7.5–7.9 Quiz

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Due May 10 at 10AM

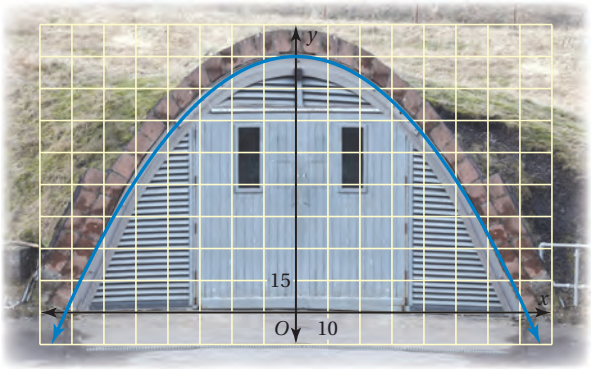
Factor the polynomial. *(Sections 7.6–7.9)*

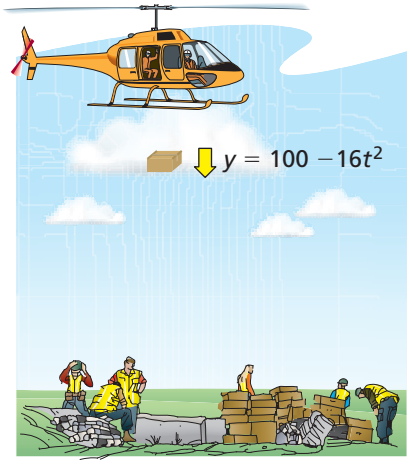
1. $3d^2 + 11d$
2. $9z^2 - 18z$
3. $x^2 + 9x + 20$
4. $r^2 - 3r - 18$
5. $2x^2 - 3x + 1$
6. $3b^2 - 13b + 4$
7. $x^2 - 9$
8. $z^2 + 22z + 121$

Solve the equation. *(Sections 7.5–7.9)*

9. $m^2 - 11m + 18 = 0$
10. $w^3 - 9w^2 = 0$
11. $6m^2 - 5m + 1 = 0$
12. $h^2 - 8 = -3h + 10$
13. $4s^2 = 144$
14. $k^2 + 100 = 20k$

15. **STORAGE** The front of a storage bunker can be modeled by $y = -\frac{5}{216}(x - 72)(x + 72)$, where x and y are measured in inches. The x-axis represents the ground. Find the width of the bunker at ground level. *(Section 7.5)*





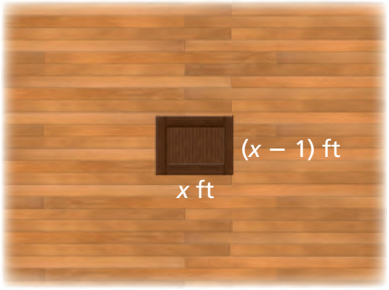
16. **DISASTER RELIEF** A helicopter drops a box of supplies after a disaster. The function represents the height y (in feet) of the box t seconds after it is dropped. After how many seconds does the box hit the ground? *(Section 7.9)*

17. **MAGIC SHOW** A magician's stage has a trap door. *(Section 7.7)*

   a. The total area of the stage can be represented by $x^2 + 27x + 176$. Write an expression for the width of the stage.

   b. The area of the trap door is 12 square feet. Find the value of x.

   c. What fraction of the area of the stage is the area of the trap door?



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Name _____ Date _____

Due May 10 at 10AM

Chapter 7 Quiz

For use after Section 7.9

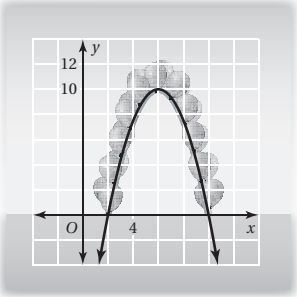
Factor the polynomial.

1. $3p - 18$
2. $33b^2 + 22$
3. $k^2 + 5k + 4$
4. $p^2 - 3p - 54$
5. $4m^2 + 14m + 6$
6. $7a^2 + 12a - 4$
7. $h^2 + 20h + 100$
8. $z^2 - 12z + 36$

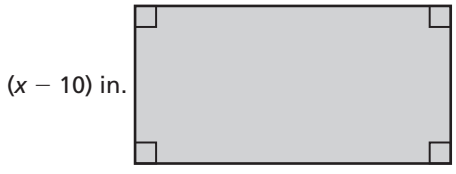
Solve the equation.

9. $2t(t + 6) = 0$
10. $g^2 + 9g + 18 = 0$
11. $2a^2 + 6a = 20$
12. $5c^2 + 5c - 60 = 0$
13. $x^2 - x - 42 = 0$
14. $c^2 + 5c - 36 = 0$
15. $w^2 - 144 = 0$
16. $9v^3 = -45v^2$

17. An arch of balloons is tied to a frame. The frame can be modeled by $y = -\frac{5}{8}(x - 2)(x - 10)$, where x and y are measured in feet. The x-axis represents the ground. Find the width of the frame at ground level.



18. Find the dimensions of the rectangle when the area is 32 square inches.



19. A ball is dropped from a height of 225 feet. The ball's height y (in feet) after t seconds can be modeled by $y = 225 - 16t^2$. After how many seconds does the ball hit the ground?

Answers

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____
14. _____
15. _____
16. _____
17. _____
18. _____
19. _____

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8.4 Lesson

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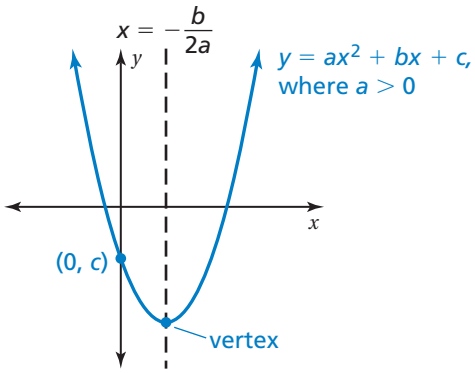
Key Vocabulary
maximum value, *p. 427*
minimum value, *p. 427*

Key Idea

Properties of the Graph of $y = ax^2 + bx + c$

- 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 $x = -\frac{b}{2a}$.



EXAMPLE 1 Finding the Axis of Symmetry and the Vertex of a Graph

Find (a) the axis of symmetry and (b) the vertex of the graph of $y = 2x^2 + 8x - 1$.

a. Find the axis of symmetry when $a = 2$ and $b = 8$.

$x = -\frac{b}{2a}$ Write the equation for the axis of symmetry.

