** when $ac < 0$ **c.** when $a > 0$ and $c > 0$

Challenge

68. ***Multi-Step Problem*** Use the two roots given by the quadratic formula.

a. Find a formula for the sum of the roots.

b. Find a formula for the product of the roots.

c. Without solving, tell the sum and product of the solutions of $2x^2 + 5x - 3 = 0$.

d. One solution of $2x^2 + bx - 3 = 0$ is −5. Find the other solution.

69. ***Write a Convincing Argument*** By symmetry, the average of the roots of a quadratic function is the x-coordinate of the vertex of its graph. Use the roots given by the quadratic formula to show that the x-coordinate of the vertex is $-\frac{b}{2a}$.

70. If $f(x) = ax^2 + bx + c$, and r_1 and r_2 are two real roots given by the quadratic formula, show that $a(x - r_1)(x - r_2) = f(x)$.

Use factoring to determine whether the graph of each quadratic function has zero, one, or two x-intercepts. State the intercepts.

71. $f(x) = x^2 + x - 12$ **72.** $f(x) = 3x^2 - 6x + 3$

73. $f(x) = -6x^2 + 11x - 4$

Mixed Review

Write in standard form and determine a, b, and c. **74.** $x^2 + 7x = 8$

75. $4x^2 + 16 = -5x$ **76.** $3x^2 - 12 = 8x + 10$ *13-1*

Find an equation of variation where y varies inversely as x. One pair of values is given. **77.** $y = 16$ when $x = 4$ **78.** $y = 0.1$ when $x = 1$ *12-6*

Solve. **79.** $11 - \sqrt{30 + x} = 5$ **80.** $\sqrt{2x + 2} = \sqrt{5x - 13}$ *11-9*

Factor. **81.** $5m^2 - 30m + 45$ **82.** $c^3 - c^2 - c + 1$ *6-5, 6-7*

67. a. all
b. all
c. some

68. a. $-\frac{b}{a}$
b. $\frac{c}{a}$
c. $-\frac{5}{2}, -\frac{3}{2}$
d. $\frac{3}{10}$

69. The two roots are $\frac{-b - \sqrt{b^2 - 4ac}}{2a}$ and $\frac{-b + \sqrt{b^2 - 4ac}}{2a}$. Their average is

$$\frac{1}{2}\left(\frac{-b - \sqrt{b^2 - 4ac}}{2a} + \frac{-b + \sqrt{b^2 - 4ac}}{2a}\right) = \frac{1}{2}\left(\frac{-2b}{2a}\right) = -\frac{b}{2a}$$

70. Check students' work.
71. two; −4, 3
72. one; 1
73. two; $\frac{1}{2}, \frac{4}{3}$

Mixed Review

74. $x^2 + 7x - 8 = 0$; $a = 1, b = 7, c = -8$
75. $4x^2 + 5x + 16 = 0$; $a = 4, b = 5, c = 16$
76. $3x^2 - 8x - 22 = 0$; $a = 3, b = -8, c = -22$
77. $y = \frac{64}{x}$
78. $y = \frac{0.1}{x}$
79. 6
80. 5
81. $5(m - 3)^2$
82. $(c - 1)^2(c + 1)$

E/ASSESS

= 1
= 5
= −1
= 1

iuide
38, 39
37, 40–43

view to maintain skills.

Extra Help On the Web

Look for worked-out examples at the Prentice Hall Web site.
www.phschool.com

13-5 Exercises

A

Solve each rational equation. Use the quadratic formula as needed.

1. $\frac{7}{x+3} = x - 3$
2. $\frac{5}{y-2} = y + 2$
3. $\frac{x-2}{3} = \frac{1}{x}$
4. $\frac{a-1}{2} = \frac{3}{a}$
5. $\frac{5}{n^2} + \frac{4}{n} = 1$
6. $\frac{4}{a^2} - \frac{2}{a} = 2$
7. $x - 3 = \frac{5}{x-3}$
8. $x + 2 = \frac{3}{x+2}$
9. $\frac{x^2}{x-4} - \frac{7}{x-4} = 0$
10. $\frac{x^2}{x+3} - \frac{5}{x+3} = 0$
11. $\frac{y+2}{y} = \frac{1}{y+2}$
12. $\frac{8}{x-2} + \frac{8}{x+2} = 3$
13. $\frac{24}{x-2} + \frac{24}{x+2} = 5$
14. $1 + \frac{12}{x^2-4} = \frac{3}{x-2}$
15. $\frac{5}{t-3} - \frac{30}{t^2-9} = 1$
16. $\frac{4}{x+2} - \frac{5}{x-3} = 2$
17. $\frac{2}{y-1} + \frac{3}{y+1} = 1$
18. $\frac{1}{t+2} + \frac{5}{t} = 1$
19. $\frac{2}{a+1} - \frac{3}{a} = 2$
20. $\frac{x}{x+1} - \frac{x}{x-2} = 1$
21. $\frac{y}{y+3} - \frac{y}{y-1} = 1$

B

Solve each rational equation. Use the quadratic formula as needed.

