4.7 EXERCISES

HOMEWORK KEY

- = WORKED-OUT SOLUTIONS on p. WS8 for Exs. 27, 45, and 65
- ★ = STANDARDIZED TEST PRACTICE Exs. 2, 12, 34, 58, 59, and 67
- = MULTIPLE REPRESENTATIONS Ex. 66

SKILL PRACTICE

1. **VOCABULARY** What is the difference between a binomial and a trinomial?

2. ★ **WRITING** *Describe* what completing the square means for an expression of the form $x^2 + bx$.

EXAMPLE 1 on p. 284 for Exs. 3–12

SOLVING BY SQUARE ROOTS **Solve the equation by finding square roots.**

3. $x^2 + 4x + 4 = 9$
4. $x^2 + 10x + 25 = 64$
5. $n^2 + 16n + 64 = 36$
6. $m^2 - 2m + 1 = 144$
7. $x^2 - 22x + 121 = 13$
8. $x^2 - 18x + 81 = 5$
9. $t^2 + 8t + 16 = 45$
10. $4u^2 + 4u + 1 = 75$
11. $9x^2 - 12x + 4 = -3$

12. ★ **MULTIPLE CHOICE** What are the solutions of $x^2 - 4x + 4 = -1$?

Ⓐ $2 \pm i$ Ⓑ $-2 \pm i$ Ⓒ $-3, -1$ Ⓓ $1, 3$

EXAMPLE 2 on p. 285 for Exs. 13–21

FINDING *c* **Find the value of *c* that makes the expression a perfect square trinomial. Then write the expression as the square of a binomial.**

13. $x^2 + 6x + c$
14. $x^2 + 12x + c$
15. $x^2 - 24x + c$
16. $x^2 - 30x + c$
17. $x^2 - 2x + c$
18. $x^2 + 50x + c$
19. $x^2 + 7x + c$
20. $x^2 - 13x + c$
21. $x^2 - x + c$

EXAMPLES 3 and 4 on pp. 285–286 for Exs. 22–34

COMPLETING THE SQUARE **Solve the equation by completing the square.**

22. $x^2 + 4x = 10$
23. $x^2 + 8x = -1$
24. $x^2 + 6x - 3 = 0$
25. $x^2 + 12x + 18 = 0$
26. $x^2 - 18x + 86 = 0$
27. $x^2 - 2x + 25 = 0$
28. $2k^2 + 16k = -12$
29. $3x^2 + 42x = -24$
30. $4x^2 - 40x - 12 = 0$
31. $3s^2 + 6s + 9 = 0$
32. $7t^2 + 28t + 56 = 0$
33. $6r^2 + 6r + 12 = 0$

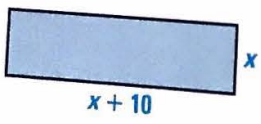
34. ★ **MULTIPLE CHOICE** What are the solutions of $x^2 + 10x + 8 = -5$?

Ⓐ $5 \pm 2\sqrt{3}$ Ⓑ $5 \pm 4\sqrt{3}$ Ⓒ $-5 \pm 2\sqrt{3}$ Ⓓ $-5 \pm 4\sqrt{3}$

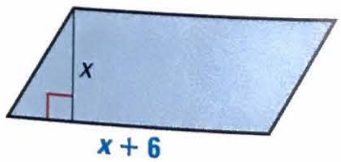
EXAMPLE 5 on p. 286 for Exs. 35–38

GEOMETRY **Find the value of *x*.**

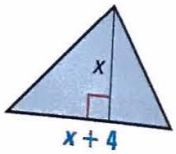
35. Area of rectangle = 50



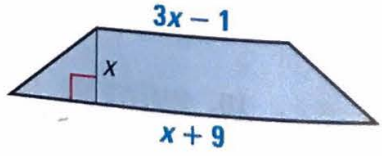
36. Area of parallelogram = 48



37. Area of triangle = 40



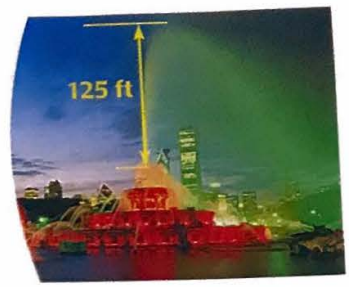
38. Area of trapezoid = 20



FINDING THE VERTEX **In Exercises 39 and 40, use completing the square to find the vertex of the given function's graph. Then tell what the vertex represents.**

39. At Buckingham Fountain in Chicago, the water's height h (in feet) above the main nozzle can be modeled by $h = -16t^2 + 89.6t$ where t is the time (in seconds) since the water has left the nozzle.