$x = -\frac{8}{2(2)}$ Substitute 2 for a and 8 for b.

$x = -2$ Simplify.

∴ The axis of symmetry is $x = -2$.

b. The axis of symmetry is $x = -2$, so the x-coordinate of the vertex is -2. Use the function to find the y-coordinate of the vertex.

$y = 2x^2 + 8x - 1$ Write the function.

$= 2(-2)^2 + 8(-2) - 1$ Substitute -2 for x.

$= -9$ Simplify.

∴ The vertex is $(-2, -9)$.

On Your Own

Now You're Ready
Exercises 6–11

Find (a) the axis of symmetry and (b) the vertex of the graph of the function.

1. $y = 3x^2 - 2x$ **2.** $y = x^2 + 6x + 5$ **3.** $y = -\frac{1}{2}x^2 + 7x - 4$

EXAMPLE 2 Graphing $y = ax^2 + bx + c$

Graph $y = 3x^2 - 6x + 5$. Describe the domain and range.

Step 1: Find and graph the axis of symmetry.

$$x = -\frac{b}{2a} = -\frac{(-6)}{2(3)} = 1$$

Step 2: Find and plot the vertex.

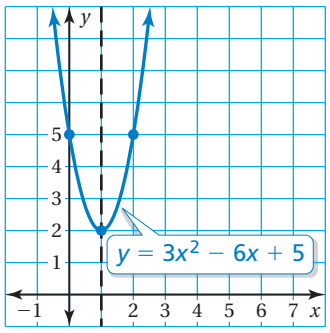
The axis of symmetry is $x = 1$, so the x-coordinate of the vertex is 1. Use the function to find the y-coordinate of the vertex.

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

$= 3(1)^2 - 6(1) + 5$ Substitute 1 for x.

$= 2$ Simplify.

So, the vertex is (1, 2).



Step 3: Use the y-intercept to find two more points on the graph.

The y-intercept is 5. So, (0, 5) lies on the graph. Because the axis of symmetry is $x = 1$, the point (2, 5) also lies on the graph.

Step 4: Draw a smooth curve through the points.

∴ The domain is all real numbers. The range is $y \geq 2$.

On Your Own

Now You're Ready
Exercises 13–18

Graph the function. Describe the domain and range.

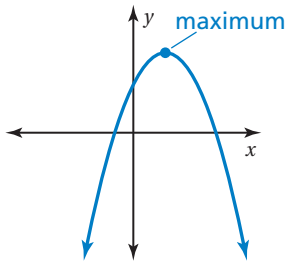
4. $y = 2x^2 + 4x + 1$ **5.** $y = x^2 - 8x + 7$ **6.** $y = -5x^2 - 10x - 2$

Key Ideas

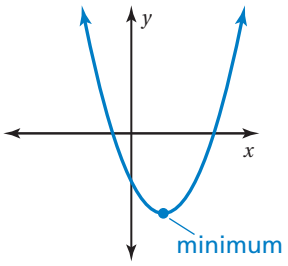
Maximum and Minimum Values

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

$y = ax^2 + bx + c, a < 0$



$y = ax^2 + bx + c, a > 0$



EXAMPLE 3 Finding Maximum and Minimum Values

Tell whether the function $f(x) = -4x^2 - 24x - 19$ has a minimum value or a maximum value. Then find the value.

For $f(x) = -4x^2 - 24x - 19$, $a = -4$ and $-4 < 0$. So, the parabola opens down and the function has a maximum value. To find the maximum value, find the y-coordinate of the vertex.

$$x = -\frac{b}{2a} = -\frac{(-24)}{2(-4)} = -3 \qquad \text{The } x\text{-coordinate of the vertex is } -\frac{b}{2a}.$$

$$f(-3) = -4(-3)^2 - 24(-3) - 19 \qquad \text{Substitute } -3 \text{ for } x.$$

$$= 17 \qquad \text{Simplify.}$$

∴ The maximum value is 17.

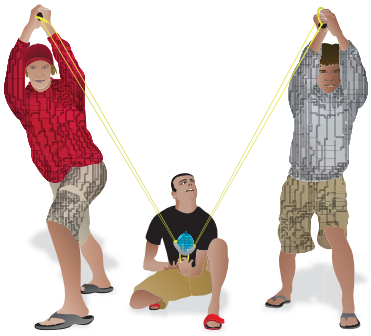
On Your Own

Now You're Ready
Exercises 21–26

Tell whether the function has a minimum value or a maximum value. Then find the value.

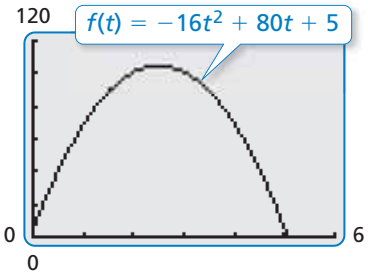
7. $g(x) = 8x^2 - 8x + 6$ **8.** $h(x) = -\frac{1}{4}x^2 + 3x + 1$

EXAMPLE 4 Real-Life Application

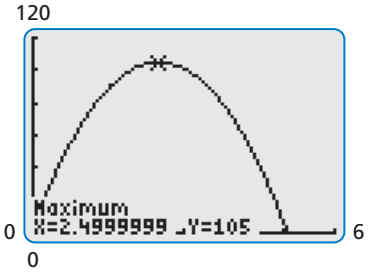


The function $f(t) = -16t^2 + 80t + 5$ gives the height (in feet) of a water balloon t seconds after it is launched. Use a graphing calculator to find the maximum height of the water balloon.

Step 1: Enter the function $f(t) = -16t^2 + 80t + 5$ into your calculator and graph it. Because time cannot be negative, use only nonnegative values of t.



Step 2: Use the *maximum* feature to find the maximum value of the function.



∴ The maximum height of the water balloon is 105 feet.

Study Tip

The *minimum* feature of a graphing calculator can be used for parabolas that open up.

On Your Own

9. When does the water balloon reach its maximum height?

Name : _____ Score : _____

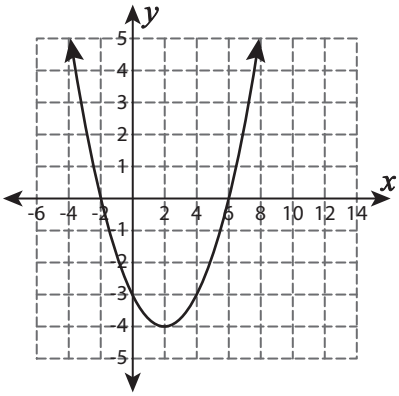
Properties of Quadratic Function

Sheet 1

Due May 17 at 10AM

Find the properties of each quadratic function.