22. $\frac{2x-1}{5} - \frac{2}{x} = \frac{x}{2}$
23. $\frac{n-1}{2} - \frac{1}{n} = \frac{n}{3}$
24. $\frac{6}{a+1} - \frac{1}{a} = \frac{1}{2}$
25. $\frac{2}{x-2} - \frac{1}{x} = \frac{1}{3}$
26. $\frac{x}{x+1} - \frac{x}{x-1} = \frac{1}{3}$
27. $\frac{y}{y-2} - \frac{y}{y+2} = \frac{1}{2}$
28. $\frac{1}{a-1} + \frac{2}{1-a} = 3a$
29. $\frac{1}{2x-1} + \frac{1}{1-2x} = x$
30. $\frac{1}{x-2} - \frac{2}{x^2-4} = 0$
31. $\frac{2}{x+3} + \frac{5}{x^2-9} = 0$
32. $\frac{1}{x+2} - \frac{2}{x^2-4} = \frac{2}{x}$
33. $\frac{2}{y+3} - \frac{1}{y^2-9} = \frac{1}{y}$
34. ***Critical Thinking*** The sum of an integer, $\frac{1}{2}$ its reciprocal, and one more than its reciprocal is $4\frac{1}{2}$. What is the number?

Exercises

1. 4, −4
2. 3, −3
3. 3, −1
4. 3, −2
5. 5, −1
6. −2, 1
7. $3 \pm \sqrt{5}$
8. $-2 \pm \sqrt{3}$
9. $\pm\sqrt{7}$
10. $\pm\sqrt{5}$
11. No real-number solution
12. 6, $-\frac{2}{3}$
13. 10, $-\frac{2}{5}$
14. 1
15. 2
16. No real-number solution
17. 0, 5
18. $2 \pm \sqrt{14}$
19. No real-number solution
20. $-1 \pm \sqrt{3}$
21. $-3 \pm 2\sqrt{3}$
22. No real-number solutions
23. $\frac{3 \pm \sqrt{33}}{2}$
24. $\frac{9 \pm \sqrt{73}}{2}$
25. −1, 6
26. $-3 \pm \sqrt{10}$
27. $4 \pm 2\sqrt{5}$
28. No real-number solutions
29. 0
30. 0
31. $\frac{1}{2}$
32. $-2 \pm 2\sqrt{3}$
33. $\frac{7 \pm \sqrt{13}}{2}$
34. 3

35. *Error Analysis* To solve $\frac{x}{x-2} - \frac{3}{x} = \frac{4}{x(x-2)}$, Leah multiplied both sides by the LCD, $x(x-2)$, and got $x^2 - 3x + 6 = 4$. For this equation, Leah claimed that the discriminant is negative, so there are no real number solutions. What error, if any, did Leah make?

36. **TEST PREP** Without solving the equation, give the only possible values of x that could be extraneous solutions of $\frac{5}{2x-2} = \frac{15}{x^2-1}$.

A. 0 and 1 **B.** 1 and 2 **C.** -1 and 1 **D.** -1 and 0

37. *Mathematical Reasoning* Lon claimed that no equation can have 0 as an extraneous solution. Show by counterexample that this is not true.

Challenge

Solve.