40. When you walk x meters per minute, your rate y of energy use (in calories per minute) can be modeled by $y = 0.0085x^2 - 1.5x + 120$.



Buckingham Fountain

EXAMPLES 6 and 7 on p. 287 for Exs. 41–49

WRITING IN VERTEX FORM **Write the quadratic function in vertex form. Then identify the vertex.**

41. $y = x^2 - 8x + 19$

42. $y = x^2 - 4x - 1$

43. $y = x^2 + 12x + 37$

44. $y = x^2 + 20x + 90$

45. $f(x) = x^2 - 3x + 4$

46. $g(x) = x^2 + 7x + 2$

47. $y = 2x^2 + 24x + 25$

48. $y = 5x^2 + 10x + 7$

49. $y = 2x^2 - 28x + 99$

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

50.

$$x^2 + 10x + 13 = 0$$
$$x^2 + 10x = -13$$
$$x^2 + 10x + 25 = -13 + 25$$
$$(x + 5)^2 = 12$$
$$x + 5 = \pm\sqrt{12}$$
$$x = -5 \pm \sqrt{12}$$
$$x = -5 \pm 4\sqrt{3}$$

51.

$$4x^2 + 24x - 11 = 0$$
$$4(x^2 + 6x) = 11$$
$$4(x^2 + 6x + 9) = 11 + 9$$
$$4(x + 3)^2 = 20$$
$$(x + 3)^2 = 5$$
$$x + 3 = \pm\sqrt{5}$$
$$x = -3 \pm \sqrt{5}$$

COMPLETING THE SQUARE **Solve the equation by completing the square.**

52. $x^2 + 9x + 20 = 0$

53. $x^2 + 3x + 14 = 0$

54. $7q^2 + 10q = 2q^2 + 155$

55. $3x^2 + x = 2x - 6$

56. $0.1x^2 - x + 9 = 0.2x$

57. $0.4v^2 + 0.7v = 0.3v - 2$

58. ★ **OPEN-ENDED MATH** Write a quadratic equation with real-number solutions that can be solved by completing the square but not by factoring.

59. ★ **SHORT RESPONSE** In this exercise, you will investigate the graphical effect of completing the square.

a. Graph each pair of functions in the same coordinate plane.

$y = x^2 + 2x$ and $y = (x + 1)^2$

$y = x^2 + 4x$ and $y = (x + 2)^2$

$y = x^2 - 6x$ and $y = (x - 3)^2$

b. *Compare* the graphs of $y = x^2 + bx$ and $y = \left(x + \frac{b}{2}\right)^2$. What happens to the graph of $y = x^2 + bx$ when you complete the square?

60. **REASONING** For what value(s) of k does $x^2 + bx + \left(\frac{b}{2}\right)^2 = k$ have exactly 1 real solution? 2 real solutions? 2 imaginary solutions?

61. **CHALLENGE** Solve $x^2 + bx + c = 0$ by completing the square. Your answer will be an expression for x in terms of b and c.

PROBLEM SOLVING

EXAMPLE 7 on p. 287 for Exs. 62–65

62. DRUM MAJOR While marching, a drum major tosses a baton into the air and catches it. The height h (in feet) of the baton after t seconds can be modeled by $h = -16t^2 + 32t + 6$. Find the maximum height of the baton.

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63. VOLLEYBALL The height h (in feet) of a volleyball t seconds after it is hit can be modeled by $h = -16t^2 + 48t + 4$. Find the volleyball's maximum height.

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64. SKATEBOARD REVENUE A skateboard shop sells about 50 skateboards per week for the price advertised. For each \$1 decrease in price, about 1 more skateboard per week is sold. The shop's revenue can be modeled by $y = (70 - x)(50 + x)$. Use vertex form to find how the shop can maximize weekly revenue.

65. VIDEO GAME REVENUE A store sells about 40 video game systems each month when it charges \$200 per system. For each \$10 increase in price, about 1 less system per month is sold. The store's revenue can be modeled by $y = (200 + 10x)(40 - x)$. Use vertex form to find how the store can maximize monthly revenue.

