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8.2 Graphing $f(x) = ax^2 + c$

For use with Exploration 8.2

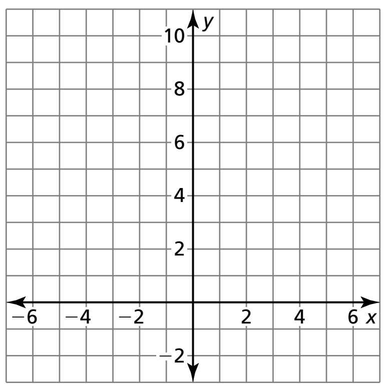
Essential Question How does the value of *c* affect the graph of $f(x) = ax^2 + c$?

1 EXPLORATION: Graphing $y = ax^2 + c$

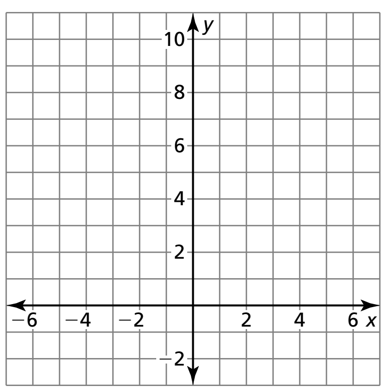
Go to *BigIdeasMath.com* for an interactive tool to investigate this exploration.

Work with a partner. Sketch the graphs of the functions in the same coordinate plane. What do you notice?

a. $f(x) = x^2$ and $g(x) = x^2 + 2$



b. $f(x) = 2x^2$ and $g(x) = 2x^2 - 2$



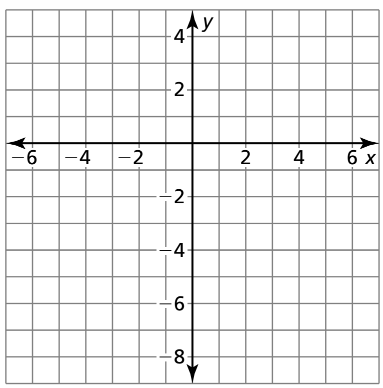
8.2 Graphing $f(x) = ax^2 + c$ (continued)

2 EXPLORATION: Finding x-Intercepts of Graphs

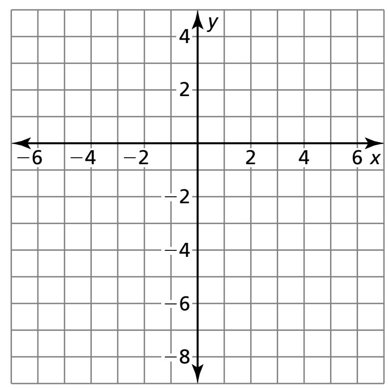
Go to *BigIdeasMath.com* for an interactive tool to investigate this exploration.

Work with a partner. Graph each function. Find the x-intercepts of the graph. Explain how you found the x-intercepts.

a. $y = x^2 - 7$



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

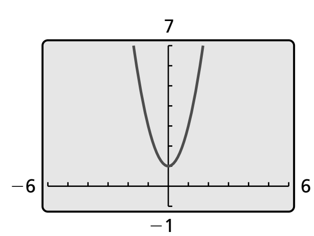


Communicate Your Answer

3. How does the value of c affect the graph of $f(x) = ax^2 + c$?

4. Use a graphing calculator to verify your answers to Question 3.

5. The figure shows the graph of a quadratic function of the form $y = ax^2 + c$. Describe possible values of a and c. Explain your reasoning.



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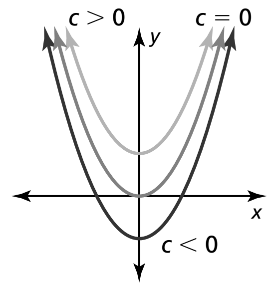
8.2 Practice
For use after Lesson 8.2

Core Concepts

Graphing $f(x) = ax^2 + c$

- When $c > 0$, the graph of $f(x) = ax^2 + c$ is a vertical translation c units up of the graph of $f(x) = ax^2$.
- When $c < 0$, the graph of $f(x) = ax^2 + c$ is a vertical translation $|c|$ units down of the graph of $f(x) = ax^2$.



The vertex of the graph of $f(x) = ax^2 + c$ is $(0, c)$, and the axis of symmetry is $x = 0$.

Notes:

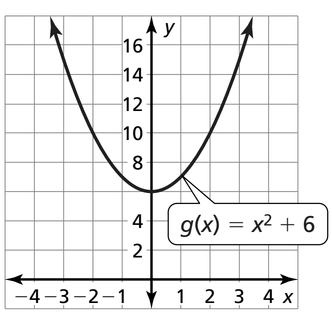
Worked-Out Examples

Example #1

Graph the function. Compare the graph to the graph of f(x) = x².

$g(x) = x^2 + 6$

x	-2	-1	0	1	2
$g(x)$	10	7	6	7	10



Both graphs open up and have the same axis of symmetry, $x = 0$. The vertex of the graph of g, (0, 6), is above the vertex of the graph of f, (0, 0). So, the graph of g is a vertical translation 6 units up of the graph of f.

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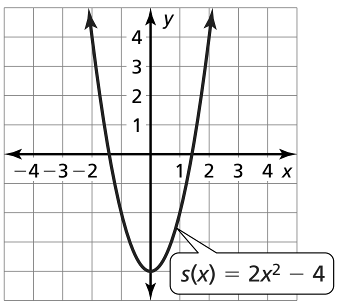
Example #2

Graph the function. Compare the graph to the graph of $f(x) = x^2$.