38. $\frac{1}{x} - \frac{3}{1-x} = \frac{2}{x^2-x}$

39. $\frac{2}{y} + \frac{1}{1-y} = \frac{5}{y^2-y}$

40. $\frac{2}{x^2-x-6} + \frac{3}{x^2-7x+12} = \frac{1}{x-4}$

41. $\frac{-1}{x^2+4x-5} + \frac{2}{x^2+x-20} = \frac{2}{x-4}$

42. $\frac{1}{x^2+3x-4} + \frac{1}{x^2+2x-8} = \frac{1}{x^2-8x+12}$

43. $\frac{1}{x^2-2x-15} + \frac{1}{x^2+x-6} = \frac{1}{x^2+2x-8}$

Mixed Review

Solve. **44.** $x^2 + 3x = 0$ **45.** $a^2 = 15$

46. $y^2 - 5y - 14 = 0$ **47.** $7x^2 + 4x = 0$

48. $9x^2 - 20 = 0$ **49.** $2x^2 - 7x - 15 = 0$ *13-1, 13-2, 13-3*

Graph. **50.** $f(x) = 2x^2 - 5$ **51.** $g(x) = \frac{1}{2}x^2 + 1$

52. $h(x) = -2x^2 + 7$ **53.** $f(x) = -\frac{1}{2}x^2 - 4$ *12-4*

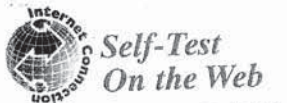
Find an equation of variation. **54.** y varies directly as x, and $y = 0.6$ when $x = 0.4$. **55.** y varies inversely as x, and $y = 2$ when $x = 3$.

56. y varies inversely as x, and $y = 5$ when $x = 2$.

57. y varies directly as x and inversely as z, and $y = 4$ when $x = 8$ and $z = 6$. *12-5, 12-6, 12-7*

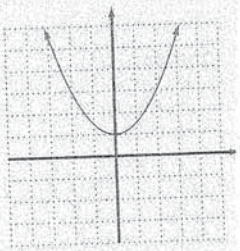
Write using scientific notation. **58.** 3,485,117 **59.** 0.0070023 *5-4*

60. Find the slope of the line containing the points $(-5, -9)$, $(1, 1)$. *7-5*



Self-Test On the Web

Check your progress. Look for a self-test at the Prentice Hall Web site. www.phschool.com

51.


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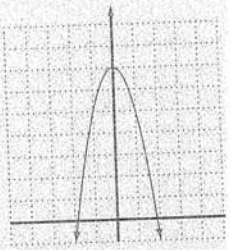

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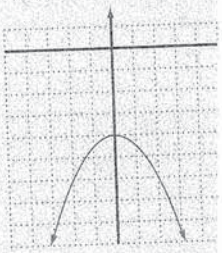
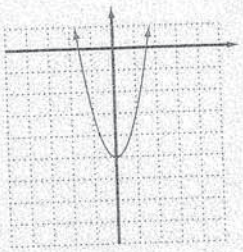


50.


35. Leah computed the discriminant (−15) of $x^2 - 3x + 6$ instead of the discriminant (1) of $x^2 - 3x + 2$.

36. C

37. Answers may vary. Sample: $\frac{x+2}{x} = \frac{2}{x}$

38. $\frac{3}{4}$

39. 7

40. $3 \pm \sqrt{13}$

41. $\frac{-7 \pm \sqrt{145}}{4}$

42. $9 \pm \sqrt{59}$

43. $\frac{-3 \pm \sqrt{61}}{2}$

Mixed Review

44. $-3, 0$

45. $\pm\sqrt{15}$

46. $7, -2$

47. $0, -\frac{4}{7}$

48. $\pm\frac{2\sqrt{5}}{3}$

49. $5, -\frac{3}{2}$

54. $y = 1.5x$

55. $y = \frac{6}{x}$

56. $y = \frac{10}{x}$

57. $y = \frac{3x}{2}$

58. 3.485117×10^6

59. 7.0023×10^{-3}

60. $m = \frac{5}{3}$

CE/ASSESS

$= \sqrt{x + 7}$.
n is 2.
$\frac{l}{t} = r$ for V.

t Guide
flexible scheduling, this
be split into parts.
22, 37–44, 47, 48
n 49–54
-36, 45, 46
n 55–60

Review to maintain skills.

Extra Help On the Web
Look for worked-out examples at the Prentice Hall Web site.
www.phschool.com

13-6 Exercises

A

Mental Math Solve each radical equation.

1. $\sqrt{a} = 6$
2. $\sqrt{x} = 9$
3. $\sqrt{x + 2} = 3$
4. $\sqrt{m - 4} = 5$
5. $\sqrt{\frac{x}{3}} = 2$
6. $\sqrt{\frac{m}{2}} = 5$

Solve each radical equation.

7. $\sqrt{2x} + 3 = 7$
8. $\sqrt{5t} - 2 = 1$
9. $\sqrt{2x + 3} = 3$
10. $\sqrt{4m - 1} = 5$
11. $\sqrt{\frac{x + 2}{3}} = 6$
12. $\sqrt{\frac{a - 3}{4}} = 2$
13. $x - 7 = \sqrt{x - 5}$
14. $\sqrt{x + 7} = x - 5$
15. $\sqrt{x + 18} = x - 2$
16. $x - 9 = \sqrt{x - 3}$
17. $\sqrt{5x + 21} = x + 3$
18. $\sqrt{2x + 3} = 6 - x$
19. $x = 1 + 6\sqrt{x - 9}$
20. $\sqrt{2x - 1} + 2 = x$
21. $x + 4 = 4\sqrt{x + 1}$
22. $x + 1 = 3\sqrt{x + 5}$

Solve each formula for the indicated variable.

