4.1 EXERCISES

HOMEWORK KEY

- ◯ = **WORKED-OUT SOLUTIONS** on p. WS7 for Exs. 15, 37, and 57
- ★ = **STANDARDIZED TEST PRACTICE** Exs. 2, 39, 40, 43, 53, 58, and 60
- ◆ = **MULTIPLE REPRESENTATIONS** Ex. 59

SKILL PRACTICE

1. **VOCABULARY** Copy and complete: The graph of a quadratic function is called a(n) ? .

2. ★ **WRITING** *Describe* how to determine whether a quadratic function has a minimum value or a maximum value.

EXAMPLE 1 on p. 236 for Exs. 3–12

USING A TABLE **Copy and complete the table of values for the function.**

3. $y = 4x^2$

x	−2	−1	0	1	2
y	?	?	?	?	?

4. $y = -3x^2$

x	−2	−1	0	1	2
y	?	?	?	?	?

5. $y = \frac{1}{2}x^2$

x	−4	−2	0	2	4
y	?	?	?	?	?

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

x	−6	−3	0	3	6
y	?	?	?	?	?

MAKING A GRAPH **Graph the function. *Compare* the graph with the graph of $y = x^2$.**

7. $y = 3x^2$
8. $y = 5x^2$
9. $y = -2x^2$
10. $y = -x^2$
11. $f(x) = \frac{1}{3}x^2$
12. $g(x) = -\frac{1}{4}x^2$

EXAMPLE 2 on p. 237 for Exs. 13–18

13. $y = 5x^2 + 1$
14. $y = 4x^2 + 1$
15. $f(x) = -x^2 + 2$
16. $g(x) = -2x^2 - 5$
17. $f(x) = \frac{3}{4}x^2 - 5$
18. $g(x) = -\frac{1}{5}x^2 - 2$

ERROR ANALYSIS ***Describe*** **and correct the error in analyzing the graph of $y = 4x^2 + 24x - 7$.**

19.

The x-coordinate of the vertex is:

$$x = \frac{b}{2a} = \frac{24}{2(4)} = 3$$

✗

20.

The y-intercept of the graph is the value of c, which is 7.

✗

EXAMPLE 3 on p. 238 for Exs. 21–32

MAKING A GRAPH **Graph the function. Label the vertex and axis of symmetry.**

21. $y = x^2 + 2x + 1$
22. $y = 3x^2 - 6x + 4$
23. $y = -4x^2 + 8x + 2$
24. $y = -2x^2 - 6x + 3$
25. $g(x) = -x^2 - 2x - 1$
26. $f(x) = -6x^2 - 4x - 5$
27. $y = \frac{2}{3}x^2 - 3x + 6$
28. $y = -\frac{3}{4}x^2 - 4x - 1$
29. $g(x) = -\frac{3}{5}x^2 + 2x + 2$
30. $f(x) = \frac{1}{2}x^2 + x - 3$
31. $y = \frac{8}{5}x^2 - 4x + 5$
32. $y = -\frac{5}{3}x^2 - x - 4$

EXAMPLE 4 on p. 239 for Exs. 33–38

MINIMUMS OR MAXIMUMS **Tell whether the function has a *minimum value* or a *maximum value*. Then find the minimum or maximum value.**

33. $y = -6x^2 - 1$ **34.** $y = 9x^2 + 7$ **35.** $f(x) = 2x^2 + 8x + 7$

36. $g(x) = -3x^2 + 18x - 5$ **37.** $f(x) = \frac{3}{2}x^2 + 6x + 4$ **38.** $y = -\frac{1}{4}x^2 - 7x + 2$

39. ★ **MULTIPLE CHOICE** What is the effect on the graph of the function $y = x^2 + 2$ when it is changed to $y = x^2 - 3$?

(A) The graph widens. (B) The graph narrows.

(C) The graph opens down. (D) The vertex moves down the y-axis.

40. ★ **MULTIPLE CHOICE** Which function has the widest graph?

