Multiply.

1. $(3x - 2)(2x - 4)$

$6x^2 - 12x - 4x + 8$
$6x^2 - 16x + 8$

2. $(5x + 2)(4x + 1)$

$20x^2 + 5x + 8x + 2$
$20x^2 + 13x + 2$

3. $(4x + y)(2x - 3y)$

$8x^2 - 12xy + 2xy - 3y^2$
$8x^2 - 10xy - 3y^2$

4. $3a(4a + 1)$

$12a^2 + 3a$

5. $(4x + 1)(5x - 2)$

$20x^2 - 8x + 5x - 2$
$20x^2 - 3x - 2$

6. $(5y + 4)(3y + 2)$

$15y^2 + 10y + 12y + 8$
$15y^2 + 22y + 8$

Warm Up

* Student may use any method to solve these
  - Foil
  - double distributive
  - area model

* have students do these as a warm up

Write a function g whose graph represents the indicated transformation of the graph f.

1. $f(x) = x + 6$; translation 3 units right

$g(x) = f(x - 3)$ $g(x) = (x - 3) + 6$
$g(x) = x + 3$

2. $f(x) = x - 3$; translation 1 unit left

$g(x) = f(x + 1)$ $g(x) = (x + 1) - 3$
$g(x) = x - 2$

3. $f(x) = |5x - 2| - 3$; translation 1 unit down

$g(x) = f(x) - 1$
$g(x) = |5x - 2| - 3 - 1$
$g(x) = |5x - 2| - 4$

Cumulative Warm Up

Review of transformations from Chapter 1.

* review how to check on the graphing calculator.

Essential Question

How do the constants a, h, and k affect the graph of the quadratic function $g(x) = a(x - h)^2 + k$?

Essential Question

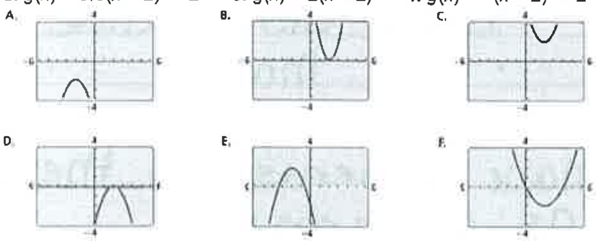
what you will learn:

- Describe transformations of Quadratic functions
- write transformations of Quadratic functions

Work with a partner. Match each quadratic function with its graph. Explain your reasoning. Then use a graphing calculator to verify that your answer is correct.

a. $g(x) = -(x - 2)^2$ **b.** $g(x) = (x - 2)^2 + 2$ **c.** $g(x) = -(x + 2)^2 - 2$

d. $g(x) = 0.5(x - 2)^2 - 2$ **e.** $g(x) = 2(x - 2)^2$ **f.** $g(x) = -(x + 2)^2 + 2$



Exploration 1

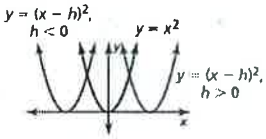
a. D
b. C
c. A
d. F
e. B
f. E

Core Concept

Horizontal Translations

$f(x) = x^2$

$f(x - h) = (x - h)^2$

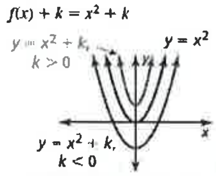


- shifts left when $h < 0$
- shifts right when $h > 0$

Vertical Translations

$f(x) = x^2$

$f(x) + k = x^2 + k$



- shifts down when $k < 0$
- shifts up when $k > 0$

Core Concept

Describe the transformation of $f(x) = x^2$ represented by $g(x) = (x + 4)^2 - 1$. Then graph each function.

$h = -4$ $k = -1$

4 units left

1 unit down

Example 1

Describe the transformation of $f(x) = x^2$ represented by g. Then graph each function.

1. $g(x) = (x - 3)^2$ **2.** $g(x) = (x - 2)^2 - 2$ **3.** $g(x) = (x + 5)^2 + 1$

$h = 3$
$k = 0$

right 3 units

$h = 2$
$k = -2$

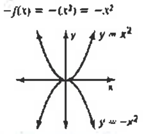
right 2 units
down 2 units

Monitoring Progress 1-3

Core Concept

Reflections in the *x*-Axis

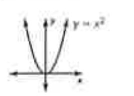
$f(x) = x^2$
$-f(x) = -(x^2) = -x^2$



flips over the *x*-axis

Reflections in the *y*-Axis

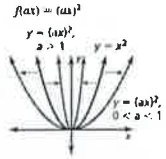
$f(x) = x^2$
$f(-x) = (-x)^2 = x^2$



$y = x^2$ is its own reflection in the *y*-axis.

Horizontal Stretches and Shrinks

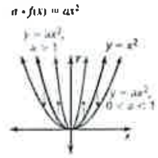
$f(x) = x^2$
$f(ax) = (ax)^2$



- horizontal stretch (away from *y*-axis) when $0 < a < 1$
- horizontal shrink (toward *y*-axis) when $a > 1$

Vertical Stretches and Shrinks

$f(x) = x^2$
$a \cdot f(x) = ax^2$



- vertical stretch (away from *x*-axis) when $a > 1$
- vertical shrink (toward *x*-axis) when $0 < a < 1$

Core Concept

Describe the transformation of $f(x) = x^2$ represented by g. Then graph each function.

a. $g(x) = -\frac{1}{2}x^2$ **b.** $g(x) = (2x)^2 + 1$

Example 2

Describe the transformation of $f(x) = x^2$ represented by g. Then graph each function.

4. $g(x) = \left(\frac{1}{3}x\right)^2$ **5.** $g(x) = 3(x - 1)^2$ **6.** $g(x) = -(x + 3)^2 + 2$

Monitoring Progress 4-6

Let the graph of g be a vertical stretch by a factor of 2 and a reflection in the x-axis, followed by a translation 3 units down of the graph of $f(x) = x^2$. Write a rule for g and identify the vertex.

Example 3

Let the graph of g be a translation 3 units right and 2 units up, followed by a reflection in the y-axis of the graph of $f(x) = x^2 - 5x$. Write a rule for g.

Example 4

The height h (in feet) of water spraying from a fire hose can be modeled by $h(x) = -0.03x^2 + x + 25$, where x is the horizontal distance (in feet) from the fire truck. The crew raises the ladder so that the water hits the ground 10 feet farther from the fire truck. Write a function that models the new path of the water.

Example 5

7. Let the graph of g be a vertical shrink by a factor of $\frac{1}{2}$ followed by a translation 2 units up of the graph of $f(x) = x^2$. Write a rule for g and identify the vertex.

Monitoring Progress 7

8. Let the graph of g be a translation 4 units left followed by a horizontal shrink by a factor of $\frac{1}{3}$ of the graph of $f(x) = x^2 + x$. Write a rule for g.

Monitoring Progress 8

9. WHAT IF? In Example 5, the water hits the ground 10 feet closer to the fire truck after lowering the ladder. Write a function that models the new path of the water.

Monitoring Progress 9

I Used to Think ... But Now I Know: Take time for students to reflect on their current understanding of transformations.

Closure