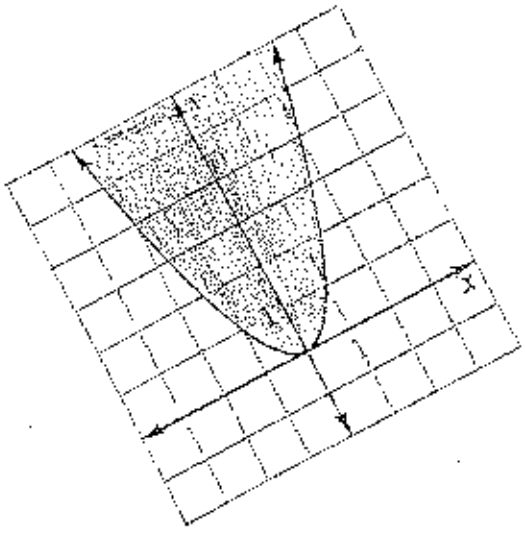
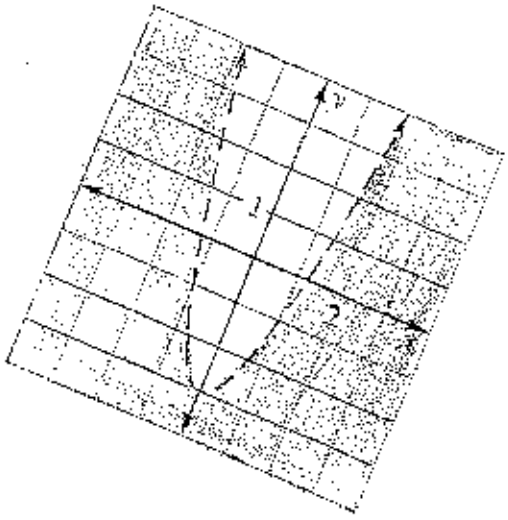
Algebra 2
Chapter 5
Quadratic Functions

$$\frac{3 + i\sqrt{11}}{2}, \frac{3 - i\sqrt{11}}{2}$$





LESSON 5.1

NAME _____ DATE _____

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WARM-UP EXERCISES

For use before Lesson 5.1, pages 249–255

Evaluate when $x = -1$, 0, and 2.

1. $y = 2x^2 - 3x + 5$
2. $y = 3(x - 7)^2 - 6$
3. $y = -(x + 3)(2x - 7)$

DAILY HOMEWORK QUIZ

For use after Lesson 4.5, pages 230–236

1. Write the linear system as a matrix equation.

   $x + y = 3$

   $2x - 5y = 7$

2. Use an inverse matrix to solve the linear system in Exercise 1.
3. Use an inverse matrix and a graphing calculator to solve the linear system.

   $2x + 8y + z = -5$

   $2x + y + z = 2$

   $5x - 3y + 2z = 12$

5.1 Graphing Quadratic Functions

Goals • Graph quadratic functions.
• Use quadratic functions to solve real-life problems.

Your Notes

VOCABULARY

Quadratic function

Parabola

Vertex of a parabola

Axis of symmetry of a parabola

Standard form

THE GRAPH OF A QUADRATIC FUNCTION

The graph of $y = ax^2 \; . \; bx \quad c$ is a parabola with these characteristics:

- The parabola opens up if a __ 0 and opens down if a __ 0. The parabola is wider than the graph of $y = x^2$ if $|a|$ __ 1 and narrower than the graph of $y = x^2$ if $|a|$ __ 1.
- The x-coordinate of the vertex is _____.
- The axis of symmetry is the vertical line $x =$ _____.

Your Notes

Example 1 *Graphing a Quadratic Function*

Graph $y = -x^2 + 2x - 2$.

Solution

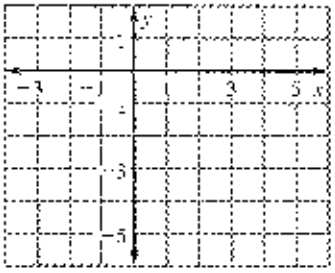
Note that the coefficients for this function are $a =$ ____, $b =$ ____, and $c =$ ____. Because a ____ 0, the parabola opens ____.

Find and plot the vertex. The x- and y-coordinates are:

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

$y =$ ____

So, the vertex is (____, ____).



Draw the axis of symmetry $x =$ ____.

Plot two points on one side of the axis of symmetry, such as (2, ____) and (3, ____). Use symmetry to plot two more points, such as (0, ____) and (−1, ____).

Draw a parabola through the plotted points.

VERTEX AND INTERCEPT FORMS OF QUADRATIC FUNCTIONS

Form of Quadratic Function	Characteristics of Graph
Vertex form:	
$y = a(x - h)^2 + k$	The vertex is (____, ____).
	Axis of symmetry is $x =$ ____.
Intercept form:	
$y = a(x - p)(x - q)$	The x-intercepts are ____ and ____.
	Axis of symmetry is halfway between (____, ____) and (____, ____).

