Practice Book

3 Practice and Apply

Use Practice Book pp. 247–248

Assignment Guide	
Decelerated	1–6, 10–12, 19
Average	2–20 Even
Accelerated	7–9, 13–21

■ Before assigning the exercises on Practice Book pages 247–248, discuss the example in the teaching display with students. Have volunteers explain each step by asking questions such as, "Why is the x-coordinate of the vertex -1?" and "Why should two x-values greater than -1 and two x-values less than -1 be used to draw the graph?"

■ For exercises 1–18, make sure students use enough points to show the shape of the parabola. Suggest that they try to include the x- and y-intercepts, if they exist.

Errors Commonly Made

Students sometimes want to use mental math to write the equation for the axis of symmetry. In their haste, they may easily overlook the negative sign, especially when a and/or b are themselves negative. Encourage students to first write the general equation and then substitute in the known values.

Problem Solving

■ Suggest that students use their handhelds to graph other functions similar to those in problems 19–20 before making generalizations about $f(x) = (x - a)^2$ and $f(x) = (x + a)^2$.

CHALLENGE

■ For exercise 21, have students refer to their results from problems 19–20.

10-2 Graph Quadratic Functions: Parabola

Name _____ Date _____

Graph: $y = x^2 + 2x - 8$

1 Find the equation of the axis of symmetry.

$a = 1$ and $b = 2$ ← Identify the values of a and b in $y = ax^2 + bx + c$.

$x = \frac{-b}{2a} = \frac{-(2)}{2(1)} = -1$ ← Substitute 1 for a and 2 for b in $x = \frac{-b}{2a}$.

The axis of symmetry is $x = -1$.

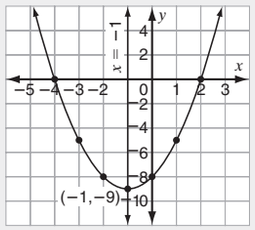
2 Find the coordinates of the vertex.
The x-coordinate of the vertex is -1.

$y = x^2 + 2x - 8$
$= (-1)^2 + 2(-1) - 8$ ← Substitute -1 for x.
$= 1 - 2 - 8$ ← Simplify.
$= -9$ ← Simplify.

The vertex is at $(-1, -9)$

3 Select two x-values greater than -1 and two x-values less than -1 and make a function table. Then graph the ordered pairs in the table on a coordinate plane and draw a smooth curve through them.

x	y	(x, y)
-3	$(-3)^2 + 2(-3) - 8 = -5$	$(-3, -5)$
-2	$(-2)^2 + 2(-2) - 8 = -8$	$(-2, -8)$
-1	$(-1)^2 + 2(-1) - 8 = -9$	$(-1, -9)$
0	$(0)^2 + 2(0) - 8 = -8$	$(0, -8)$
1	$(1)^2 + 2(1) - 8 = -5$	$(1, -5)$



The parabola opens upward because $a = 1$ and $1 > 0$.

Write the equation of the axis of symmetry, and find the coordinates of the vertex of the parabola. Use a separate sheet of paper to make a function table and graph each function. Check students' tables and graphs.

1. $y = x^2 + 2x - 10$

$x = -\frac{b}{2a} = -\frac{2}{2(1)} = -1$
$y = (-1)^2 + 2(-1) - 10 = -11$
vertex: $(-1, -11)$

2. $y = x^2 + 4x - 3$

$x = -\frac{b}{2a} = -\frac{4}{2(1)} = -2$
$y = (-2)^2 + 4(-2) - 3 = -7$
vertex: $(-2, -7)$

3. $y = 4x^2 + 8x - 7$

$x = -\frac{b}{2a} = -\frac{8}{2(4)} = -1$
$y = 4(-1)^2 + 8(-1) - 7 = -11$
vertex: $(-1, -11)$

4. $y = 3x^2 + 12x - 2$

$x = -\frac{b}{2a} = -\frac{12}{2(3)} = -2$
$y = 3(-2)^2 + 12(-2) - 2 = -14$
vertex: $(-2, -14)$

5. $y = -5x^2 + 10x - 1$

$x = -\frac{b}{2a} = -\frac{10}{2(-5)} = 1$
$y = -5(1)^2 + 10(1) - 1 = 4$
vertex: $(1, 4)$

6. $y = -3x^2 + 18x - 20$

$x = -\frac{b}{2a} = -\frac{18}{2(-3)} = 3$
$y = -3(3)^2 + 18(3) - 20 = 7$
vertex: $(3, 7)$

7. $y = -6x^2 + 36x - 40$

$x = -\frac{b}{2a} = -\frac{36}{2(-6)} = 3$
$y = -6(3)^2 + 36(3) - 40 = 14$
vertex: $(3, 14)$

8. $y = -5x^2 + 40x - 60$

$x = -\frac{b}{2a} = -\frac{40}{2(-5)} = 4$
$y = -5(4)^2 + 40(4) - 60 = 20$
vertex: $(4, 20)$

9. $y = 6x^2 - 24$

$x = -\frac{b}{2a} = -\frac{0}{2(5)} = 0$
$y = 5(0)^2 - 24 = -24$
vertex: $(0, -24)$

Use with SOURCEBOOK Lesson 10-2, pages 250–253.

Write the equation of the axis of symmetry, and find the coordinates of the vertex of the parabola. Use a separate sheet of paper to make a function table and graph each function. Check students' tables and graphs.

