

**Chapter  
9**

**Maintaining Mathematical Proficiency**

**Factor the trinomial.**

1.  $x^2 - 6x + 9$

2.  $x^2 + 4x + 4$

3.  $x^2 - 14x + 49$

4.  $x^2 + 22x + 121$

5.  $x^2 - 24x + 144$

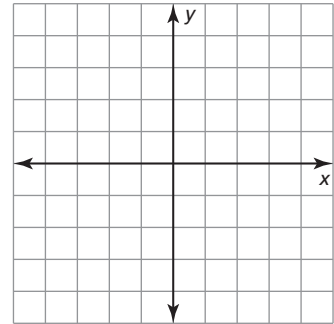
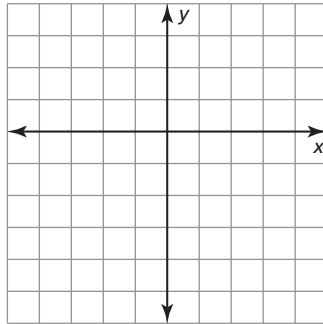
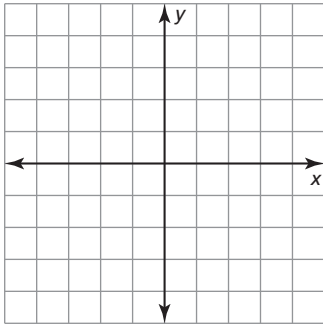
6.  $x^2 + 26x + 169$

**Solve the system of linear equations by graphing.**

7.  $y = 2x - 1$   
 $y = -3x + 9$

8.  $y = -\frac{1}{2}x - 1$   
 $y = \frac{1}{4}x - 4$

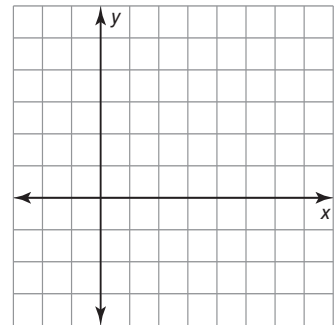
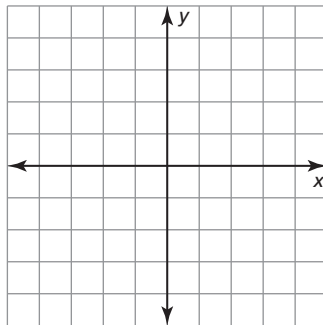
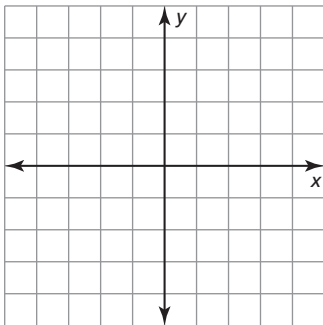
9.  $y = 2x + 3$   
 $y = -3x - 2$



10.  $y = x + 3$   
 $y = -\frac{1}{3}x - 1$

11.  $y = x + 1$   
 $y = 3x - 1$

12.  $y = 2x - 3$   
 $y = x + 1$



**9.1****Properties of Radicals**

For use with Exploration 9.1

**Essential Question** How can you multiply and divide square roots?**1 EXPLORATION:** Operations with Square Roots

**Work with a partner.** For each operation with square roots, compare the results obtained using the two indicated orders of operations. What can you conclude?

**a. Square Roots and Addition**Is  $\sqrt{36} + \sqrt{64}$  equal to  $\sqrt{36 + 64}$ ?In general, is  $\sqrt{a} + \sqrt{b}$  equal to  $\sqrt{a + b}$ ? Explain your reasoning.**b. Square Roots and Multiplication**Is  $\sqrt{4} \cdot \sqrt{9}$  equal to  $\sqrt{4 \cdot 9}$ ?In general, is  $\sqrt{a} \cdot \sqrt{b}$  equal to  $\sqrt{a \cdot b}$ ? Explain your reasoning.**c. Square Roots and Subtraction**Is  $\sqrt{64} - \sqrt{36}$  equal to  $\sqrt{64 - 36}$ ?In general, is  $\sqrt{a} - \sqrt{b}$  equal to  $\sqrt{a - b}$ ? Explain your reasoning.**d. Square Roots and Division**Is  $\frac{\sqrt{100}}{\sqrt{4}}$  equal to  $\sqrt{\frac{100}{4}}$ ?In general, is  $\frac{\sqrt{a}}{\sqrt{b}}$  equal to  $\sqrt{\frac{a}{b}}$ ? Explain your reasoning.

**9.1** Properties of Radicals (continued)**2** **EXPLORATION:** Writing Counterexamples

**Work with a partner.** A **counterexample** is an example that proves that a general statement is *not* true. For each general statement in Exploration 1 that is not true, write a counterexample different from the example given.

**Communicate Your Answer**

3. How can you multiply and divide square roots?
  
  
  
  
  
  
  
  
  
  
4. Give an example of multiplying square roots and an example of dividing square roots that are different from the examples in Exploration 1.
  
  
  
  
  
  
  
  
  
  
5. Write an algebraic rule for each operation.
  - a. the product of square roots
  
  
  
  
  
  
  
  
  
  
  - b. the quotient of square roots

**9.1****Notetaking with Vocabulary**

For use after Lesson 9.1

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

counterexample

radical expression

simplest form

rationalizing the denominator

conjugates

like radicals

**Core Concepts****Product Property of Square Roots**

**Words** The square root of a product equals the product of the square roots of the factors.

**Numbers**  $\sqrt{9 \cdot 5} = \sqrt{9} \cdot \sqrt{5} = 3\sqrt{5}$

**Algebra**  $\sqrt{ab} = \sqrt{a} \cdot \sqrt{b}$ , where  $a, b \geq 0$

**Notes:**

**9.1** Notetaking with Vocabulary (continued)**Quotient Property of Square Roots**

**Words** The square root of a quotient equals the quotient of the square roots of the numerator and denominator.

**Numbers**  $\sqrt{\frac{3}{4}} = \frac{\sqrt{3}}{\sqrt{4}} = \frac{\sqrt{3}}{2}$

**Algebra**  $\sqrt{\frac{a}{b}} = \frac{\sqrt{a}}{\sqrt{b}}$ , where  $a \geq 0$  and  $b > 0$

**Notes:**

**Extra Practice**

In Exercises 1–12, simplify the expression.