(A) $y = 2x^2$ (B) $y = x^2$ (C) $y = 0.5x^2$ (D) $y = -x^2$

IDENTIFYING COEFFICIENTS **In Exercises 41 and 42, identify the values of *a*, *b*, and *c* for the quadratic function.**

41. The path of a basketball thrown at an angle of 45° can be modeled by $y = -0.02x^2 + x + 6$.

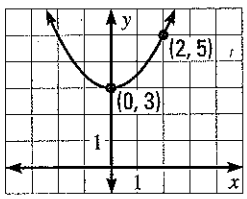
42. The path of a shot put released at an angle of 35° can be modeled by $y = -0.01x^2 + 0.7x + 6$.

43. ★ **OPEN-ENDED MATH** Write three different quadratic functions whose graphs have the line $x = 4$ as an axis of symmetry but have different y-intercepts.

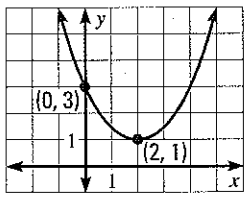
MATCHING **In Exercises 44–46, match the equation with its graph.**

44. $y = 0.5x^2 - 2x$ **45.** $y = 0.5x^2 + 3$ **46.** $y = 0.5x^2 - 2x + 3$

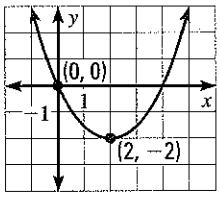
A.



B.



C.



MAKING A GRAPH **Graph the function. Label the vertex and axis of symmetry.**

47. $f(x) = 0.1x^2 + 2$ **48.** $g(x) = -0.5x^2 - 5$ **49.** $y = 0.3x^2 + 3x - 1$

50. $y = 0.25x^2 - 1.5x + 3$ **51.** $f(x) = 4.2x^2 + 6x - 1$ **52.** $g(x) = 1.75x^2 - 2.5$

53. ★ **SHORT RESPONSE** The points (2, 3) and (−4, 3) lie on the graph of a quadratic function. *Explain* how these points can be used to find an equation of the axis of symmetry. Then write an equation of the axis of symmetry.

54. **CHALLENGE** For the graph of $y = ax^2 + bx + c$, show that the y-coordinate of the vertex is $-\frac{b^2}{4a} + c$.

PROBLEM SOLVING

EXAMPLE 5 on p. 239 for Exs. 55–58

55. ONLINE MUSIC An online music store sells about 4000 songs each day when it charges \$1 per song. For each \$.05 increase in price, about 80 fewer songs per day are sold. Use the verbal model and quadratic function to find how the store can maximize daily revenue.

Revenue (dollars)	=	Price (dollars/song)	•	Sales (songs)
$R(x)$	=	$(1 + 0.05x)$	•	$(4000 - 80x)$

@HomeTutor for problem solving help at classzone.com

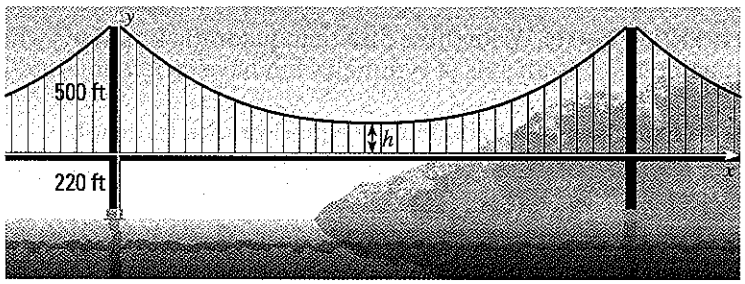
56. DIGITAL CAMERAS An electronics store sells about 70 of a new model of digital camera per month at a price of \$320 each. For each \$20 decrease in price, about 5 more cameras per month are sold. Write a function that models the situation. Then tell how the store can maximize monthly revenue from sales of the camera.

@HomeTutor for problem solving help at classzone.com

57. GOLDEN GATE BRIDGE Each cable joining the two towers on the Golden Gate Bridge can be modeled by the function

$$y = \frac{1}{9000}x^2 - \frac{7}{15}x + 500$$

where x and y are measured in feet. What is the height h above the road of a cable at its lowest point?