1)



Domain : _____

Range : _____

x-intercepts : _____

y-intercept : _____

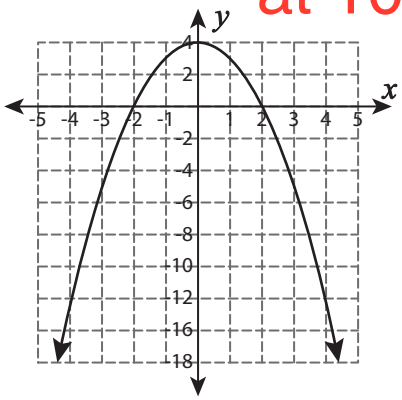
Vertex : _____

Minimum value : _____

Axis of symmetry : _____

Open up or down : _____

2)



Domain : _____

Range : _____

x-intercepts : _____

y-intercept : _____

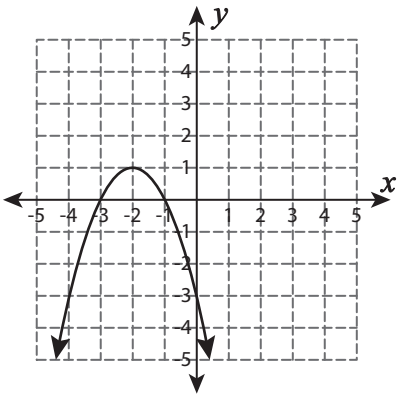
Vertex : _____

Maximum value : _____

Axis of symmetry : _____

Open up or down : _____

3)



Domain : _____

Range : _____

x-intercepts : _____

y-intercept : _____

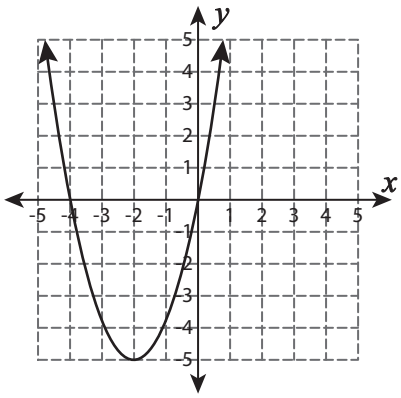
Vertex : _____

Maximum value : _____

Axis of symmetry : _____

Open up or down : _____

4)



Domain : _____

Range : _____

x-intercepts : _____

y-intercept : _____

Vertex : _____

Minimum value : _____

Axis of symmetry : _____

Open up or down : _____

Name : _____ Score : _____

Due May 17 at 10AM

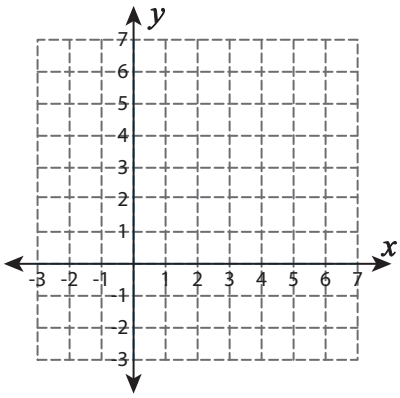
Sheet 1

Function Table

Complete the function table and sketch the graph.