1.  $\sqrt{24}$

2.  $-\sqrt{48}$

3.  $\sqrt{162g^6}$

4.  $-\sqrt{512h^7}$

5.  $\sqrt{\frac{25}{64}}$

6.  $-\sqrt{\frac{6}{49}}$

7.  $-\sqrt{\frac{196}{r^4}}$

8.  $\sqrt{\frac{49x^3}{64y^2}}$

9.  $\sqrt[3]{-135}$

10.  $\sqrt[3]{729}$

11.  $-\sqrt[3]{-192x^5}$

12.  $\sqrt[3]{\frac{12a^6}{512b^4}}$

**9.1** Notetaking with Vocabulary (continued)

In Exercises 13–20, simplify the expression.

13.  $\frac{\sqrt{15}}{\sqrt{500}}$

14.  $\sqrt{\frac{8}{100}}$

15.  $\frac{\sqrt{3x^2y^3}}{\sqrt{80xy^3}}$

16.  $\frac{8}{\sqrt[3]{16}}$

17.  $\frac{5}{-3 - 3\sqrt{3}}$

18.  $\frac{3}{4 + 4\sqrt{5}}$

19.  $\frac{4}{\sqrt{2} - 5\sqrt{3}}$

20.  $\frac{\sqrt{5}}{\sqrt{3} + \sqrt{5}}$

21. The ratio of the length to the width of a *golden rectangle* is  $(1 + \sqrt{5}) : 2$ . The length of a golden rectangle is 62 meters. What is the width? Round your answer to the nearest meter.

In Exercises 22–27, simplify the expression.

22.  $3\sqrt{8} + 3\sqrt{2}$

23.  $2\sqrt{18} - 2\sqrt{20} - 2\sqrt{5}$

24.  $3\sqrt{12} + 3\sqrt{18} + 2\sqrt{27}$

25.  $2\sqrt{5}(\sqrt{6} + 2)$

26.  $(\sqrt{7} - \sqrt{3})(\sqrt{7} + \sqrt{3})$

27.  $\sqrt[3]{2}(\sqrt[3]{108} - \sqrt[3]{135})$

# 9.2

## Solving Quadratic Equations by Graphing

For use with Exploration 9.2

**Essential Question** How can you use a graph to solve a quadratic equation in one variable?

**1 EXPLORATION:** Solving a Quadratic Equation by Graphing

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

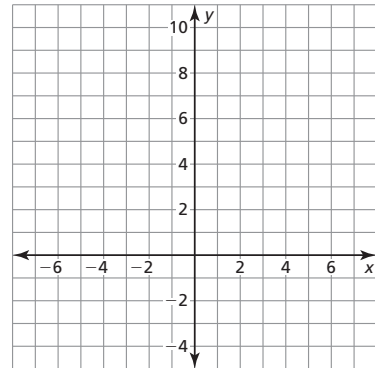
Work with a partner.

a. Sketch the graph of  $y = x^2 - 2x$ .

b. What is the definition of an  $x$ -intercept of a graph? How many  $x$ -intercepts does this graph have? What are they?

c. What is the definition of a solution of an equation in  $x$ ? How many solutions does the equation  $x^2 - 2x = 0$  have? What are they?

d. Explain how you can verify the solutions you found in part (c).



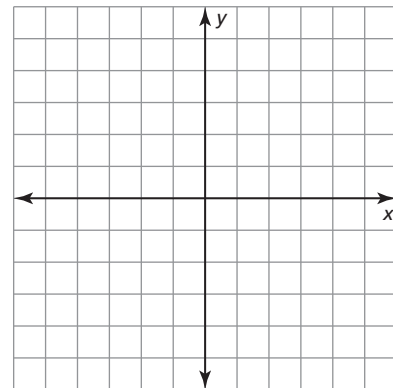
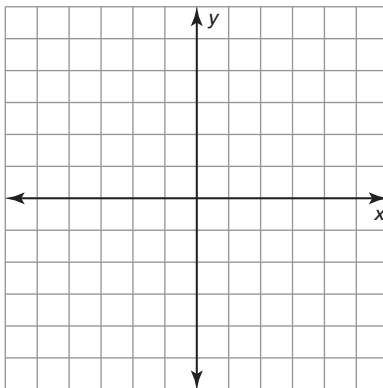
**2 EXPLORATION:** Solving Quadratic Equations by Graphing

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

Work with a partner. Solve each equation by graphing.

