4.8 EXERCISES

HOMEWORK KEY

○ = **WORKED-OUT SOLUTIONS** on p. WS9 for Exs. 19, 39, and 71

★ = **STANDARDIZED TEST PRACTICE** Exs. 2, 12, 51, 55, 62, 69, 72, and 73

SKILL PRACTICE

1. **VOCABULARY** Copy and complete: You can use the ? of a quadratic equation to determine the equation's number and type of solutions.

2. ★ **WRITING** *Describe* a real-life situation in which you can use the model $h = -16t^2 + v_0t + h_0$ but not the model $h = -16t^2 + h_0$.

EXAMPLES 1, 2, and 3 on pp. 292–293 for Exs. 3–30

EQUATIONS IN STANDARD FORM **Use the quadratic formula to solve the equation.**

3. $x^2 - 4x - 5 = 0$
4. $x^2 - 6x + 7 = 0$
5. $t^2 + 8t + 19 = 0$
6. $x^2 - 16x + 7 = 0$
7. $8w^2 - 8w + 2 = 0$
8. $5p^2 - 10p + 24 = 0$
9. $4x^2 - 8x + 1 = 0$
10. $6u^2 + 4u + 11 = 0$
11. $3r^2 - 8r - 9 = 0$

12. ★ **MULTIPLE CHOICE** What are the complex solutions of the equation $2x^2 - 16x + 50 = 0$?

(A) $4 + 3i, 4 - 3i$ (B) $4 + 12i, 4 - 12i$

(C) $16 + 3i, 16 - 3i$ (D) $16 + 12i, 16 - 12i$

EQUATIONS NOT IN STANDARD FORM **Use the quadratic formula to solve the equation.**

13. $3w^2 - 12w = -12$
14. $x^2 + 6x = -15$
15. $s^2 = -14 - 3s$
16. $-3y^2 = 6y - 10$
17. $3 - 8v - 5v^2 = 2v$
18. $7x - 5 + 12x^2 = -3x$
19. $4x^2 + 3 = x^2 - 7x$
20. $6 - 2t^2 = 9t + 15$
21. $4 + 9n - 3n^2 = 2 - n$

SOLVING USING TWO METHODS **Solve the equation using the quadratic formula. Then solve the equation by factoring to check your solution(s).**

22. $z^2 + 15z + 24 = -32$
23. $x^2 - 5x + 10 = 4$
24. $m^2 + 5m - 99 = 3m$
25. $s^2 - s - 3 = s$
26. $r^2 - 4r + 8 = 5r$
27. $3x^2 + 7x - 24 = 13x$
28. $45x^2 + 57x + 1 = 5$
29. $5p^2 + 40p + 100 = 25$
30. $9n^2 - 42n - 162 = 21n$

EXAMPLE 4 on p. 294 for Exs. 31–39

USING THE DISCRIMINANT **Find the discriminant of the quadratic equation and give the number and type of solutions of the equation.**

31. $x^2 - 8x + 16 = 0$
32. $s^2 + 7s + 11 = 0$
33. $8p^2 + 8p + 3 = 0$
34. $-4w^2 + w - 14 = 0$
35. $5x^2 + 20x + 21 = 0$
36. $8z - 10 = z^2 - 7z + 3$
37. $8n^2 - 4n + 2 = 5n - 11$
38. $5x^2 + 16x = 11x - 3x^2$
39. $7r^2 - 5 = 2r + 9r^2$

SOLVING QUADRATIC EQUATIONS **Solve the equation using any method.**

40. $16t^2 - 7t = 17t - 9$
41. $7x - 3x^2 = 85 + 2x^2 + 2x$
42. $4(x - 1)^2 = 6x + 2$
43. $25 - 16v^2 = 12v(v + 5)$
44. $\frac{3}{2}y^2 - 6y = \frac{3}{4}y - 9$
45. $3x^2 + \frac{9}{2}x - 4 = 5x + \frac{3}{4}$
46. $1.1(3.4x - 2.3)^2 = 15.5$
47. $19.25 = -8.5(2r - 1.75)^2$
48. $4.5 = 1.5(3.25 - s)^2$

ERROR ANALYSIS *Describe* **and correct the error in solving the equation.**

49.

$3x^2 + 6x + 15 = 0$

$x = \dfrac{-6 \pm \sqrt{6^2 - 4(3)(15)}}{2(3)}$

$= \dfrac{-6 \pm \sqrt{-144}}{6}$

$= \dfrac{-6 \pm 12}{6}$

$= 1$ or -3

50.