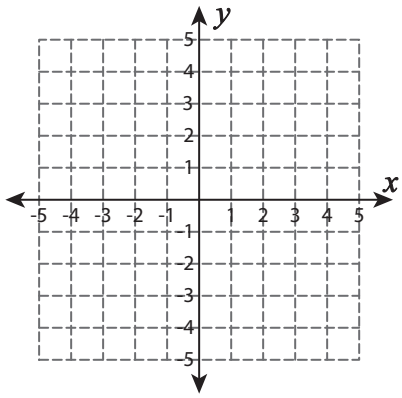
1) $f(x) = x^2 - 6x + 11$

x	1	2	3	4	5
$f(x)$					



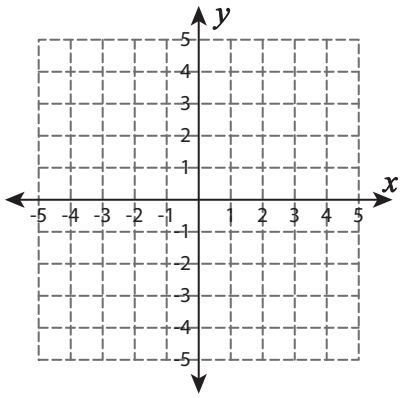
2) $f(x) = -(x + 1)^2 + 3$

x	−3	−2	−1	0	1
$f(x)$					



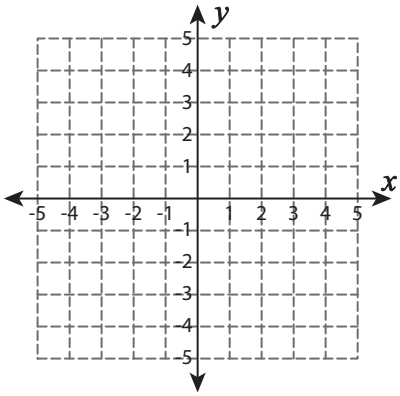
3) $f(x) = x^2 + 4x + 1$

x	−4	−3	−2	−1	0
$f(x)$					



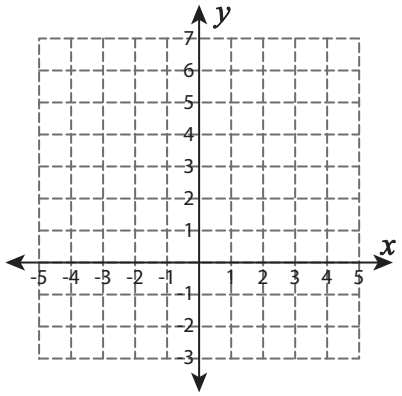
4) $f(x) = x^2 - 2$

x	−2	−1	0	1	2
$f(x)$					



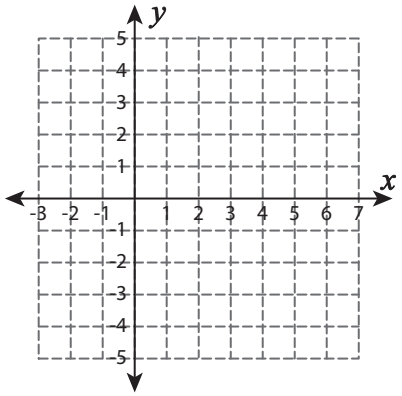
5) $f(x) = (x - 1)^2 + 1$

x	−1	0	1	2	3
$f(x)$					



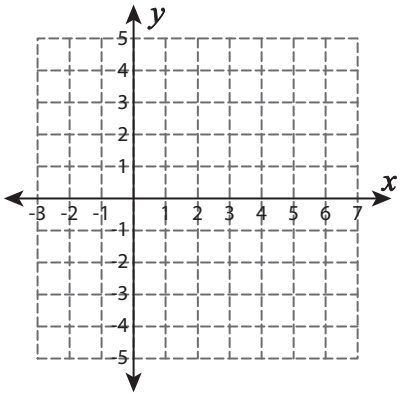
6) $f(x) = x^2 - 8x + 16$

x	2	3	4	5	6
$f(x)$					



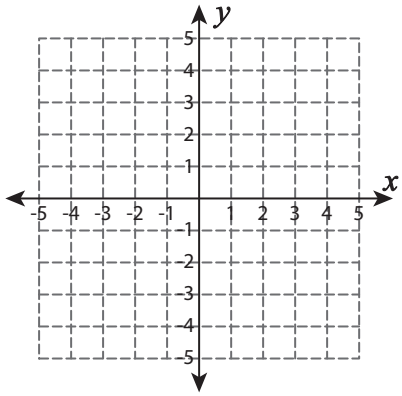
7) $f(x) = -x(x - 4)$

x	0	1	2	3	4
$f(x)$					



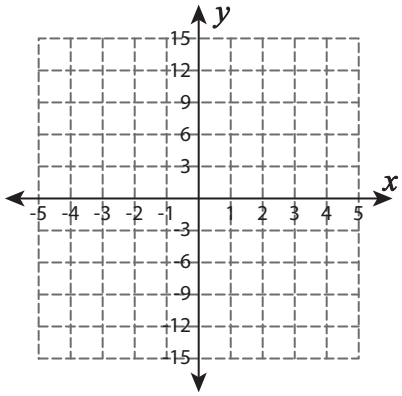
8) $f(x) = -x^2 - 4x - 2$

x	−4	−3	−2	−1	0
$f(x)$					



9) $f(x) = 3x^2$

x	−2	−1	0	1	2
$f(x)$					



9.1 Lesson

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Key Vocabulary
quadratic equation, *p. 456*

A **quadratic equation** is a nonlinear equation that can be written in the standard form $ax^2 + bx + c = 0$, where $a \neq 0$.

In Chapter 7, you solved quadratic equations by factoring. You can also solve quadratic equations in standard form by finding the x-intercept(s) of the graph of the related function $y = ax^2 + bx + c$.

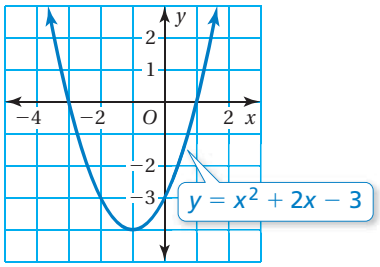
EXAMPLE 1 Solving a Quadratic Equation: Two Real Solutions

Remember
The solutions of a quadratic equation are also called roots.

Solve $x^2 + 2x - 3 = 0$ by graphing.

Step 1: Graph the related function $y = x^2 + 2x - 3$.

Step 2: Find the x-intercepts. They are -3 and 1.



∴ So, the solutions are $x = -3$ and $x = 1$.

Check Check each solution in the original equation.

$x^2 + 2x - 3 = 0$	Original equation	$x^2 + 2x - 3 = 0$
$(-3)^2 + 2(-3) - 3 \stackrel{?}{=} 0$	Substitute.	$1^2 + 2(1) - 3 \stackrel{?}{=} 0$
$0 = 0$ ✓	Simplify.	$0 = 0$ ✓

EXAMPLE 2 Solving a Quadratic Equation: One Real Solution

Study Tip
You can also solve the equation in Example 2 by factoring.
$x^2 - 8x + 16 = 0$
$(x - 4)(x - 4) = 0$
So, $x = 4$.

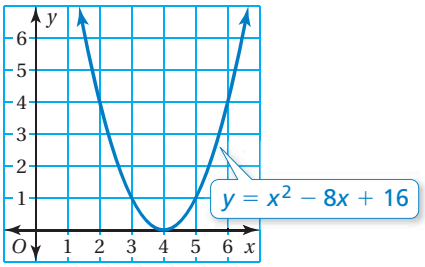
Solve $x^2 - 8x = -16$ by graphing.

Step 1: Rewrite the equation in standard form.

$x^2 - 8x = -16$	Write the equation.
$x^2 - 8x + 16 = 0$	Add 16 to each side.

Step 2: Graph the related function $y = x^2 - 8x + 16$.

Step 3: Find the x-intercept. The only x-intercept is at the vertex $(4, 0)$.



∴ So, the solution is $x = 4$.

On Your Own

Now You're Ready
Exercises 8–10

Solve the equation by graphing. Check your solution(s).

1. $x^2 - x - 2 = 0$
2. $x^2 + 7x + 10 = 0$
3. $x^2 + x = 12$
4. $x^2 + 1 = 2x$
5. $x^2 + 4x = 0$
6. $x^2 + 10x = -25$

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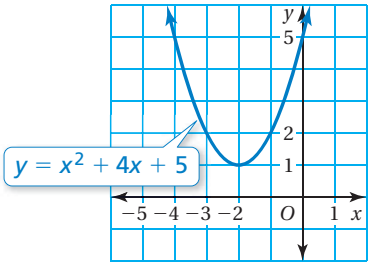
EXAMPLE 3 Solving a Quadratic Equation: No Real Solutions

Solve $-x^2 = 4x + 5$ by graphing.

Method 1: Rewrite the equation in standard form and graph the related function $y = x^2 + 4x + 5$.

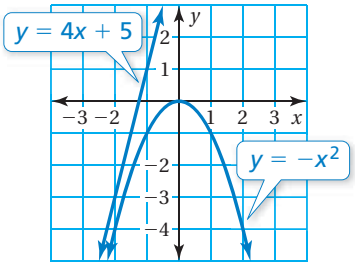


∴ There are no x-intercepts. So, $-x^2 = 4x + 5$ has no real solutions.

Method 2: Graph each side of the equation.

$y = -x^2$ Left side

$y = 4x + 5$ Right side



∴ The graphs do not intersect. So, $-x^2 = 4x + 5$ has no real solutions.