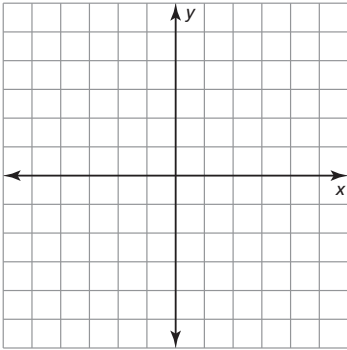
a.  $x^2 - 4 = 0$

b.  $x^2 + 3x = 0$

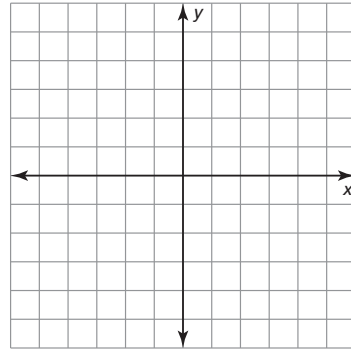


**9.2 Solving Quadratic Equations by Graphing (continued)****2 EXPLORATION: Solving Quadratic Equations by Graphing (continued)**

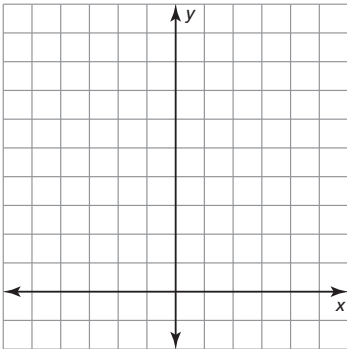
c.  $-x^2 + 2x = 0$



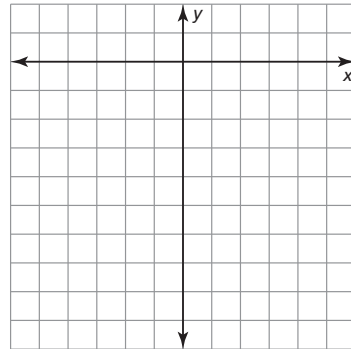
d.  $x^2 - 2x + 1 = 0$



e.  $x^2 - 3x + 5 = 0$



f.  $-x^2 + 3x - 6 = 0$

**Communicate Your Answer**

- How can you use a graph to solve a quadratic equation in one variable?
- After you find a solution graphically, how can you check your result algebraically?  
Check your solutions for parts (a)–(d) in Exploration 2 algebraically.
- How can you determine graphically that a quadratic equation has no solution?



**9.2****Notetaking with Vocabulary**

For use after Lesson 9.2

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

quadratic equation

**Core Concepts****Solving Quadratic Equations by Graphing**

**Step 1** Write the equation in standard form,  $ax^2 + bx + c = 0$ .

**Step 2** Graph the related function  $y = ax^2 + bx + c$ .

**Step 3** Find the  $x$ -intercepts, if any.

The solutions, or *roots*, of  $ax^2 + bx + c = 0$  are the  $x$ -intercepts of the graph.

**Notes:**

**Number of Solutions of a Quadratic Equation**

A quadratic equation has:

- two real solutions when the graph of its related function has two  $x$ -intercepts.
- one real solution when the graph of its related function has one  $x$ -intercept.
- no real solutions when the graph of its related function has no  $x$ -intercepts.

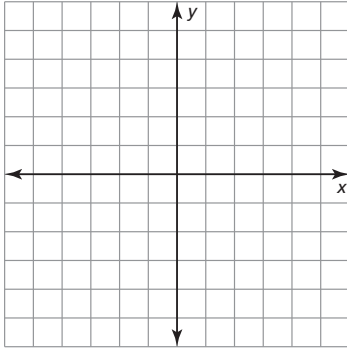
**Notes:**

**9.2** Notetaking with Vocabulary (continued)

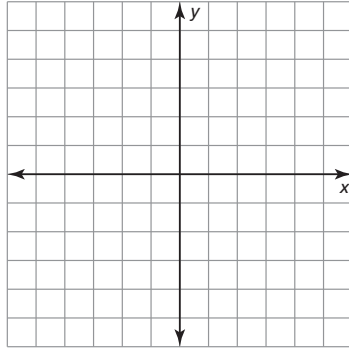
**Extra Practice**

In Exercises 1–9, solve the equation by graphing.