10. $y = 4x^2 + 64$

$x = -\frac{b}{2a} = -\frac{0}{2(4)} = 0$
$y = 5(0)^2 + 64 = 64$
vertex: (0, 64)

11. $y = 2x^2 + 98$

$x = -\frac{b}{2a} = -\frac{0}{2(2)} = 0$
$y = 2(0)^2 + 98 = 98$
vertex: (0, 98)

12. $y = -5x^2 + 1.2$

$x = -\frac{b}{2a} = -\frac{0}{2(-5)} = 0$
$y = -6(0)^2 + 1.2 = 1.2$
vertex: (0, 1.2)

13. $y = -3x^2 + 6.75$

$x = -\frac{b}{2a} = -\frac{0}{2(-3)} = 0$
$y = -3(0)^2 + 6.75 = 6.75$
vertex: (0, 6.75)

14. $y = x^2 - 9x - 1$

$x = -\frac{b}{2a} = -\frac{-9}{2(1)} = \frac{9}{2}$
$y = \left(\frac{9}{2}\right)^2 - 9\left(\frac{9}{2}\right) - 1 = -21.25$
vertex: (4.5, −21.25)

15. $y = x^2 - 5x - 10$

$x = -\frac{b}{2a} = -\frac{-5}{2(1)} = \frac{5}{2}$
$y = \left(\frac{5}{2}\right)^2 - 5\left(\frac{5}{2}\right) - 10 = -16.25$
vertex: (2.5, −16.25)

16. $y = \frac{1}{4}x^2 - 2x + 1$

$x = -\frac{b}{2a} = -\frac{-2}{2\left(\frac{1}{4}\right)} = \frac{2}{\left(\frac{1}{2}\right)} = 4$
$y = \frac{1}{4}(4)^2 - 2(4) + 1 = -3$
vertex: (4, −3)

17. $y = \frac{1}{3}x^2 - 6x + 8$

$x = -\frac{b}{2a} = -\frac{-6}{2\left(\frac{1}{3}\right)} = \frac{3}{\left(\frac{1}{3}\right)} = 9$
$y = \frac{1}{3}(9)^2 - 6(9) + 8 = -19$
vertex: (9, −19)

18. $y = -\frac{1}{8}x^2 + x - 1$

$x = -\frac{b}{2a} = -\frac{1}{2\left(-\frac{1}{8}\right)} = \frac{1}{\left(\frac{1}{4}\right)} = 4$
$y = -\frac{1}{8}(4)^2 + (4) - 1 = 1$
vertex: (4, 1)

Problem Solving

19. Using a handheld, graph the equations $f(x) = (x - 3)^2$, $f(x) = (x - 5)^2$, and $f(x) = (x - 7)^2$. Examine how these graphs differ from $f(x) = x^2$. Then explain how the graph of $f(x) = (x - a)^2$ differs from the graph of $f(x) = x^2$.

Account for all possibilities. Answers will vary. Possible response: The graphs of $f(x) = (x - 3)^2$, $f(x) = (x - 5)^2$ and $f(x) = (x - 7)^2$ are in the same shape and size as the graph of $f(x) = x^2$, but shifted 3, 5, and 7 units to the right, respectively. This means that the graph of $f(x) = (x - a)^2$ will be in the same shape and size as the graph of $f(x) = x^2$, but shifted *a* units to the right.

20. Using a handheld, graph the equations $f(x) = (x + 2)^2$, $f(x) = (x + 4)^2$, and $f(x) = (x + 8)^2$. Examine how these graphs differ from $f(x) = x^2$. Then explain how the graph of $f(x) = (x + a)^2$ differs from the graph of $f(x) = x^2$.

Account for all possibilities. Answers will vary. Possible response: The graphs of $f(x) = (x + 2)^2$, $f(x) = (x + 4)^2$ and $f(x) = (x + 8)^2$ are in the same shape and size as the graph of $f(x) = x^2$, but shifted 2, 4, and 8 units to the left, respectively. This means that the graph of $f(x) = (x + a)^2$ will be in the same shape and size as the graph of $f(x) = x^2$, but shifted *a* units to the left.

CHALLENGE

21. Using a handheld, find the equation of a parabola that opens upward with a vertex of (3, 4) and is as wide as the parabola $f(x) = x^2$. Give the equation in the form $y = ax^2 + bx + c$.

The equation $f(x) = x^2$ has vertex (0, 0) and points (−2, 4), (−1, 1), (1, 1), and (2, 4). To be the same size, the parabola must contain points (−2 + 3, 4 + 4), (−1 + 3, 1 + 4), (0 + 3, 0 + 4), (1 + 3, 1 + 4), (2 + 3, 4 + 4) or (1, 8), (2, 5), (3, 4), (4, 5), (5, 8). The equation can be found by guess and test as $f(x) = (x - 3)^2 + 4$, or $f(x) = x^2 - 6x + 13$.

Additional Resources

ONLINE www.progressinmathematics.com
- Meeting Individual Needs Activities
- Alternative Teaching Models
- Vocabulary Activities
- Audio Glossary
- Virtual Manipulatives

4 Summarize/Assess

Conceptual Thinking

■ To assess whether students have conceptualized the lesson concepts, have them explain how to find the axis of symmetry and the vertex. Use examples like $y = 2x^2 + 8x - 3$. $x = -2$; $(-2, -11)$ Then discuss how to create a table of values and graph the parabola.

MATH JOURNAL In their *Math Journals*, have students graph the equation $y = -x^2 + 6x + 2$, explaining each step of the process.

5 Follow-Up

Reteaching

ONLINE **Virtual Manipulatives: Grapher**

■ Students can use the Grapher Virtual Manipulative to practice graphing quadratic equations.

■ Create identical sets of cards with quadratic equations written on each. Pass out one set of cards to pairs of students. Have the pairs choose a card at random and work together to graph each equation on grid paper. After they have completed all of the graphs, have two pairs work together to match the equations with each other's graphs. Have them discuss any inconsistencies and help each other find the errors.

ONLINE **See Chapter 10 Alternative Teaching Models.**

End of Lesson