On Your Own

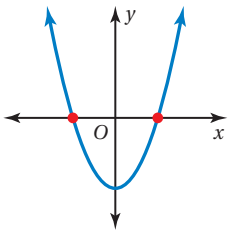
Now You're Ready
Exercises 11–16

Solve the equation by graphing. Check your solution(s).

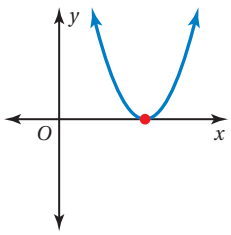
7. $x^2 = 3x - 3$ **8.** $x^2 + 7x = -6$ **9.** $2x + 5 = -x^2$

Summary

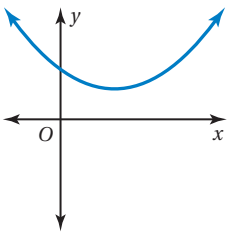
Quadratic equations may have two real solutions, one real solution, or no real solutions.



- two real solutions
- two x-intercepts



- one real solution
- one x-intercept



- no real solutions
- no x-intercepts

EXAMPLE 4 Real-Life Application

A football player kicks a football 2 feet above the ground with an upward velocity of 75 feet per second. The function $h = -16t^2 + 75t + 2$ gives the height h (in feet) of the football after t seconds. After how many seconds is the football 50 feet above the ground?

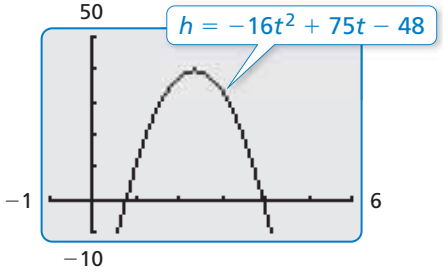
To determine when the football is 50 feet above the ground, find the t-values for which $h = 50$. So, solve the equation $-16t^2 + 75t + 2 = 50$.

Step 1: Rewrite the equation in standard form.

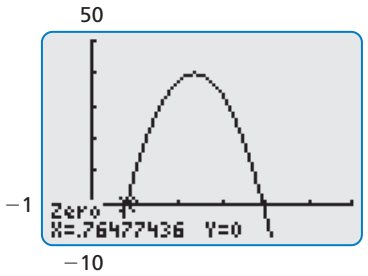
$-16t^2 + 75t + 2 = 50$ Write the equation.

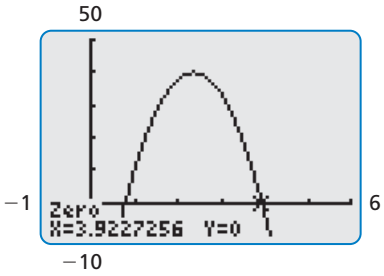
$-16t^2 + 75t - 48 = 0$ Subtract 50 from each side.

Step 2: Use a graphing calculator to graph the related function $h = -16t^2 + 75t - 48$.



Step 3: Use the *zero* feature to find the zeros of the function.





∴ The football is 50 feet above the ground after about 0.8 second and about 3.9 seconds.

Remember

A zero of a function $y = f(x)$ is an x-value for which the value of the function is zero.

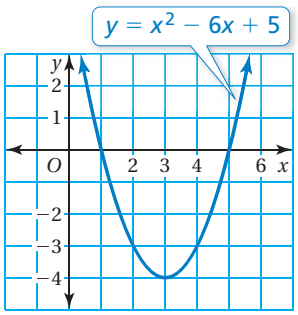
On Your Own

Now You're Ready
Exercise 18

10. **WHAT IF?** After how many seconds is the football 65 feet above the ground?

Summary

- The *solutions*, or *roots*, of $x^2 - 6x + 5 = 0$ are $x = 1$ and $x = 5$.
- The *x-intercepts* of the graph of $y = x^2 - 6x + 5$ are 1 and 5.
- The *zeros* of the function $f(x) = x^2 - 6x + 5$ are 1 and 5.



Name : _____ Score : _____

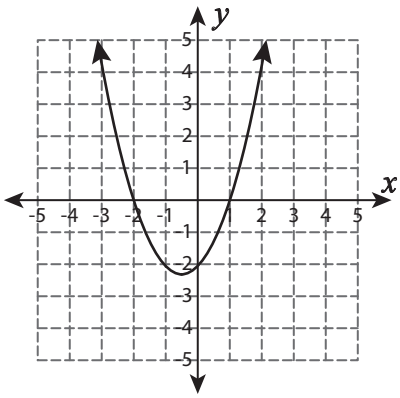
Due May 17 at 10AM

Sheet 1

Identifying Zeros

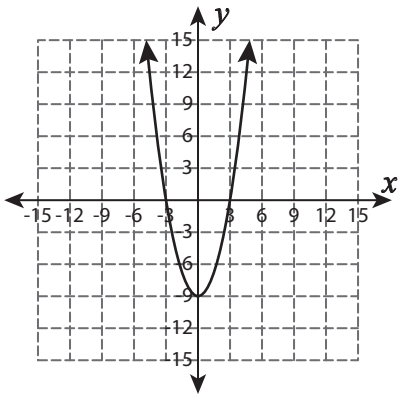
Identify the zeros of each quadratic function.

1)



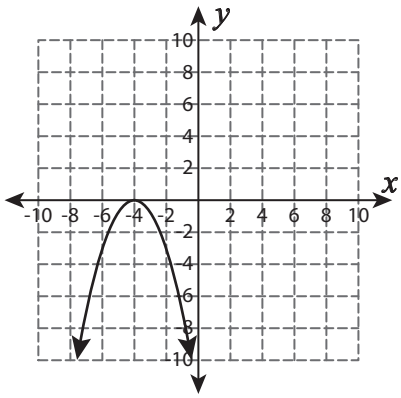
zeros : _____

2)



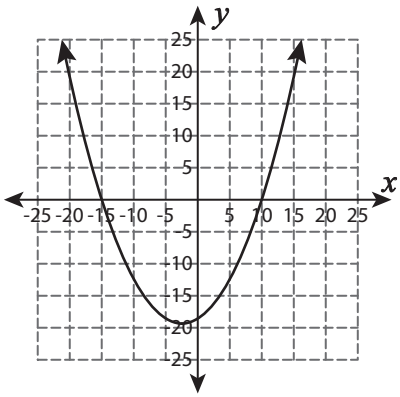
zeros : _____

3)