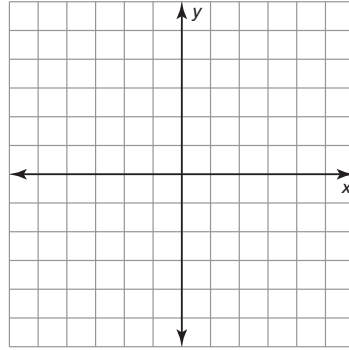
1.  $x^2 + 4x = 0$



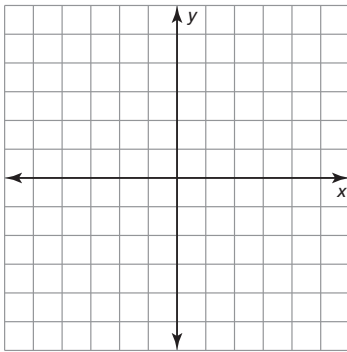
2.  $-x^2 = -2x + 1$



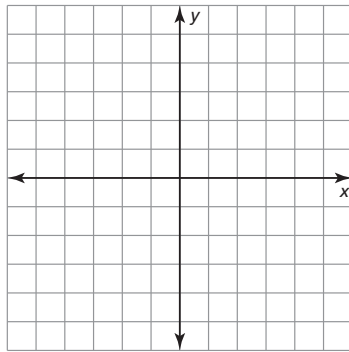
3.  $x^2 + 2x + 4 = 0$



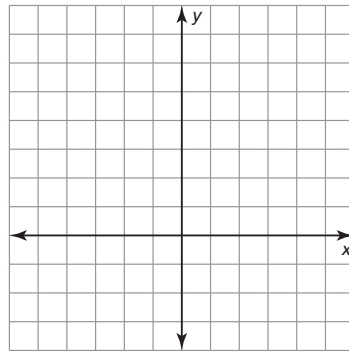
4.  $x^2 - 5x + 4 = 0$



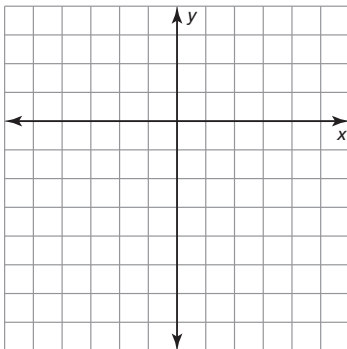
5.  $x^2 + 6x + 9 = 0$



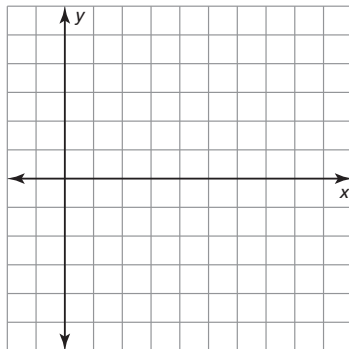
6.  $x^2 = 2x - 6$



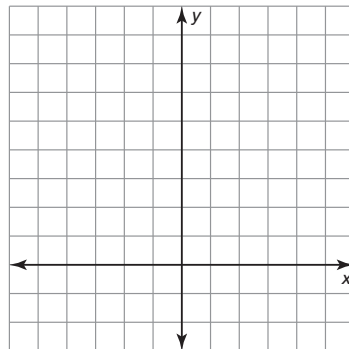
7.  $x^2 - x - 12 = 0$



8.  $x^2 - 10x + 25 = 0$



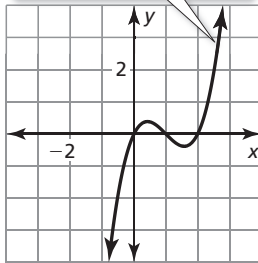
9.  $x^2 + 4 = 0$



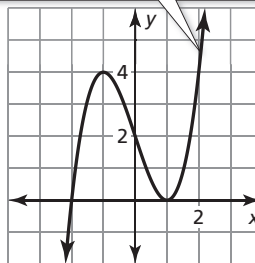
**9.2** Notetaking with Vocabulary (continued)

In Exercises 10–15, find the zero(s) of  $f$ .

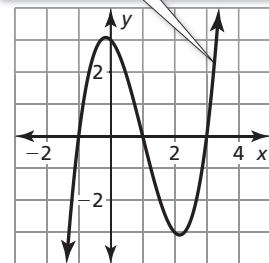
10.  $f(x) = (x - 2)(x^2 - x)$



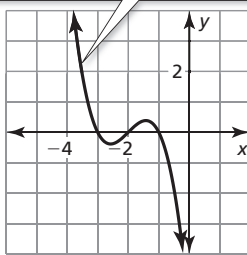
11.  $f(x) = (x + 2)(x^2 - 2x + 1)$



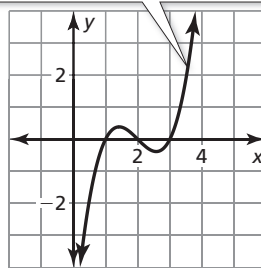
12.  $f(x) = (x + 1)(x^2 - 4x + 3)$



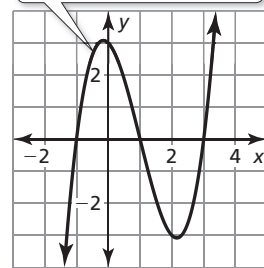
13.  $f(x) = (x + 3)(-x^2 - 3x - 2)$



14.  $f(x) = (x - 1)(x^2 - 5x + 6)$

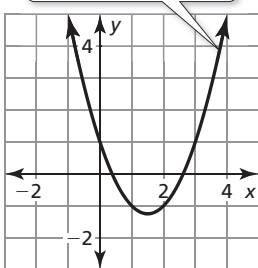


15.  $f(x) = (x - 3)(x^2 - 1)$

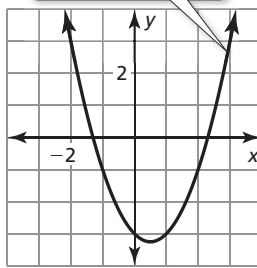


In Exercises 16–18, approximate the zeros of  $f$  to the nearest tenth.

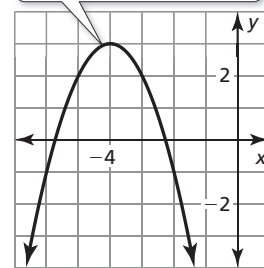
16.  $f(x) = x^2 - 3x + 1$



17.  $f(x) = x^2 - x - 3$



18.  $f(x) = -x^2 - 8x - 13$



# 9.3

## Solving Quadratic Equations Using Square Roots

For use with Exploration 9.3

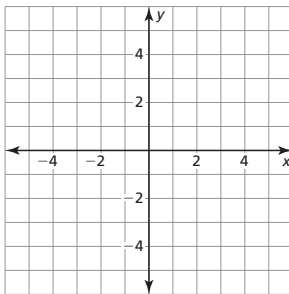
**Essential Question** How can you determine the number of solutions of a quadratic equation of the form  $ax^2 + c = 0$ ?

### 1 EXPLORATION: The Number of Solutions of $ax^2 + c = 0$

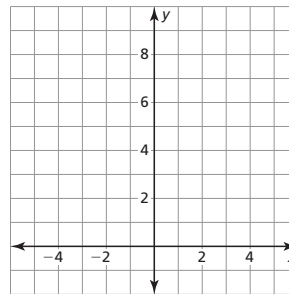
Go to *BigIdeasMath.com* for an interactive tool to investigate this exploration.

**Work with a partner.** Solve each equation by graphing. Explain how the number of solutions of  $ax^2 + c = 0$  relates to the graph of  $y = ax^2 + c$ .