58. ★ SHORT RESPONSE A woodland jumping mouse hops along a parabolic path given by $y = -0.2x^2 + 1.3x$ where x is the mouse's horizontal position (in feet) and y is the corresponding height (in feet). Can the mouse jump over a fence that is 3 feet high? *Explain.*

59. ❖ MULTIPLE REPRESENTATIONS A community theater sells about 150 tickets to a play each week when it charges \$20 per ticket. For each \$1 decrease in price, about 10 more tickets per week are sold. The theater has fixed expenses of \$1500 per week.

a. Writing a Model Write a verbal model and a quadratic function to represent the theater's weekly profit.

b. Making a Table Make a table of values for the quadratic function.

c. Drawing a Graph Use the table to graph the quadratic function. Then use the graph to find how the theater can maximize weekly profit.

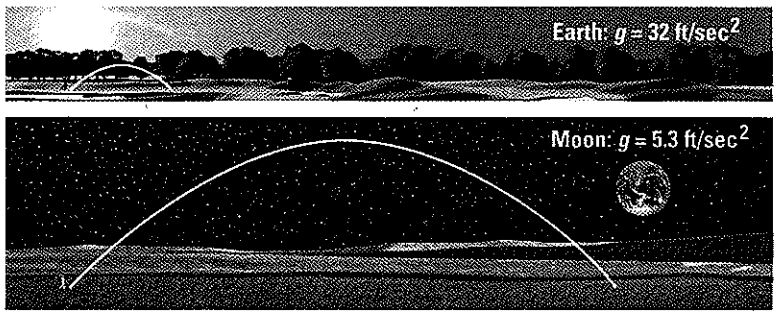
○ = WORKED-OUT SOLUTIONS on p. WS1 ★ = STANDARDIZED TEST PRACTICE ❖ = MULTIPLE REPRESENTATIONS

60. ★ EXTENDED RESPONSE In 1971, astronaut Alan Shepard hit a golf ball on the moon. The path of a golf ball hit at an angle of 45° and with a speed of 100 feet per second can be modeled by

$$y = -\frac{g}{10{,}000}x^2 + x$$

where x is the ball's horizontal position (in feet), y is the corresponding height (in feet), and g is the acceleration due to gravity (in feet per second squared).

a. Model Use the information in the diagram to write functions for the paths of a golf ball hit on Earth and a golf ball hit on the moon.



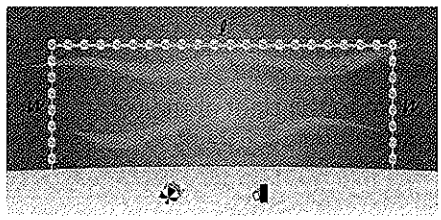
GRAPHING CALCULATOR
In part (b), use the calculator's *zero* feature to answer the questions.

b. Graphing Calculator Graph the functions from part (a) on a graphing calculator. How far does the golf ball travel on Earth? on the moon?

c. Interpret *Compare* the distances traveled by a golf ball on Earth and on the moon. Your answer should include the following:

- a calculation of the ratio of the distances traveled
- a discussion of how the distances and values of g are related

61. CHALLENGE Lifeguards at a beach want to rope off a rectangular swimming section. They have P feet of rope with buoys. In terms of P, what is the maximum area that the swimming section can have?



MIXED REVIEW

Solve the equation. *(p. 18)*

62. $x - 3 = 0$ **63.** $3x + 4 = 0$ **64.** $-9x + 7 = -4x - 5$

65. $5x - 2 = -2x + 12$ **66.** $0.7x + 3 = 0.2x - 2$ **67.** $0.4x = -0.5x - 5$

PREVIEW
Prepare for Lesson 4.2 in Exs. 68–73.

Graph the function. *(p. 123)*

68. $y = |x - 5|$ **69.** $y = -|x + 2|$ **70.** $y = 3|x - 1|$

71. $y = -4|x + 1|$ **72.** $f(x) = 2|x - 3| + 6$ **73.** $g(x) = -5|x + 4| - 1$

74. AVERAGE SPEED You are driving on a road trip. At 9:00 A.M., you are 340 miles west of Nashville. At 2:00 P.M., you are 70 miles west of Nashville. Find your average speed. *(p. 82)*