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

$x = \dfrac{-6 \pm \sqrt{6^2 - 4(1)(8)}}{2(1)}$

$= \dfrac{-6 \pm \sqrt{4}}{2}$

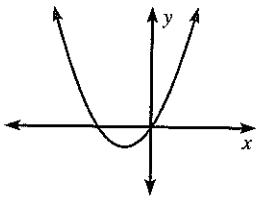
$= \dfrac{-6 \pm 2}{2}$

$= -2$ or -4

51. ★ SHORT RESPONSE For a quadratic equation $ax^2 + bx + c = 0$ with two real solutions, show that the mean of the solutions is $-\dfrac{b}{2a}$. How is this fact related to the symmetry of the graph of $y = ax^2 + bx + c$?

VISUAL THINKING In Exercises 52–54, the graph of a quadratic function $y = ax^2 + bx + c$ is shown. Tell whether the discriminant of $ax^2 + bx + c = 0$ is *positive*, *negative*, or *zero*.

52.



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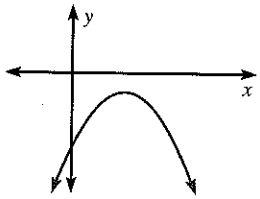

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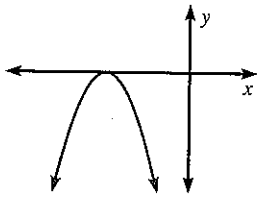

55. ★ MULTIPLE CHOICE What is the value of c if the discriminant of $2x^2 + 5x + c = 0$ is -23?

Ⓐ -23 Ⓑ -6 Ⓒ 6 Ⓓ 14

THE CONSTANT TERM Use the discriminant to find all values of c for which the equation has (a) two real solutions, (b) one real solution, and (c) two imaginary solutions.

56. $x^2 - 4x + c = 0$

57. $x^2 + 8x + c = 0$

58. $-x^2 + 16x + c = 0$

59. $3x^2 + 24x + c = 0$

60. $-4x^2 - 10x + c = 0$

61. $x^2 - x + c = 0$

62. ★ OPEN-ENDED MATH Write a quadratic equation in standard form that has a discriminant of -10.

WRITING EQUATIONS Write a quadratic equation in the form $ax^2 + bx + c = 0$ such that $c = 4$ and the equation has the given solutions.

63. -4 and 3

64. $-\dfrac{4}{3}$ and -1

65. $-1 + i$ and $-1 - i$

66. REASONING Show that there is no quadratic equation $ax^2 + bx + c = 0$ such that a, b, and c are real numbers and $3i$ and $-2i$ are solutions.

67. CHALLENGE Derive the quadratic formula by completing the square to solve the general quadratic equation $ax^2 + bx + c = 0$.

PROBLEM SOLVING

EXAMPLE 5 on p. 295 for Exs. 68–69

68. FOOTBALL In a football game, a defensive player jumps up to block a pass by the opposing team's quarterback. The player bats the ball downward with his hand at an initial vertical velocity of -50 feet per second when the ball is 7 feet above the ground. How long do the defensive player's teammates have to intercept the ball before it hits the ground?

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69. ★ MULTIPLE CHOICE For the period 1990–2002, the number S (in thousands) of cellular telephone subscribers in the United States can be modeled by $S = 858t^2 + 1412t + 4982$ where t is the number of years since 1990. In what year did the number of subscribers reach 50 million?

Ⓐ 1991 Ⓑ 1992 Ⓒ 1996 Ⓓ 2000

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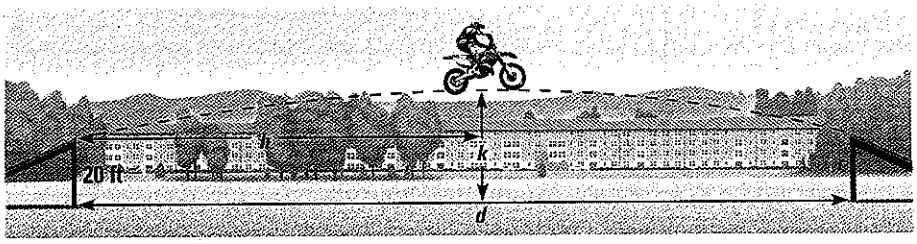
70. MULTI-STEP PROBLEM A stunt motorcyclist makes a jump from one ramp 20 feet off the ground to another ramp 20 feet off the ground. The jump between the ramps can be modeled by $y = -\frac{1}{640}x^2 + \frac{1}{4}x + 20$ where x is the horizontal distance (in feet) and y is the height above the ground (in feet).



a. What is the motorcycle's height r when it lands on the ramp?