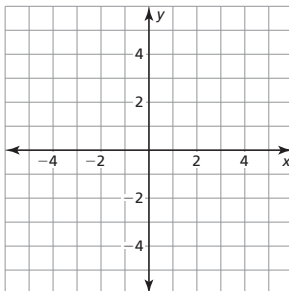
a.  $x^2 - 4 = 0$



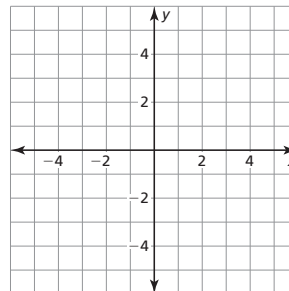
b.  $2x^2 + 5 = 0$



c.  $x^2 = 0$



d.  $x^2 - 5 = 0$



### 2 EXPLORATION: Estimating Solutions

**Work with a partner.** Complete each table. Use the completed tables to estimate the solutions of  $x^2 - 5 = 0$ . Explain your reasoning.

a.

x	$x^2 - 5$
2.21	
2.22	
2.23	
2.24	
2.25	
2.26	

b.

x	$x^2 - 5$
-2.21	
-2.22	
-2.23	
-2.24	
-2.25	
-2.26	

**9.3 Solving Quadratic Equations Using Square Roots (continued)****3 EXPLORATION: Using Technology to Estimate Solutions**

**Work with a partner.** Two equations are equivalent when they have the same solutions.

- a. Are the equations  $x^2 - 5 = 0$  and  $x^2 = 5$  equivalent? Explain your reasoning.
  
  
  
  
  
  
  
  
  
  
- b. Use the square root key on a calculator to estimate the solutions of  $x^2 - 5 = 0$ . Describe the accuracy of your estimates in Exploration 2.
  
  
  
  
  
  
  
  
  
  
- c. Write the exact solutions of  $x^2 - 5 = 0$ .

**Communicate Your Answer**

4. How can you determine the number of solutions of a quadratic equation of the form  $ax^2 + c = 0$ ?
  
  
  
  
  
  
  
  
  
  
5. Write the exact solutions of each equation. Then use a calculator to estimate the solutions.
  - a.  $x^2 - 2 = 0$
  
  
  
  
  
  
  
  
  
  
  - b.  $3x^2 - 18 = 0$
  
  
  
  
  
  
  
  
  
  
  - c.  $x^2 = 8$

**9.3****Notetaking with Vocabulary**

For use after Lesson 9.3

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

square root

zero of a function

**Core Concepts****Solutions of  $x^2 = d$** 

- When  $d > 0$ ,  $x^2 = d$  has two real solutions,  $x = \pm\sqrt{d}$ .
- When  $d = 0$ ,  $x^2 = d$  has one real solution,  $x = 0$ .
- When  $d < 0$ ,  $x^2 = d$  has no real solutions.

**Notes:**

**9.3** Notetaking with Vocabulary (continued)**Extra Practice**

In Exercises 1–18, solve the equation using square roots.

1.  $x^2 + 49 = 0$

2.  $x^2 - 25 = 0$

3.  $x^2 + 6 = 6$

4.  $2x^2 + 84 = 0$

5.  $2x^2 - 72 = 0$

6.  $-x^2 - 12 = -12$

7.  $8x^2 - 49 = 151$

8.  $-3x^2 + 16 = -11$

9.  $81x^2 - 49 = -24$

10.  $16x^2 - 1 = 0$

11.  $25x^2 + 9 = 0$

12.  $16 - 2x^2 = 16$

13.  $(x - 4)^2 = 0$

14.  $(x + 2)^2 = 196$

15.  $(2x + 7)^2 = 49$

**9.3** Notetaking with Vocabulary (continued)

16.  $16(x - 3)^2 = 25$

17.  $81(3x + 1)^2 = 49$

18.  $(4x - 3)^2 = 64$

In Exercises 19–24, solve the equation using square roots. Round your solutions to the nearest hundredth.

19.  $x^2 + 6 = 8$

20.  $x^2 - 12 = 3$

21.  $x^2 + 25 = 49$

22.  $3x^2 - 4 = 14$

23.  $6x^2 + 5 = 20$

24.  $20 - 4x^2 = 18$

25. A ball is dropped from a window at a height of 81 feet. The function  $h = -16x^2 + 81$  represents the height (in feet) of the ball after  $x$  seconds. How long does it take for the ball to hit the ground?

26. The volume of a cone with height  $h$  and radius  $r$  is given by the formula  $V = \frac{1}{3}\pi r^2 h$ . Solve the formula for  $r$ . Then find the radius of a cone with volume  $27\pi$  cubic inches and height 4 inches.



# 9.4

## Solving Quadratic Equations by Completing the Square

For use with Exploration 9.4

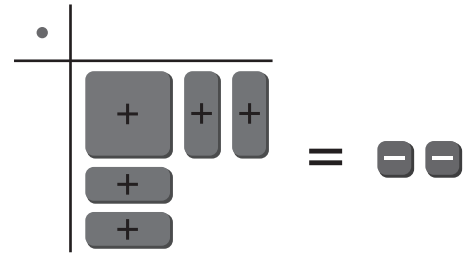
**Essential Question** How can you use “completing the square” to solve a quadratic equation?

### 1 EXPLORATION: Solving by Completing the Square

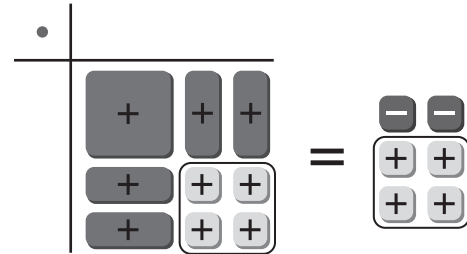
Go to *BigIdeasMath.com* for an interactive tool to investigate this exploration.

Work with a partner.

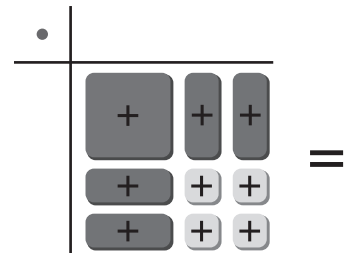
- a. Write the equation modeled by the algebra tiles. This is the equation to be solved.