23. $c^2 = a^2 + b^2; a$
24. $E = mc^2; c$
25. $c = \sqrt{a^2 + b^2}; b$
26. $N = 2.5\sqrt{A}; A$
27. $V = \pi r^2 h; r$
28. $s = \frac{gt^2}{2}; t$
29. $x^2 + y^2 + z^2 = r^2; x$
30. $P = \frac{V^2}{R}; V$

Solve for the indicated variable. Justify each step.

31. $F = \frac{GmM}{r^2}; r$
32. $\sqrt{\frac{2s}{a}} = t; s$
33. $\sqrt{\frac{P}{R}} = I; R$
34. $x = 2V + at^2; t$
35. $P = R(4 + I)^2; I$
36. $T = 2\pi\sqrt{\frac{l}{g}}; g$

B

Solve.

37. $\sqrt{x + 3} = \frac{8}{\sqrt{x - 9}}$
38. $\frac{12}{\sqrt{5x + 6}} = \sqrt{2x + 5}$
39. $\sqrt{4x^2 + 3} = 3x$
40. $\sqrt{2y^2 - 4} = y$
41. $6\sqrt{a} = 18\sqrt{7}$
42. $2\sqrt{x} = 5\sqrt{10}$
43. $\sqrt{t^2 + 1} = 1 - t$
44. $\sqrt{a^2 - 1} = 1 + a$
45. ***Critical Thinking*** Find a formula for the area of a square in terms of the perimeter of the square. Then use the formula to express the perimeter of the square in terms of the area of the square.

Exercises

1. 36
2. 81
3. 7
4. 29
5. 12
6. 50
7. 8
8. $\frac{9}{5}$
9. 3
10. $\frac{13}{2}$
11. 106
12. 19
13. 9
14. 9
15. 7
16. 12
17. 3
18. 3
19. 13, 25
20. 5
21. 0, 8
22. 11
23. $a = \sqrt{c^2 - b^2}$
24. $c = \sqrt{\frac{E}{m}}$
25. $b = \sqrt{c^2 - a^2}$
26. $A = \frac{N^2}{6.25}$
27. $r = \sqrt{\frac{V}{\pi h}}$ or $\frac{\sqrt{V\pi h}}{\pi h}$
28. $t = \sqrt{\frac{2s}{g}}$ or $\frac{\sqrt{2sg}}{g}$
29. $\sqrt{r^2 - y^2 - z^2}$
30. $\sqrt{PR}$
31. $\sqrt{\frac{GmM}{F}}$
32. $\frac{t^2 a}{2}$
33. $\frac{P}{I^2}$
34. $\sqrt{\frac{x - 2V}{a}}$
35. $\sqrt{\frac{P}{R}} - 4$
36. $\frac{4\pi^2 l}{T^2}$
37. 13
38. 2
39. $\sqrt{\frac{3}{5}}$ or $\frac{\sqrt{15}}{5}$
40. 2
41. 63
42. $\frac{125}{2}$
43. 0
44. -1
45. $A = \frac{p^2}{16}$, $p = 4\sqrt{A}$

46. ***Critical Thinking*** Find a formula for the circumference of a circle in terms of the area of a circle. Then use the formula to express the area of the circle in terms of the circumference of the circle.

Error Analysis Each exercise has an error commonly made by algebra students. Can you find and correct the error?

47.
$$\sqrt{3x+7} = x+3$$
$$3x+7 = x^2+9$$
$$0 = x^2-3x+2$$
$$0 = (x-2)(x-1)$$
$$x-2=0 \text{ or } x-1=0$$
$$x=2 \text{ or } x=1$$

The solutions are 2 and 1.

48.
$$\sqrt{x+1} = x-5$$
$$x+1 = x^2-10x+25$$
$$0 = x^2-11x+24$$
$$0 = (x-8)(x-3)$$
$$x-8=0 \text{ or } x-3=0$$
$$x=8 \text{ or } x=3$$

The solutions are 8 and 3.

Mathematical Reasoning What, if any, extraneous solutions result when the principle of squaring is used to help solve each equation?

