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

**For use with Exploration 8.3**

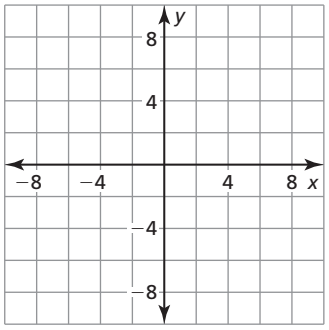
**Essential Question** How can you find the vertex of the graph of $f(x) = ax^2 + bx + c$?

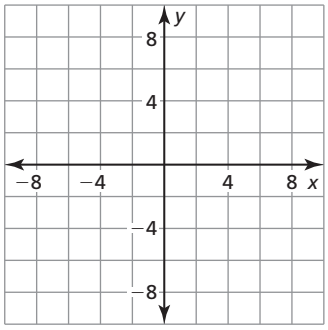
## 1 EXPLORATION: Comparing $x$-Intercepts with the Vertex

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

**Work with a partner.**

**a.** Sketch the graphs of $y = 2x^2 - 8x$ and $y = 2x^2 - 8x + 6$.




**b.** What do you notice about the $x$-coordinate of the vertex of each graph?

**c.** Use the graph of $y = 2x^2 - 8x$ to find its $x$-intercepts. Verify your answer by solving $0 = 2x^2 - 8x$.

**d.** Compare the value of the $x$-coordinate of the vertex with the values of the $x$-intercepts.

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## 2 EXPLORATION: Finding $x$-Intercepts

**Work with a partner.**

**a.** Solve $0 = ax^2 + bx$ for $x$ by factoring.

**b.** What are the $x$-intercepts of the graph of $y = ax^2 + bx$?

**c.** Complete the table to verify your answer.

| $x$ | $y = ax^2 + bx$ |
|---|---|
| 0 | |
| $-\frac{b}{a}$ | |

## 3 EXPLORATION: Deductive Reasoning

**Work with a partner.** Complete the following logical argument.

The $x$-intercepts of the graph of $y = ax^2 + bx$ are 0 and $-\frac{b}{a}$.

The vertex of the graph of $y = ax^2 + bx$ occurs when $x =$ _____.

The vertices of the graphs of $y = ax^2 + bx$ and $y = ax^2 + bx + c$ have the same $x$-coordinate.

The vertex of the graph of $y = ax^2 + bx + c$ occurs when $x =$ _____.

## Communicate Your Answer

**4.** How can you find the vertex of the graph of $f(x) = ax^2 + bx + c$?

**5.** Without graphing, find the vertex of the graph of $f(x) = x^2 - 4x + 3$. Check your result by graphing.

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# 8.3 Notetaking with Vocabulary

**For use after Lesson 8.3**

**In your own words, write the meaning of each vocabulary term.**

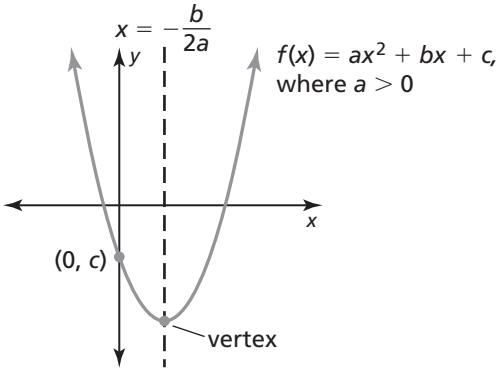
maximum value

minimum value

## Core Concepts

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

- The graph opens up when $a > 0$, and the graph opens down when $a < 0$.
- The $y$-intercept is $c$.
- The $x$-coordinate of the vertex is $-\frac{b}{2a}$.
- The axis of symmetry is $x = -\frac{b}{2a}$.




**Notes:**

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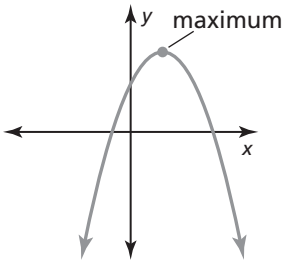
## 8.3 Notetaking with Vocabulary (continued)

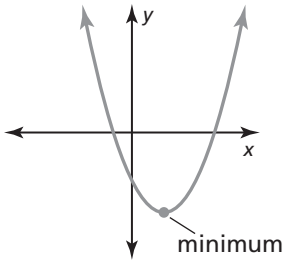
### Maximum and Minimum Values

The $y$-coordinate of the vertex of the graph of $f(x) = ax^2 + bx + c$ is the **maximum value** of the function when $a < 0$ or the **minimum value** of the function when $a > 0$.

$f(x) = ax^2 + bx + c, a < 0$




$f(x) = ax^2 + bx + c, a > 0$




**Notes:**

## Extra Practice

**In Exercises 1–4, find (a) the axis of symmetry and (b) the vertex of the graph of the function.**

**1.** $f(x) = x^2 - 10x + 2$

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

**3.** $y = -2x^2 - 8x + 5$

**4.** $f(x) = -3x^2 + 6x + 1$

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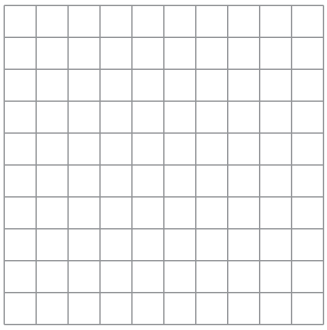
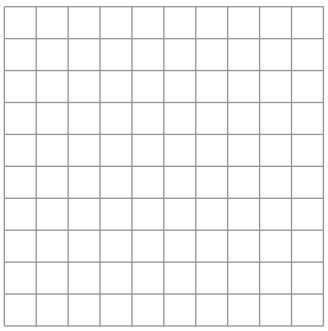
## 8.3 Notetaking with Vocabulary (continued)

**In Exercises 5–7, graph the function. Describe the domain and range.**

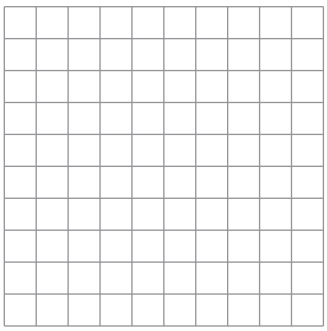
**5.** $f(x) = 3x^2 + 6x + 2$



**6.** $y = 2x^2 - 8x - 1$



**7.** $y = -\frac{1}{5}x^2 - x + 5$



**In Exercises 8–13, tell whether the function has a minimum value or a maximum value. Then find the value.**

**8.** $y = -\frac{1}{2}x^2 - 5x + 2$

**9.** $y = 8x^2 + 16x - 2$

**10.** $y = -x^2 - 4x - 7$

**11.** $y = -7x^2 + 7x + 5$

**12.** $y = 9x^2 + 6x + 4$

**13.** $y = -\frac{1}{4}x^2 + x - 6$

**14.** The function $h = -16t^2 + 250t$ represents the height $h$ (in feet) of a rocket $t$ seconds after it is launched. The rocket explodes at its highest point.

**a.** When does the rocket explode?

**b.** At what height does the rocket explode?