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.

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. $g(x) = -\frac{1}{4}x^2$

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:

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

20.

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

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
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 $y = x^2 - 3$?

Ⓐ The graph widens.

Ⓑ The graph narrows.

Ⓒ The graph opens down.

Ⓓ The vertex moves down the y-axis.

40. ★ **MULTIPLE CHOICE** Which function has the widest graph?
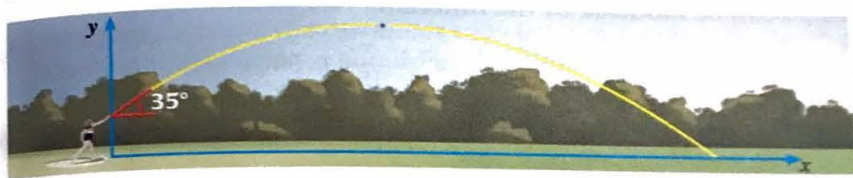
Ⓐ $y = 2x^2$

Ⓑ $y = x^2$

Ⓒ $y = 0.5x^2$

Ⓓ $y = -x^2$

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 $y = -0.01x^2 + 0.7x + 6$.
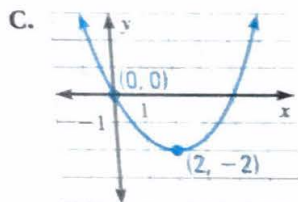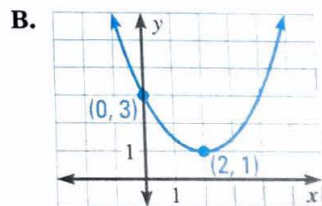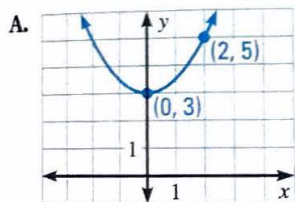

43. ★ **OPEN-ENDED MATH** Write three different quadratic functions whose graphs have the line $x = 4$ as an axis of symmetry but have different y-intercepts.

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

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.

$$\begin{array}{ccccc} \text{Revenue} & = & \text{Price} & \cdot & \text{Sales} \\ \text{(dollars)} & & \text{(dollars/song)} & & \text{(songs)} \end{array}$$

$$R(x) = (1 + 0.05x) \cdot (4000 - 80x)$$

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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.

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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 REPRESENTATION**

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.

Earth: $g = 32$ ft/sec^2

Moon: $g = 5.3$ ft/sec^2

  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?

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62. Liz's high score in a video game is 1200 points less than three times her friend's high score. Let x represent her friend's high score. Which expression can be used to determine Liz's high score?

  Ⓐ $1200 - 3x$　　**Ⓑ** $\dfrac{x - 1200}{3}$　　**Ⓒ** $\dfrac{x}{3} - 1200$　　**Ⓓ** $3x - 1200$

63. The total cost, c, of a school banquet is given by $c = 25n + 1400$, where n is the total number of students attending the banquet. The total cost of the banquet was $9900. How many students attended the banquet?

  Ⓐ 177　　　　**Ⓑ** 340　　　　**Ⓒ** 396　　　　**Ⓓ** 452