49. $\sqrt{x^2} = x$ **50.** $\sqrt{x^2} = -x$ **51.** $\sqrt{x^2} = |x|$ **52.** $\frac{1}{\sqrt{x}} = \sqrt{x}$

Challenge

53. Solve. $2\sqrt{x-1} - \sqrt{3x-5} = \sqrt{x-9}$

54. Solve. $\sqrt{y+1} - \sqrt{2y-5} = \sqrt{y-2}$

55. Solve $x + 1 + 3\sqrt{x+1} - 28 = 0$ using two methods. First use the principle of squaring. Second, let $y = \sqrt{x+1}$. (Then $y^2 = x+1$.) Solve for y, then substitute to find x.

56. Solve $h = vt + 8t^2$ for t.

Solve the following systems of equations.

57. $2\sqrt{a} + 3\sqrt{b} = 21$
$\sqrt{a} - \sqrt{b} = -2$

58. $5\sqrt{m} + 2\sqrt{n} = 39$
$3\sqrt{m} - \sqrt{n} = 19$

59. $3r^2 + 2s^2 = 11$
$r^2 - 2s^2 = -7$

60. $5x^2 - 3y^2 = -7$
$-x^2 + 3y^2 = 23$

Mixed Review

Complete the square. **61.** $x^2 + 4x$ **62.** $m^2 - 5m$ **63.** $a^2 - a$ *13-3*

Solve. **64.** $9a^2 - 18a = 0$ **65.** $3x^2 - 13x + 4 = 0$

66. $2m^2 - 25 = 0$ **67.** $(x-3)^2 = 36$ **68.** $(c-5)^2 = 17$ *13-1, 13-2*

Simplify. **69.** $\frac{\sqrt{1}}{\sqrt{81}}$ **70.** $-\frac{\sqrt{4}}{\sqrt{121}}$ **71.** $\frac{\sqrt{11}}{\sqrt{22}}$ **72.** $\frac{\sqrt{56}}{\sqrt{8}}$ **73.** $\frac{\sqrt{64}}{\sqrt{4}}$ *11-5*

Solve by graphing. **74.** $y = x - 1$, $y = -x - 5$ **75.** $y = 2x$, $x + y = 0$ **76.** $y = 1 - x$, $x - y = 7$ *8-1*

77. The numerical value for the area of a square is 32 more than the perimeter. Find the length of a side. *6-9*

Exercises

46. $c = 2\sqrt{\pi A}$, $A = \frac{C^2}{4\pi}$
47. The student squared $x + 3$ incorrectly. $(x+3)^2 = x^2 + 6x + 9$. The correct solutions are -2 and -1.
48. The student forgot to check. The correct solution is just 8.
49. all numbers $x < 0$
50. all numbers $x > 0$
51. none
52. $x = -1$
53. 10
54. 3
55. 15
56. $\frac{-v \pm \sqrt{v^2 + 32h}}{16}$
57. $a = 9$, $b = 25$
58. $m = 49$, $n = 4$
59. $(-1, -2)$, $(1, -2)$, $(-1, 2)$, $(1, 2)$
60. $(-2, -3)$, $(2, -3)$, $(-2, 3)$, $(2, 3)$

Mixed Review

61. $x^2 + 4x + 4$
62. $m^2 - 5m + \frac{25}{4}$
63. $a^2 - a + \frac{1}{4}$
64. 2, 0
65. $\frac{1}{3}$, 4
66. $\pm \frac{5\sqrt{2}}{2}$
67. 9, -3
68. $5 \pm \sqrt{17}$
69. $\frac{1}{9}$
70. $-\frac{2}{11}$
71. $\frac{\sqrt{2}}{2}$
72. $\sqrt{7}$
73. 4
74. $(-2, -3)$
75. $(0, 0)$
76. $(4, -3)$
77. 8 units

Try This Solve.

c. The speed of a boat in still water is 12 km/h. The boat travels 45 km upstream and 45 km downstream in a total time of 8 hours. What is the speed of the stream? (Hint: Let s = the speed of the stream. Then $12 - s$ is the speed upstream and $12 + s$ is the speed downstream).

13-7 Exercises

A

Solve.

1. A picture frame is 20 cm by 12 cm. There are 84 cm^2 of a picture showing. Find the width of the frame.
2. A picture frame is 18 cm by 14 cm. There are 192 cm^2 of picture showing. Find the width of the frame.
3. The hypotenuse of a right triangle is 25 ft long. One leg is 17 ft longer than the other. Find the lengths of the legs.
4. The hypotenuse of a right triangle is 26 yd long. One leg is 14 yd longer than the other. Find the lengths of the legs.
5. The length of a rectangle is 2 cm greater than the width. The area is 80 cm^2. Find the length and width.
6. The width of a rectangle is 4 cm less than the length. The area is 320 cm^2. Find the length and width.