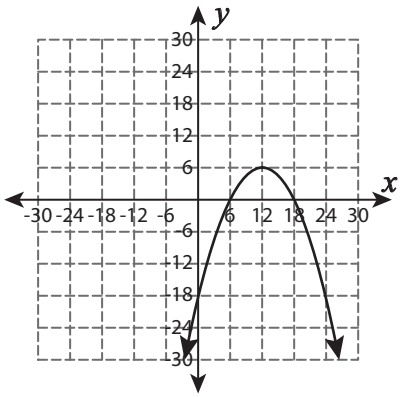
zeros : _____

4)



zeros : _____

5)



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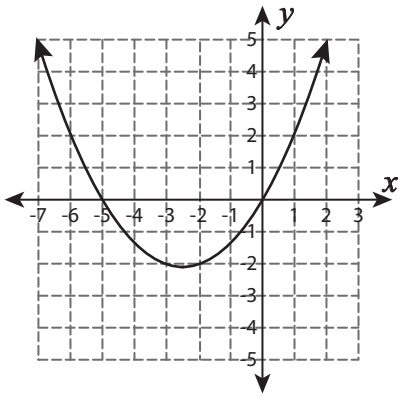
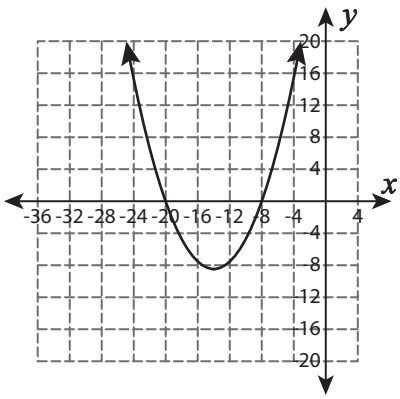
6)



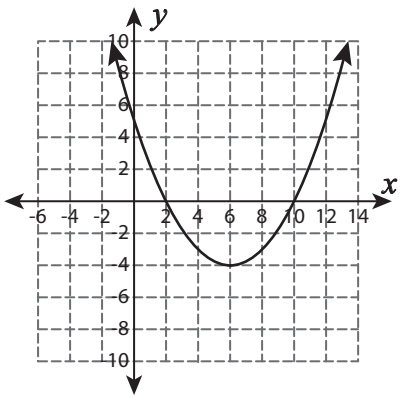
zeros : _____

7)



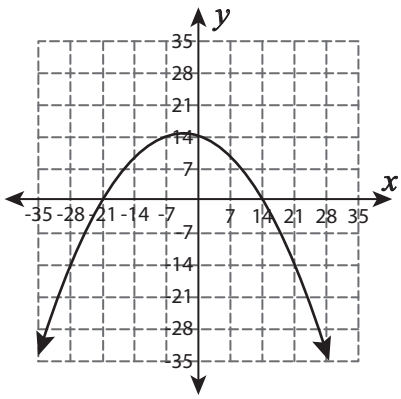
zeros : _____

8)



zeros : _____

9)



zeros : _____

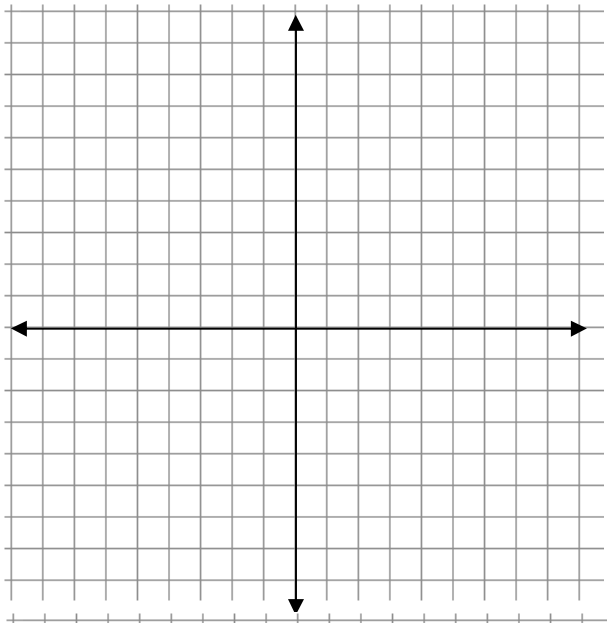
Due May 17 at 10AM

10.1-10.2 Practice Worksheet

Benchmarks: B.8- Solve quadratic functions by graphing.
B.9 – Analyze quadratic functions using graphs, tables, & equations.

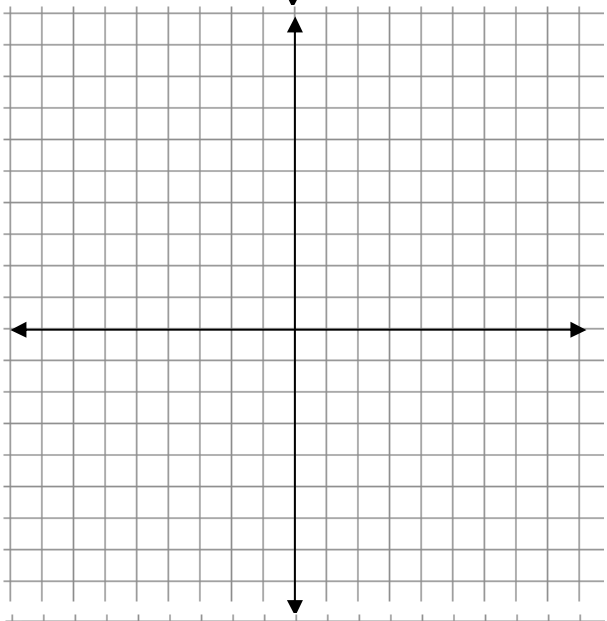
Solve the quadratic by graphing.