- b. Four algebra tiles are added to the left side to “complete the square.” Why are four algebra tiles also added to the right side?



- c. Use algebra tiles to label the dimensions of the square on the left side and simplify on the right side.



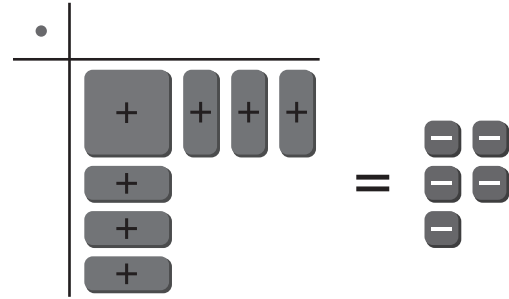
- d. Write the equation modeled by the algebra tiles so that the left side is the square of a binomial. Solve the equation using square roots.

**9.4 Solving Quadratic Equations by Completing the Square (continued)****2 EXPLORATION: Solving by Completing the Square**

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

Work with a partner.

- a. Write the equation modeled by the algebra tiles.



- b. Use algebra tiles to “complete the square.”

- c. Write the solutions of the equation.

- d. Check each solution in the original equation.

**Communicate Your Answer**

3. How can you use “completing the square” to solve a quadratic equation?

4. Solve each quadratic equation by completing the square.

a.  $x^2 - 2x = 1$

b.  $x^2 - 4x = -1$

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

**9.4****Notetaking with Vocabulary**

For use after Lesson 9.4

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

completing the square

**Core Concepts****Completing the Square**

**Words** To complete the square for an expression of the form  $x^2 + bx$ , follow these steps.

**Step 1** Find one-half of  $b$ , the coefficient of  $x$ .

**Step 2** Square the result from Step 1.

**Step 3** Add the result from Step 2 to  $x^2 + bx$ .

Factor the resulting expression as the square of a binomial.

**Algebra**  $x^2 + bx + \left(\frac{b}{2}\right)^2 = \left(x + \frac{b}{2}\right)^2$

**Notes:**

**9.4** Notetaking with Vocabulary (continued)**Extra Practice**

In Exercises 1–6, complete the square for the expression. Then factor the trinomial.

1.  $x^2 + 12x$

2.  $x^2 - 14x$

3.  $x^2 + 4x$

4.  $x^2 + 18x$

5.  $x^2 - 7x$

6.  $x^2 + 11x$

In Exercises 7–18, solve the equation by completing the square. Round your solutions to the nearest hundredth, if necessary.

7.  $x^2 - 8x = -15$

8.  $x^2 + 2x = 3$

9.  $x^2 + 7x = 30$

10.  $x^2 - 26x = -9$

11.  $x^2 - 12x = 10$

12.  $x^2 - 15x = 18$

13.  $x^2 - 12x + 9 = 0$

14.  $x^2 + 14x - 10 = 0$

15.  $x^2 + 2x - 99 = 0$

**9.4** Notetaking with Vocabulary (continued)

16.  $10x^2 - 13x - 9 = 0$

17.  $3x^2 + 6x - 1 = 0$

18.  $12x^2 - 8x - 2 = 0$

In Exercises 19–24, determine whether the quadratic function has a maximum or minimum value. Then find the value.

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

20.  $y = x^2 + 6x + 10$

21.  $y = -x^2 + 8x - 2$

22.  $y = x^2 - 10x + 8$

23.  $y = 3x^2 + 3x - 1$

24.  $y = -4x^2 + 8x + 12$

25. A diver jumps off a diving board. The function  $h = -16x^2 + 6x + 5$  represents the height (in feet) of the diver after  $x$  seconds. What is the maximum height above the water of the diver? How many seconds did it take for the diver to reach the maximum height? Round your answers to the nearest hundredth.

**9.5****Solving Quadratic Equations Using the Quadratic Formula**

For use with Exploration 9.5

**Essential Question** How can you derive a formula that can be used to write the solutions of any quadratic equation in standard form?

**1 EXPLORATION:** Deriving the Quadratic Formula

**Work with a partner.** The following steps show a method of solving

$ax^2 + bx + c = 0$ . Explain what was done in each step.

$$ax^2 + bx + c = 0$$

1. Write the equation.

$$4a^2x^2 + 4abx + 4ac = 0$$

2. \_\_\_\_\_

$$4a^2x^2 + 4abx + 4ac + b^2 = b^2$$

3. \_\_\_\_\_

$$4a^2x^2 + 4abx + b^2 = b^2 - 4ac$$

4. \_\_\_\_\_

$$(2ax + b)^2 = b^2 - 4ac$$

5. \_\_\_\_\_

$$2ax + b = \pm\sqrt{b^2 - 4ac}$$

6. \_\_\_\_\_

$$2ax = -b \pm \sqrt{b^2 - 4ac}$$

7. \_\_\_\_\_

**Quadratic Formula:**  $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

8. \_\_\_\_\_

**9.5 Solving Quadratic Equations Using the Quadratic Formula (continued)****2 EXPLORATION: Deriving the Quadratic Formula by Completing the Square**

Work with a partner.

- a. Solve  $ax^2 + bx + c = 0$  by completing the square. (*Hint: Subtract  $c$  from each side, divide each side by  $a$ , and then proceed by completing the square.*)
  
  
  
  
  
  
  
  
  
  
- b. Compare this method with the method in Exploration 1. Explain why you think  $4a$  and  $b^2$  were chosen in Steps 2 and 3 of Exploration 1.