66. MULTIPLE REPRESENTATIONS The path of a ball thrown by a softball player can be modeled by the function

$$y = -0.0110x^2 + 1.23x + 5.50$$

where x is the softball's horizontal position (in feet) and y is the corresponding height (in feet).

a. Rewriting a Function Write the given function in vertex form.

b. Making a Table Make a table of values for the function. Include values of x from 0 to 120 in increments of 10.

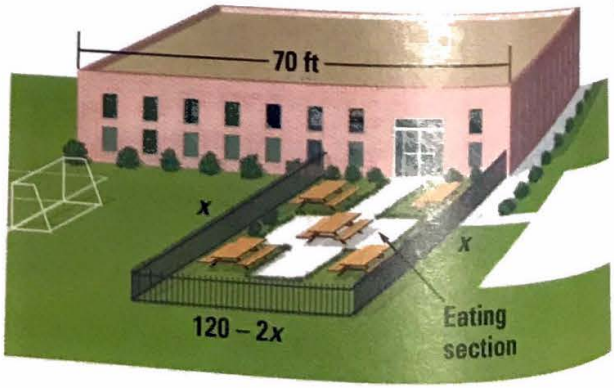
c. Drawing a Graph Use your table to graph the function. What is the maximum height of the softball? How far does it travel?

67. ★ EXTENDED RESPONSE Your school is adding a rectangular outdoor eating section along part of a 70 foot side of the school. The eating section will be enclosed by a fence along its three open sides. The school has 120 feet of fencing and plans to use 1500 square feet of land for the eating section.

a. Write an equation for the area of the eating section.

b. Solve the equation. *Explain* why you must reject one of the solutions.

c. What are the dimensions of the eating section?



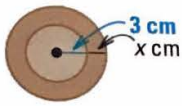
○ = WORKED-OUT SOLUTIONS on p. WS1

★ = STANDARDIZED TEST PRACTICE

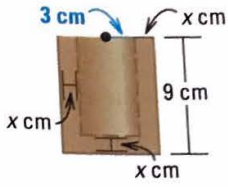
= MULTIPLE REPRESENTATIONS

GEOMETRY REVIEW The volume of clay equals the difference of the volumes of two cylinders.

68. **CHALLENGE** In your pottery class, you are given a lump of clay with a volume of 200 cubic centimeters and are asked to make a cylindrical pencil holder. The pencil holder should be 9 centimeters high and have an inner radius of 3 centimeters. What thickness x should your pencil holder have if you want to use all of the clay?



Top view

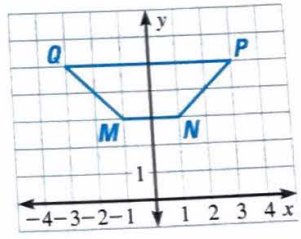


Side view

MISSOURI MIXED REVIEW

TEST PRACTICE at classzone.com

69. If quadrilateral $MNPQ$ is reflected in the line $y = 3$, in which quadrant will the image of point N appear?



(A) Quadrant I (B) Quadrant II

(C) Quadrant III (D) Quadrant IV

70. A hose adds 120 gallons of water to a swimming pool in 1.5 hours. How many hours will it take for the hose to fill a different swimming pool that holds 600 gallons of water?

(A) 5 h (B) 6.25 h (C) 7.5 h (D) 8 h

QUIZ for Lessons 4.5–4.7

Solve the equation.

1. $4x^2 = 64$ *(p. 266)*
2. $3(p - 1)^2 = 15$ *(p. 266)*
3. $16(m + 5)^2 = 8$ *(p. 266)*
4. $-2z^2 = 424$ *(p. 275)*
5. $s^2 + 12 = 9$ *(p. 275)*
6. $7x^2 - 4 = -6$ *(p. 275)*

Write the expression as a complex number in standard form. *(p. 275)*

7. $(5 - 3i) + (-2 + 5i)$
8. $(-2 + 9i) - (7 + 8i)$
9. $3i(7 - 9i)$
10. $(8 - 3i)(-6 - 10i)$
11. $\frac{4i}{-6 - 11i}$
12. $\frac{3 - 2i}{-8 + 5i}$

Write the quadratic function in vertex form. Then identify the vertex. *(p. 284)*

13. $y = x^2 - 4x + 9$
14. $y = x^2 + 14x + 45$
15. $f(x) = x^2 - 10x + 17$
16. $g(x) = x^2 - 2x - 7$
17. $y = x^2 + x + 1$
18. $y = x^2 + 9x + 19$

19. **FALLING OBJECT** A student drops a ball from a school roof 45 feet above ground. How long is the ball in the air? *(p. 266)*