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



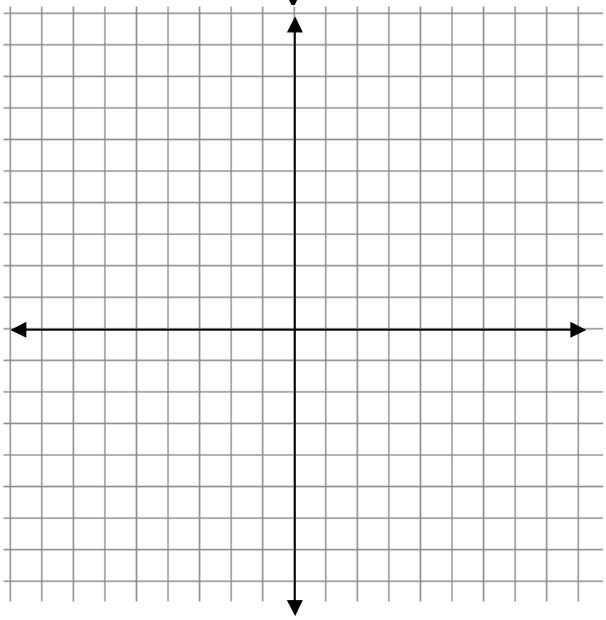
Solution(s):_____

7. $2x^2 + 4x - 6 = 0$



Solution(s):_____

8. $\frac{1}{2}x^2 - x - 4 = 0$



Solution(s):_____

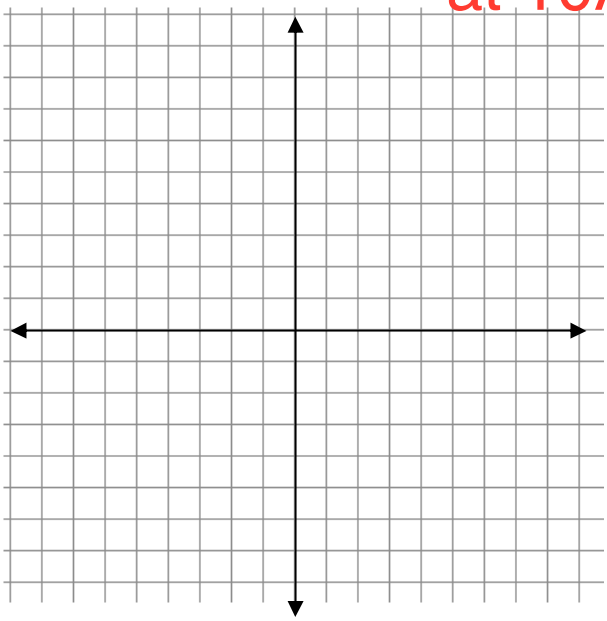
10.1-10.2 Practice Worksheet

Benchmarks: B.8- Solve quadratic functions by graphing.
B.9 – Analyze quadratic functions using graphs, tables, & equations.

Due May 17 at 10AM

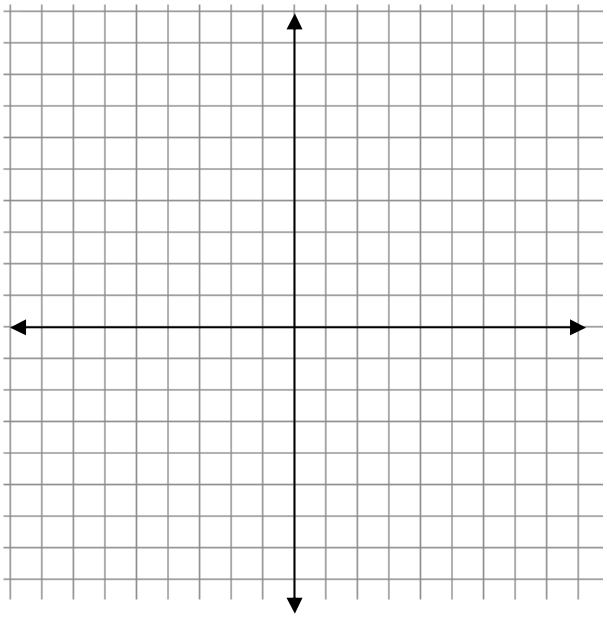
Solve the quadratic by graphing. (Make sure you set the equation = 0)

9. $x^2 - 6x = -5$



Solution(s):_____

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



Solution(s):_____

9.4 Lesson

Check It Out
Lesson Tutorials
BigIdeasMath.com

Key Vocabulary
quadratic formula, *p. 478*
discriminant, *p. 480*

Another way to solve quadratic equations is to use the *quadratic formula.*

Key Idea

Quadratic Formula

The real solutions of the quadratic equation $ax^2 + bx + c = 0$ are

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

where $a \neq 0$ and $b^2 - 4ac \geq 0$. This is called the **quadratic formula.**

EXAMPLE 1 Solving a Quadratic Equation Using the Quadratic Formula

Solve $2x^2 - 5x + 3 = 0$ using the quadratic formula.

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

$$= \frac{-(-5) \pm \sqrt{(-5)^2 - 4(2)(3)}}{2(2)}$$ Substitute 2 for a, -5 for b, and 3 for c.

$$= \frac{5 \pm \sqrt{1}}{4}$$ Simplify.

$$= \frac{5 \pm 1}{4}$$ Evaluate the square root.

∴ So, the solutions are $x = \frac{5 + 1}{4} = \frac{3}{2}$ and $x = \frac{5 - 1}{4} = 1$.

Study Tip

You can use the roots of a quadratic equation to factor the related expression. In Example 1, you can use 1 and $\frac{3}{2}$ to factor $2x^2 - 5x + 3$ as $(x - 1)(2x - 3)$.

Check Check each solution in the original equation.

$2x^2 - 5x + 3 = 0$	Original equation	$2x^2 - 5x + 3 = 0$
$2\left(\frac{3}{2}\right)^2 - 5\left(\frac{3}{2}\right) + 3 \stackrel{?}{=} 0$	Substitute.	$2(1)^2 - 5(1) + 3 \stackrel{?}{=} 0$
$\frac{9}{2} - \frac{15}{2} + 3 \stackrel{?}{=} 0$	Simplify.	$2 - 5 + 3 \stackrel{?}{=} 0$
$0 = 0$ ✓	Simplify.	$0 = 0$ ✓

On Your Own

Solve the equation using the quadratic formula.

1. $x^2 - 6x + 5 = 0$
2. $4x^2 + x - 3 = 0$
3. $-6x^2 + 7x - 2 = 0$

Now You're Ready
Exercises 12–14

Multi-Language Glossary at BigIdeasMath.com

EXAMPLE 2 Solving a Quadratic Equation Using the Quadratic Formula

Solve $4x^2 + 20x + 25 = 0$ using the quadratic formula.

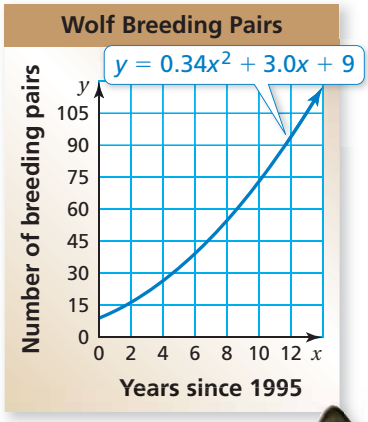
$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$ Quadratic Formula

$$= \frac{-20 \pm \sqrt{20^2 - 4(4)(25)}}{2(4)}$$ Substitute 4 for a, 20 for b, and 25 for c.

$$= \frac{-20 \pm \sqrt{0}}{8} = -\frac{5}{2}$$ Simplify.