$s(x) = 2x^2 - 4$

x	-2	-1	0	1	2
$s(x)$	4	-2	-4	-2	4

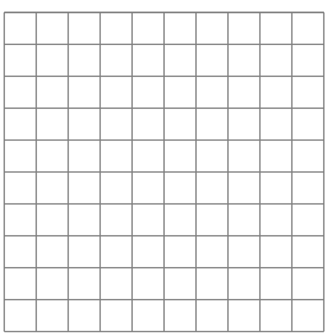


Both graphs open up and have the same axis of symmetry, $x = 0$, but the graph of s is narrower than the graph of f. Also, the vertex of the graph of s, $(0, -4)$, is below the vertex of the graph of f, $(0, 0)$. So, the graph of s is a vertical stretch by a factor of 2 and a vertical translation 4 units down of the graph of f.

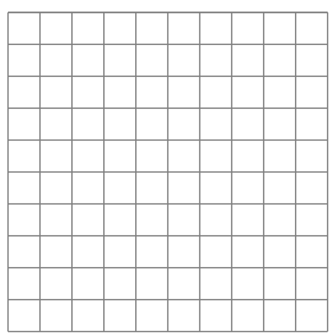
Practice A

In Exercises 1–4, graph the function. Compare the graph to the graph of $f(x) = x^2$.

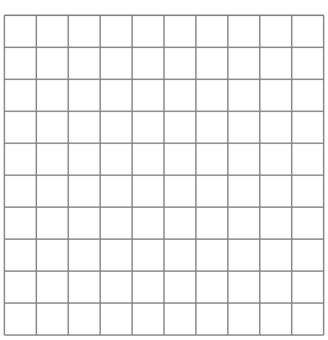
1. $g(x) = x^2 + 5$



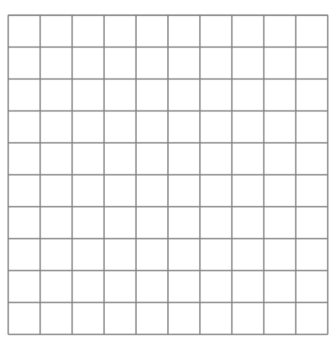
2. $m(x) = x^2 - 3$



3. $n(x) = -3x^2 - 2$



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



8.2 Practice (continued)

In Exercises 5–8, find the zeros of the function.

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

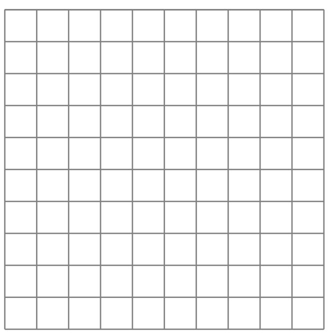
6. $y = -4x^2 + 16$

7. $n(x) = -x^2 + 64$

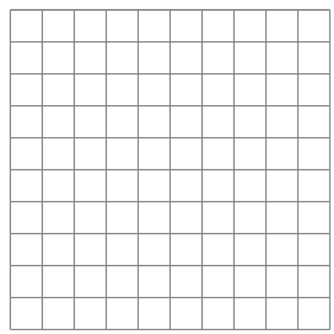
8. $p(x) = -9x^2 + 1$

In Exercises 9 and 10, sketch a parabola with the given characteristics.

9. The parabola opens down, and the vertex is (0, 5).



10. The lowest point on the parabola is (0, 4).



11. The function $f(t) = -16t^2 + s_0$ represents the approximate height (in feet) of a falling object t seconds after it is dropped from an initial height s_0 (in feet). A tennis ball falls from a height of 400 feet.

a. After how many seconds does the tennis ball hit the ground?

b. Suppose the initial height is decreased by 384 feet. After how many seconds does the ball hit the ground?

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Practice B

In Exercises 1–3, graph the function. Compare the graph to the graph of $f(x) = x^2$.

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

2. $h(x) = x^2 + 10$

3. $j(x) = x^2 - 5$

In Exercises 4–6, graph the function. Compare the graph to the graph of $f(x) = x^2$.

4. $g(x) = -2x^2 + 4$

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

6. $k(x) = \frac{1}{3}x^2 + 5$

In Exercises 7 and 8, describe the transformation from the graph of *f* to the graph of *g*. Then graph *f* and *g* in the same coordinate plane. Write an equation that represents *g* in terms of *x*.

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

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

8. $f(x) = 2x^2 + 7$

$g(x) = f(x) - 9$

In Exercises 9–12, find the zeros of the function.

9. $y = -x^2 + 81$

10. $y = 3x^2 - 75$

11. $f(x) = -5x^2 + 20$

12. $f(x) = -12x^2 + 27$

13. The function $y = -16x^2 + 100$ represents the height y (in feet) of a pencil x seconds after falling out the window of a school building. Find and interpret the x- and y-intercepts.

14. The paths of water from three different waterfalls are given below. Each function gives the height h (in feet) and the horizontal distance d (in feet) of the water.

Waterfall 1: $h = -2.4d^2 + 1.5$

Waterfall 2: $h = -2.4d^2 + 3$

Waterfall 3: $h = -1.4d^2 + 3$

a. Which waterfall drops water from the lowest point?

b. Which waterfall sends water the farthest horizontal distance?

c. What do you notice about the paths of Waterfall 1 and Waterfall 2?