For Exercises 7 and 8, round your answers to the nearest tenth.

7. The hypotenuse of a right triangle is 8 m long. One leg is 2 m longer than the other. Find the lengths of the legs.
8. The hypotenuse of a right triangle is 5 cm long. One leg is 2 cm longer than the other. Find the lengths of the legs.
9. The current in a stream moves at a speed of 3 km/h. A boat travels 40 km upstream and 40 km downstream in a total time of 14 hours. What is the speed of the boat in still water?
10. The current in a stream moves at a speed of 4 mi/h. A boat travels 4 mi upstream and 12 mi downstream in a total time of 2 hours. What is the speed of the boat in still water?
11. The speed of a boat in still water is 10 km/h. The boat travels 12 km upstream and 28 km downstream in a total time of 4 hours. What is the speed of the stream?
12. An airplane flies 738 mi against the wind and 1062 mi with the wind in a total time of 9 hours. The speed of the airplane in still air is 200 mi/h. What is the speed of the wind?

B

13. Find the side of a square whose diagonal is 3 cm longer than a side.

Extra Help On the Web

Look for worked-out examples at the Prentice Hall Web site.
www.phschool.com

Practice Multiple Choice

Choose the best answer.

1. How many points are in the intersection of the x-axis and the graph of $y = 9x^2 + 12x + 4$?

A 1
B 2
C 0
D 3

2. Solve the rational equation. $\frac{1}{z+2} - \frac{1}{z-3} = \frac{1}{z}$

F $z = 2, z = 3$
G $z = 2 \pm \sqrt{10}$
H $z = -2 \pm \sqrt{10}$
J Not shown.

1. A; Algebra 22.0
2. H; Algebra 2.0, 20.0

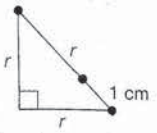
Try This

c. 3 km/h

Exercises

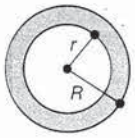
1. 3 cm
2. 1 cm
3. 7 ft, 24 ft
4. 10 yd, 24 yd
5. 10 cm, 8 cm
6. 20 cm, 16 cm
7. 4.6 m, 6.6 m
8. 2.4 cm, 4.4 cm
9. 7 km/h
10. 8 mi/h
11. 4 km/h
12. 36 mi/h
13. $3 + 3\sqrt{2} \approx 7.243$ cm

14. Find r in this figure.
Round to the nearest hundredth.



15. What should be the diameter (d) of a pizza so that it has the same area as two 10-in.-diameter pizzas? Do you get more to eat with a 15-in. pizza or two 10-in. pizzas?

16. In this figure, the area of the shaded region is 24 cm^2. Find r if $R = 6$ cm. Round to the nearest hundredth.

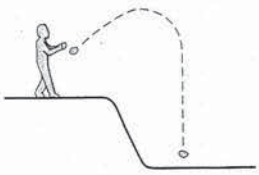


17. Trains A and B leave the same city at the same time. Train A heads north and train B heads east. Train B travels 5 mi/h faster than train A. After 2 hours they are 50 mi apart. Find the speed of each train.

18. ***Write a Convincing Argument*** Solve the problem below. Then write an argument to convince a classmate that your solution is correct. A 10-ft long ladder leans against a wall. The bottom of the ladder is 6 ft from the wall. How much would the lower end have to be pulled away so that the top end would be pulled down the same amount?

Challenge

The formula $d = rt - 5t^2$ gives the approximate distance in meters of an object above its starting point t seconds after it is thrown with an initial upward velocity of r meters per second. Use this formula to solve the following problems.



19. How high would a ball be in 5 seconds if it is thrown upward with an initial velocity of 45 meters per second?

20. How long would it take a ball batted upward at an initial velocity of 55 meters per second to be 50 meters above its starting point?

21. Where would a rock be (vertically) in 5 seconds if it is thrown as shown at the left with an initial upward velocity of 20 meters per second?

Mixed Review

Solve. **22.** $\sqrt{m-3} = 10$ **23.** $\sqrt{\frac{a}{3}} = 1$ **24.** $x + 7 = 2\sqrt{x+7}$ *13-6*

Solve. **25.** $x^2 + 2x - 15 = 0$ **26.** $x^2 - 10x + 25 = 0$

27. $x^2 + 5x + 2 = 0$ **28.** $x^2 - 7x + 12 = 0$ *13-3*

29. Find an equation of the line containing the points $(2, -4)$ and $(-3, -2)$. *7-6*

Exercises

14. 2.41 cm
15. 14.14 in.; a 15-in. pizza
16. 5.33 cm
17. 15 mi/h, 20 mi/h
18. 2 ft
19. 100 m above its starting point
20. 1 second (It will also be 50 m above its starting point in 10 seconds.)
21. −25 or 25 m below the starting point

Mixed Review

22. 103
23. 3
24. −7, −3
25. 3, −5
26. 5
27. $\frac{-5 \pm \sqrt{17}}{2}$
28. 3, 4
29. $y = -\frac{2}{5}x - \frac{16}{5}$

13 Chapter Wrap Up

13-1

To solve a **quadratic equation** in **standard form,** $ax^2 + bx + c = 0$, you may be able to factor the equation and use the principle of zero products to find the solutions.