**Communicate Your Answer**

3. How can you derive a formula that can be used to write the solutions of any quadratic equation in standard form?
  
  
  
  
  
4. Use the Quadratic Formula to solve each quadratic equation.
  - a.  $x^2 + 2x - 3 = 0$
  - b.  $x^2 - 4x + 4 = 0$
  - c.  $x^2 + 4x + 5 = 0$
  
  
  
  
  
5. Use the Internet to research *imaginary numbers*. How are they related to quadratic equations?

**9.5****Notetaking with Vocabulary**

For use after Lesson 9.5

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

Quadratic Formula

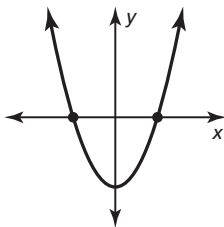
discriminant

**Core Concepts****Quadratic Formula**The real solutions of the quadratic equation  $ax^2 + bx + c = 0$  are

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \quad \text{Quadratic Formula}$$

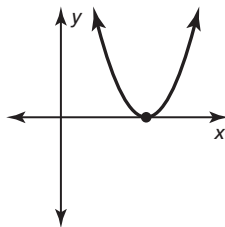
where  $a \neq 0$  and  $b^2 - 4ac \geq 0$ .**Notes:****Interpreting the Discriminant**

$$b^2 - 4ac > 0$$



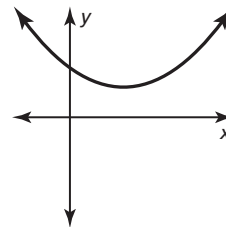
- two real solutions
- two  $x$ -intercepts

$$b^2 - 4ac = 0$$



- one real solution
- one  $x$ -intercept

$$b^2 - 4ac < 0$$



- no real solutions
- no  $x$ -intercepts

**Notes:**



**9.5** Notetaking with Vocabulary (continued)**Methods for Solving Quadratic Equations**

Method	Advantages	Disadvantages
Factoring (Lessons 7.5–7.8)	<ul style="list-style-type: none"><li>• Straightforward when the equation can be factored easily</li></ul>	<ul style="list-style-type: none"><li>• Some equations are not factorable.</li></ul>
Graphing (Lesson 9.2)	<ul style="list-style-type: none"><li>• Can easily see the number of solutions</li><li>• Use when approximate solutions are sufficient.</li><li>• Can use a graphing calculator</li></ul>	<ul style="list-style-type: none"><li>• May not give exact solutions</li></ul>
Using Square Roots (Lesson 9.3)	<ul style="list-style-type: none"><li>• Used to solve equations of the form <math>x^2 = d</math>.</li></ul>	<ul style="list-style-type: none"><li>• Can only be used for certain equations</li></ul>
Completing the Square (Lesson 9.4)	<ul style="list-style-type: none"><li>• Best used when <math>a = 1</math> and <math>b</math> is even</li></ul>	<ul style="list-style-type: none"><li>• May involve difficult calculations</li></ul>
Quadratic Formula (Lesson 9.5)	<ul style="list-style-type: none"><li>• Can be used for any quadratic equation</li><li>• Gives exact solutions</li></ul>	<ul style="list-style-type: none"><li>• Takes time to do calculations</li></ul>

**Notes:****Extra Practice**

In Exercises 1–6, solve the equation using the Quadratic Formula. Round your solutions to the nearest tenth, if necessary.

1.  $x^2 - 10x + 16 = 0$

2.  $x^2 + 2x - 8 = 0$

3.  $3x^2 - x - 2 = 0$

4.  $x^2 + 6x = -13$

5.  $-3x^2 + 5x - 1 = -7$

6.  $-4x^2 + 8x + 12 = 6$

**9.5** Notetaking with Vocabulary (continued)

7. A square pool has a side length of  $x$  feet. A uniform border around the pool is 1 foot wide. The total area of the pool and the border is 361 square feet. What is the area of the pool?

In Exercises 8–10, determine the number of real solutions of the equation.

8.  $-x^2 + 6x + 3 = 0$

9.  $x^2 + 6x + 9 = 0$

10.  $x^2 + 3x + 8 = 0$

In Exercises 11–13 find the number of  $x$ -intercepts of the graph of the function.

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

12.  $y = x^2 + 14x + 49$

13.  $y = -x^2 - 8x - 18$

In Exercises 14–16, solve the equation using any method. Explain your choice of method.

14.  $x^2 - 4x + 4 = 16$

15.  $x^2 - 8x + 7 = 0$

16.  $3x^2 + x - 5 = 0$

**9.6****Solving Nonlinear Systems of Equations**

For use with Exploration 9.6

**Essential Question** How can you solve a system of two equations when one is linear and the other is quadratic?

**1 EXPLORATION: Solving a System of Equations**

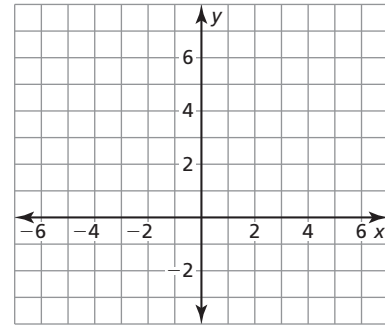
Go to *BigIdeasMath.com* for an interactive tool to investigate this exploration.

**Work with a partner.** Solve the system of equations by graphing each equation and finding the points of intersection.

**System of Equations**

$$y = x + 2 \quad \text{Linear}$$

$$y = x^2 + 2x \quad \text{Quadratic}$$

**2 EXPLORATION: Analyzing Systems of Equations**

**Work with a partner.** Match each system of equations with its graph (shown on the next page). Then solve the system of equations.