∴ The solution is $x = -\frac{5}{2}$.

EXAMPLE 3 Real-Life Application



The number y of Northern Rocky Mountain wolf breeding pairs x years since 1995 can be modeled by $y = 0.34x^2 + 3.0x + 9$. When were there about 30 breeding pairs?

To determine when there were 30 breeding pairs, find the x-values for which $y = 30$. So, solve the equation $30 = 0.34x^2 + 3.0x + 9$.

$$30 = 0.34x^2 + 3.0x + 9$$ Write the equation.

$$0 = 0.34x^2 + 3.0x - 21$$ Write in standard form.

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

$$= \frac{-3.0 \pm \sqrt{3.0^2 - 4(0.34)(-21)}}{2(0.34)}$$ Substitute 0.34 for a, 3.0 for b, and -21 for c.

$$= \frac{-3.0 \pm \sqrt{37.56}}{0.68}$$ Simplify.

The solutions are $x = \frac{-3.0 + \sqrt{37.56}}{0.68} \approx 5$ and $x = \frac{-3.0 - \sqrt{37.56}}{0.68} \approx -13$.

∴ Because x represents the number of years since 1995, x is greater than or equal to zero. So, there were about 30 breeding pairs 5 years after 1995, in 2000.

On Your Own

Now You're Ready
Exercises 15–23

Solve the equation using the quadratic formula.

4. $4x^2 - 4x + 1 = 0$ **5.** $-5x^2 + x = -4$ **6.** $3x^2 + 2x = 5$

7. WHAT IF? In Example 3, when were there about 85 breeding pairs?

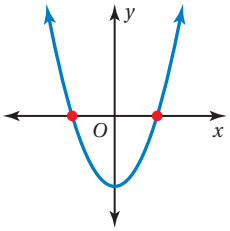
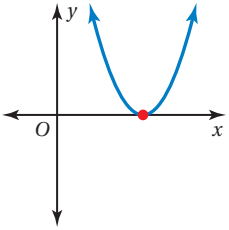
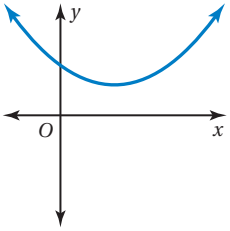
The expression $b^2 - 4ac$ in the quadratic formula is the **discriminant**.

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$ ← discriminant

You can use the discriminant to determine the number of real solutions of a quadratic equation.

Key Idea

Interpreting the Discriminant

$b^2 - 4ac > 0$	$b^2 - 4ac = 0$	$b^2 - 4ac < 0$
		
• two real solutions • two x-intercepts	• one real solution • one x-intercept	• no real solutions • no x-intercepts

Study Tip

The solutions of a quadratic equation may be real numbers or *imaginary numbers*. You will study imaginary numbers in a future course.

EXAMPLE 4 Determining the Number of Real Solutions

a. Determine the number of real solutions of $x^2 + 8x - 3 = 0$.

$b^2 - 4ac = 8^2 - 4(1)(-3)$ Substitute 1 for a, 8 for b, and -3 for c.

$= 64 + 12$ Simplify.

$= 76$ Add.

∴ The discriminant is greater than 0, so the equation has two real solutions.

b. Determine the number of real solutions of $2x^2 + 7 = 6x$.

Write the equation in standard form: $2x^2 - 6x + 7 = 0$.

$b^2 - 4ac = (-6)^2 - 4(2)(7)$ Substitute 2 for a, -6 for b, and 7 for c.

$= 36 - 56$ Simplify.

$= -20$ Subtract.

∴ The discriminant is less than 0, so the equation has no real solutions.

On Your Own

Now You're Ready
Exercises 27–32

Determine the number of real solutions of the equation.

8. $-x^2 + 4x - 4 = 0$ **9.** $6x^2 + 2x = -1$ **10.** $\frac{1}{2}x^2 = 7x - 1$

Name : _____

Due May 24 at 10AM

Solving Quadratic Equations

ES1

Solve each quadratic equation using quadratic formula.

1) $m^2 + 6m = -8$

2) $-64 + k^2 = 0$

3) $-4z^2 + 13z - 3 = 0$

4) $12x^2 + 1 = -7x$

5) $3u^2 - 2 = 5u$

6) $-w^2 + 6w + 72 = 0$

7) $-h^2 - 4h + 5 = 0$

8) $2v^2 + 5v = 7$

9) $5n^2 - 3n = 2$

10) $-y^2 + 8y = 0$

Name_____ Date _____

9.4 Practice A

Due May 24 at 10AM

Write the equation in standard form. Then identify the values of *a*, *b*, and *c* that you would use to solve the equation using the quadratic formula.

1. $x^2 = 2x - 9$ **2.** $5x^2 + 7x = 3$ **3.** $6x^2 - 2 = x$

Solve the equation using the quadratic formula. Round to the nearest tenth, if necessary.

4. $x^2 + 8x + 16 = 0$ **5.** $x^2 - 7x + 10 = 0$ **6.** $x^2 - 3x + 8 = 0$

7. $3x^2 + 4x + 1 = 0$ **8.** $2x^2 - 5x + 6 = 0$ **9.** $4x^2 - 4x + 1 = 0$

10. $5x^2 + 2x = 6$ **11.** $x^2 = 7x - 9$ **12.** $4 - 12x = -9x^2$

Describe and correct the error in solving the equation.

13. $x^2 - 6x - 10 = 0$

✗

$$x = \frac{-6 \pm \sqrt{-6^2 - 4(1)(-10)}}{2(1)}$$

$$x = \frac{-6 \pm \sqrt{4}}{2}$$

$$x = -2 \text{ and } x = -4$$

14. $-3x^2 + 7x - 2 = 0$

✗

$$x = \frac{-7 \pm \sqrt{(7)^2 - 4(-3)(-2)}}{2(-3)}$$

$$x = \frac{-7 \pm \sqrt{25}}{6}$$

$$x = -\frac{1}{3} \text{ and } x = -2$$

15. The difference of two numbers is 2 and the product of the numbers is 41.25.

a. Write an equation representing the product.

b. Find the two numbers.

Use the discriminant to determine the number of real solutions of the equation.

16. $x^2 + 9x + 4 = 0$ **17.** $x^2 - 5x + 7 = 0$ **18.** $5x^2 = 10x - 5$

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