Write in standard form.

1. $3x^2 + 6x = -4$

2. $5x^2 = 2x$

Solve.

3. $5x^2 - 7x = 0$

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

5. $5x^2 - 8x + 3 = 0$

6. $3y^2 + 5y = 2$

Key Terms

complete the square (p. 586)
discriminant (p. 591)
quadratic equation (p. 576)
quadratic formula (p. 589)
standard form of a quadratic equation (p. 576)

13-2

To solve a quadratic equation of the form $ax^2 = k$ or $(x + a)^2 = k$, first solve for x^2 or $(x + a)^2$, and then find the square roots of each side.

Solve.

7. $5x^2 = 40$

8. $8x^2 = 24$

9. $(x + 8)^2 = 13$

10. $(x + 6)^2 = 49$

11. $4y^2 + 20y + 25 = 16$

12. Suppose we know a polygon has $d = 35$ diagonals. Use the formula $d = \frac{n^2 - 3n}{2}$ to find n the number of sides.

13. The sum of \$1000 is invested at interest rate r. In 2 years the total grows to \$1690. Use the formula $A = P(1 + r)^t$ to find the annual interest rate.

14. The sum of \$4000, invested at 8% for 2 years, compounded annually, will grow to what amount?

13-3

To **complete the square** for an expression like $x^2 + 8x$, take half of the coefficient of x and square it. Add this new term to the binomial $x^2 + 8x$ to make a trinomial square, $x^2 + 8x + 16$. You can use the technique of completing the square to solve quadratic equations.

Complete the square.

15. $c^2 + 22c$

16. $w^2 - 7w$

Solve by completing the square.

17. $x^2 - 2x - 10 = 0$

18. $9x^2 - 6x - 9 = 0$

19. $3x^2 - 2x - 5 = 0$

20. $2x^2 + 7x - 1 = 0$

Chapter 13 Wrap Up

1. $3x^2 + 6x + 4 = 0$
2. $5x^2 - 2x = 0$
3. $0, \frac{7}{5}$
4. $0, \frac{4}{3}$
5. $\frac{3}{5}, 1$
6. $\frac{1}{3}, -2$
7. $2\sqrt{2}, -2\sqrt{2}$
8. $\sqrt{3}, -\sqrt{3}$
9. $-8 \pm \sqrt{13}$
10. $1, -13$
11. $-\frac{1}{2}, -\frac{9}{2}$
12. $n = 10$
13. 30%
14. \$4665.60
15. $c^2 + 22c + 121$
16. $w^2 - 7w + \frac{49}{4}$
17. $1 \pm \sqrt{11}$
18. $\frac{1 \pm \sqrt{10}}{3}$
19. $\frac{5}{3}, -1$
20. $\frac{-7 \pm \sqrt{57}}{4}$

Internet Activity On the Web

Look for extension problems for this chapter at the Prentice Hall Web site.
www.phschool.com

13-4

You can use the **quadratic formula** $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ to solve quadratic equations. The expression under the radical, $b^2 - 4ac$, is called the **discriminant.** When the discriminant is positive, there are two real-number solutions to the quadratic equation. When the discriminant is 0, there is only one real-number solution, and when the discriminant is negative, there are no real-number solutions.

Solve using the quadratic formula.

21. $x^2 - 6x - 9 = 0$ **22.** $3x^2 - x - 5 = 0$ **23.** $x^2 - 3x - 6 = 0$

24. $5x^2 + 3x - 4 = 0$ **25.** $x^2 + 6x + 7 = 0$ **26.** $x^2 - 14x + 49 = 0$

Compute the discriminant and determine how many real-number solutions there are.

27. $5x^2 - 8x + 2 = 0$ **28.** $x^2 - 18x + 83 = 0$

13-5

When you multiply both sides of a rational equation by the LCM of the denominators, you may get a quadratic equation. Be sure to check all possible solutions in the original equation.

Solve.