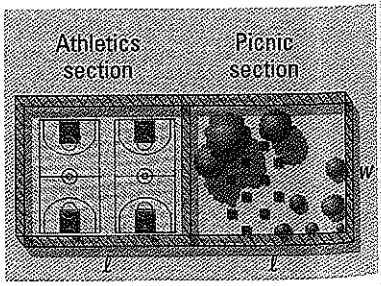
b. What is the distance d between the ramps?

c. What is the horizontal distance h the motorcycle has traveled when it reaches its maximum height?

d. What is the motorcycle's maximum height k above the ground?

71. BIOLOGY The number S of ant species in Kyle Canyon, Nevada, can be modeled by the function $S = -0.000013E^2 + 0.042E - 21$ where E is the elevation (in meters). Predict the elevation(s) at which you would expect to find 10 species of ants.

72. ★ SHORT RESPONSE A city planner wants to create adjacent sections for athletics and picnics in the yard of a youth center. The sections will be rectangular and will be surrounded by fencing as shown. There is 900 feet of fencing available. Each section should have an area of 12,000 square feet.



a. Show that $w = 300 - \frac{4}{3}\ell$.

b. Find the possible dimensions of each section.

○ = WORKED-OUT SOLUTIONS on p. WS1

★ = STANDARDIZED TEST PRACTICE

73. ★ EXTENDED RESPONSE You can model the position (x, y) of a moving object using a pair of *parametric equations*. Such equations give x and y in terms of a third variable t that represents time. For example, suppose that when a basketball player attempts a free throw, the path of the basketball can be modeled by the parametric equations

$$x = 20t$$

$$y = -16t^2 + 21t + 6$$

where x and y are measured in feet, t is measured in seconds, and the player's feet are at $(0, 0)$.

a. Evaluate Make a table of values giving the position (x, y) of the basketball after 0, 0.25, 0.5, 0.75, and 1 second.

b. Graph Use your table from part (a) to graph the parametric equations.

c. Solve The position of the basketball rim is (15, 10). The top of the backboard is (15, 12). Does the player make the free throw? *Explain*.

74. CHALLENGE The Stratosphere Tower in Las Vegas is 921 feet tall and has a "needle" at its top that extends even higher into the air. A thrill ride called the Big Shot catapults riders 160 feet up the needle and then lets them fall back to the launching pad.

a. The height h (in feet) of a rider on the Big Shot can be modeled by $h = -16t^2 + v_0t + 921$ where t is the elapsed time (in seconds) after launch and v_0 is the initial vertical velocity (in feet per second). Find v_0 using the fact that the maximum value of h is $921 + 160 = 1081$ feet.

b. A brochure for the Big Shot states that the ride up the needle takes two seconds. *Compare* this time with the time given by the model $h = -16t^2 + v_0t + 921$ where v_0 is the value you found in part (a). Discuss the model's accuracy.

MIXED REVIEW

Find the slope of the line passing through the given points. Then tell whether the line *rises, falls, is horizontal,* or *is vertical.* *(p. 82)*

75. (2, −7), (4, 9)

76. (−8, 3), (4, −5)

77. (−3, −2), (6, −2)

78. $\left(\frac{3}{4}, 2\right), \left(\frac{1}{2}, \frac{5}{4}\right)$

79. (−1, 0), (−1, 5)

80. $\left(\frac{1}{3}, \frac{7}{3}\right), \left(4, \frac{2}{3}\right)$

PREVIEW
Prepare for Lesson 4.9 in Exs. 81–86.

Graph the inequality or equation in a coordinate plane.

81. $y \leq 10$ *(p. 132)*

82. $8x - 4y < -16$ *(p. 132)*

83. $\frac{1}{2}x + 3y > 8$ *(p. 132)*

84. $y \geq -\frac{4}{9}x - 7$ *(p. 132)*

85. $y = 3(x + 1)(x + 2)$ *(p. 245)*

86. $y = -2(x - 3)(x - 1)$ *(p. 245)*

87. HANG-GLIDING Suppose that t minutes after beginning a descent, a hang glider has an altitude a (in feet) given by the model $a = 2000 - 250t$. What is the height of the hang glider prior to the descent? How long does it take the hang glider to reach the ground? *(p. 72)*