**a.**  $y = x^2 - 4$   
 $y = -x - 2$

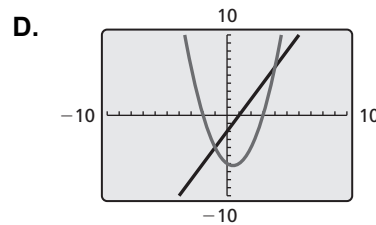
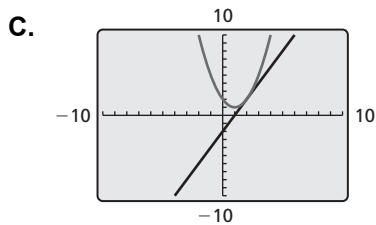
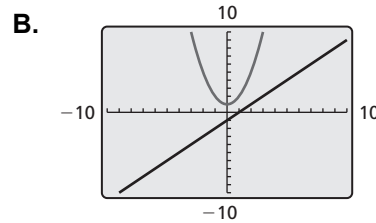
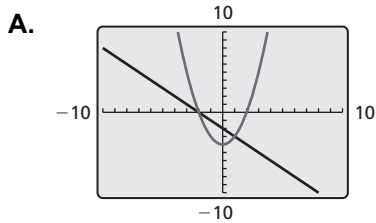
**b.**  $y = x^2 - 2x + 2$   
 $y = 2x - 2$

**c.**  $y = x^2 + 1$   
 $y = x - 1$

**d.**  $y = x^2 - x - 6$   
 $y = 2x - 2$

**9.6 Solving Nonlinear Systems of Equations (continued)**

**2 EXPLORATION: Analyzing Systems of Equations (continued)**



**Communicate Your Answer**

3. How can you solve a system of two equations when one is linear and the other is quadratic?
  
4. Write a system of equations (one linear and one quadratic) that has (a) no solutions, (b) one solution, and (c) two solutions. Your systems should be different from those in Explorations 1 and 2.

**9.6**

**Notetaking with Vocabulary**

For use after Lesson 9.6

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

system of nonlinear equations

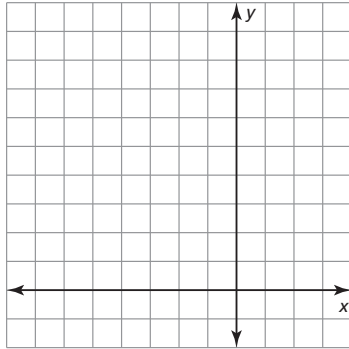
**Notes:**

**9.6** Notetaking with Vocabulary (continued)

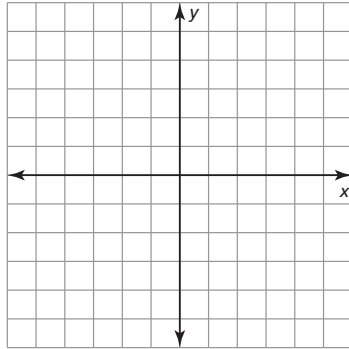
**Extra Practice**

In Exercises 1–6, solve the system by graphing.

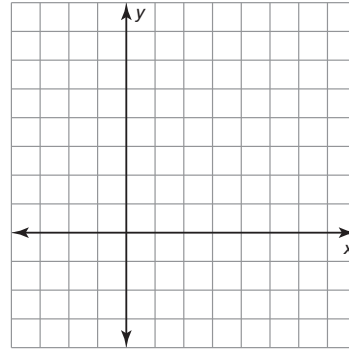
1.  $y = x^2 + 5x + 6$   
 $y = -x + 1$



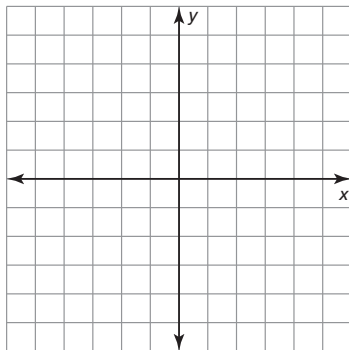
2.  $y = x^2 + x - 3$   
 $y = x + 1$



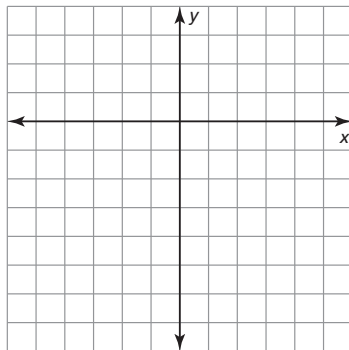
3.  $y = \frac{1}{2}x^2 - 2x + 1$   
 $y = -x + 1$



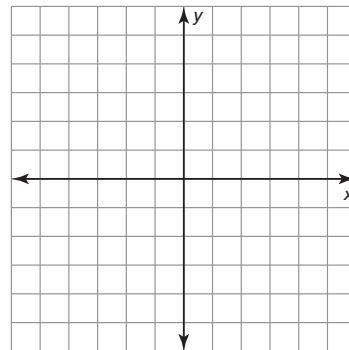
4.  $y = -3x^2 - 3x + 2$   
 $y = 2x$



5.  $y = -\frac{1}{3}x^2 + x - 2$   
 $y = -2$



6.  $y = 6x^2 + 3x - 5$   
 $y = -3x - 5$



In Exercises 7–9, solve the equation by substitution.

7.  $y - 2 = x^2$   
 $y = 6$

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

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

**9.6** Notetaking with Vocabulary (continued)

In Exercises 10–12, solve the equation by elimination.

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

11.  $y = x^2 + 3x - 5$   
 $y = 3x - 1$

12.  $y = x^2 + x - 2$   
 $y = x + 14$

In Exercises 13–18, solve the equation. Round your solution(s) to the nearest hundredth, if necessary.

13.  $-6x + 14 = x^2 - 9x + 16$

14.  $-x^2 + 4x = -2x + 8$

15.  $4x^2 - 9 = 4x - 1$

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

17.  $2x^2 - 4 = -x^2 + 6$

18.  $-3\left(\frac{2}{3}\right)^x + 2 = x^2 - 2$