29. $\frac{15}{x} - \frac{15}{x+2} = 2$ **30.** $x + \frac{1}{x} = 2$

13-6

To solve a radical equation, first square both sides. If a quadratic equation results, then solve by factoring or using the quadratic equation.

31. $\sqrt{x - 3} = 7$ **32.** $\sqrt{3x + 4} = \sqrt{2x + 14}$

33. Solve for F: $V = \sqrt{\frac{Fqr}{m}}$ **34.** Solve for r: $A = \frac{1}{3}\pi r^2$

13-7

You can use the Problem-Solving Guidelines to solve problems involving quadratic equations.

35. The length of a rectangle is 3 m greater than the width. The area is 70 m^2. Find the length and the width.

36. You can row upstream 5 miles and then row back downstream all in 3 hours and 20 minutes. If the river has an average current of 2 mi/h, at what rate are you able to row in still water?

37. One side of a right triangle is 1 ft, 4 in. shorter than the hypotenuse. The other side is 2 in. shorter than the hypotenuse. Find the lengths of the two legs.

Chapter 13 Wrap Up

21. $3 \pm 3\sqrt{2}$
22. $\frac{1 \pm \sqrt{61}}{6}$
23. $\frac{3 \pm \sqrt{33}}{2}$
24. $\frac{-3 \pm \sqrt{89}}{10}$
25. $-3 \pm \sqrt{2}$
26. 7
27. 24, two real-number solutions
28. −8, no real-number solutions
29. 3, −5
30. 1
31. 52
32. 10
33. $F = \frac{mV^2}{qr}$
34. $\sqrt{\frac{3A}{\pi}}$
35. 10 m, 7 m
36. 4 mi/h
37. 10 in., 24 in. or 2 ft

13 Chapter Assessment

Assessment Item Analysis	
Item	Lesson
1–6	13-1
7–10	13-2
11–12	13-3
13–16	13-4
17–18	13-5
19–20	13-4
21–23	13-6
24	13-2
25–26	13-7

Write in standard form.

1. $6x^2 = 3x + 4$

2. $3y = 2y^2$

Solve.

3. $4a^2 + 4a = 0$

4. $7x^2 + 8x = 0$

5. $x^2 + 2x - 48 = 0$

6. $3y^2 + 5y = 2$

7. $16b^2 - 25b = 0$

8. $7x^2 = 35$

9. $(x + 8)^2 = 13$

10. $(x - 1)^2 = 8$

Complete the square.

11. $x^2 + 8x$

12. $y^2 + 9y$

Solve.

13. $x^2 + 4x - 10 = 0$

14. $x^2 - 3x - 7 = 0$

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

16. $3x^2 - 7x + 1 = 0$

17. $x - \frac{2}{x} = 1$

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

Compute the value of the discriminant and use it to determine how many real-number solutions each quadratic equation has.

19. $3x^2 + 12x + 13 = 0$

20. $5x^2 + 17x + 14 = 0$

Solve.

21. $\sqrt{x+1} = 6$

22. $\sqrt{6x+1} = \sqrt{5x+13}$

23. Solve $g = 2\sqrt{\frac{v}{kh}}$ for h.

24. The sum of \$2000 is invested at the compound interest rate r. In 4 years it grows to \$2621.59. Use the formula $A = P(1 + r)^t$ to find r.

25. The width of a rectangle is 4 m less than the length. The area is 16.25 m^2. Find the length and the width.

26. An airplane flies between two cities that are 700 miles apart, traveling with a wind of 25 mi/h when going, and traveling against it when returning. The trip out takes 15 minutes less time than the return flight. What is the speed of the plane in still air?

Chapter 13 Assessment

1. $6x^2 - 3x - 4 = 0$
2. $2y^2 - 3y = 0$
3. 0, −1
4. $0, -\frac{8}{7}$
5. −8, 6
6. $\frac{1}{3}$, −2
7. $0, \frac{25}{16}$
8. $\pm\sqrt{5}$
9. $-8 \pm \sqrt{13}$
10. $1 \pm 2\sqrt{2}$
11. $x^2 + 8x + 16$
12. $y^2 + 9y + \frac{81}{4}$
13. $-2 \pm \sqrt{14}$
14. $\frac{3 \pm \sqrt{37}}{2}$
15. $\frac{1 \pm \sqrt{13}}{2}$
16. $\frac{7 \pm \sqrt{37}}{6}$
17. 2, −1
18. 2, −4
19. −12, no real-number solutions
20. 9, two-real number solutions
21. 35
22. 12
23. $\frac{4v}{kg^2}$
24. 7%
25. $l = 6.5$ m, $w = 2.5$ m
26. 375 mi/h