For both forms, the graph opens up if a ____ 0 and down if a ____ 0.

Your Notes

Example 2 *Graphing a Quadratic Function in Vertex Form*

Graph $y = 2(x - 3)^2 - 2$.

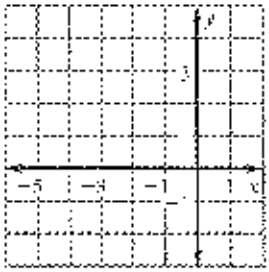
Solution

The function is in vertex form where $a =$ ___, $h =$ ___, and $k =$ ___. Because a ___ 0, the parabola opens _____. To graph the function, first plot the vertex $(h, k) =$ (___, ___). Draw the axis of symmetry $x =$ ___ and plot two points on one side of it, such as (2, ___) and (1, ___). Use symmetry to complete the graph.

Checkpoint **Graph the quadratic function.**

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

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

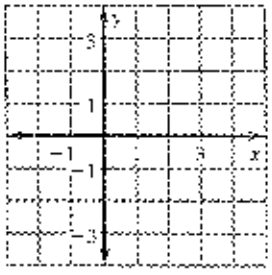


Example 3 *Graphing a Quadratic Function in Intercept Form*

Graph $y =$ ___ $(x - 3)(x - 1)$.

Solution

The quadratic function is in intercept form $y = a(x - p)(x - q)$ where $a =$ ___, $p =$ ___, and $q =$ ___. The x-intercepts occur at (___, ___) and (___, ___). The axis of symmetry lies halfway between these points, at $x =$ ___. So, the x-coordinate of the vertex is $x =$ ___ and the y-coordinate of the vertex is $y =$ _____.



Your Notes

Example 4 *Writing Quadratic Functions in Standard Form*

Write $y = 2(x - 2)(x + 3)$ in standard form.

Solution

$y = 2(x - 2)(x + 3)$ — **Write original function.**

$= 2(\_\_\_\_\_)$ — **Multiply using FOIL.**

$= 2(\_\_\_\_\_)$ — **Combine like terms.**

$= \_\_\_\_\_$ — **Use distributive property.**

Example 5 *Using a Quadratic Model in Standard Form*

The path of a ball after you kicked it can be modeled by $y = -0.1x^2 + 4x$, where x is the horizontal distance in feet and y is the height in feet of the ball. What was the height of the ball at its highest point? How many feet had the ball traveled horizontally at this height?

Solution

Because $a =$ _____, the graph of the quadratic function opens _____ and has a maximum value. The maximum value occurs at $x = \frac{\_\_\_\_}{\_\_\_\_} = \_\_\_$.

The corresponding value of y is $y = \_\_\_\_\_ = \_\_\_$.

The maximum height of the ball was ___ feet. At this height the ball had traveled ___ feet horizontally.

Checkpoint **Complete the following exercises.**

3. Write $y = 2(x - 3)^2 + 4$ in standard form.

4. In Example 5, assume the path can be modeled by $y = -0.2x^2 + 4x + 1$. What is the height of the ball at its highest point?

Homework

Extra Examples for Lesson 5.1

Example 1

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

Example 2

Graph $y = 2(x - 1)^2 + 3$.

Checkpoint Exercises

1. Graph $y = \frac{1}{2}x^2 - x - 6$.

(For use after Example 1)

2. Graph $y = -(x + 5)^2 + 2$.

(For use after Example 2)

Example 3

Graph $y = 2(x - 3)(x + 1)$.

Example 4

Write the quadratic function in standard form.

a. $y = \frac{1}{2}(x - 6)(x - 4)$

b. $y = -4(x - 7)^2 + 2$

Extra Examples for Lesson 5.1 *continued*

Checkpoint Exercises

1. Graph $y = 2x(x - 4)$.

   (For use after Example 3)

2. Write the quadratic function in standard form.

   a. $y = \frac{1}{2}(x - 2)^2 - 3$

   b. $y = -3(x + 1)(x - 5)$

   (For use after Example 4)

Example 5

Suppose that a group of high school students conducted an experiment to determine the number of hours of study that leads to the highest score on a comprehensive year-end exam. The exam score y for each student who studied for x hours can be modeled by $y = -0.853x^2 + 17.48x + 6.923$. Which amount of studying produced the highest score on the exam? What is the highest score the model predicts?

Example 6

The path of a ball thrown by a baseball player forms a parabola with equation

$$y = \frac{-3}{2401}(x - 49)^2 + 8.5,$$

where x is the horizontal distance in feet of the ball from the player and y is the height in feet of the ball.

a. How far does the ball travel before it again reaches the same height from which it was thrown?

b. How high was the ball at its highest point?

Extra Examples *for Lesson 5.1 continued*

☑ Checkpoint Exercises

1. The archway that forms the ceiling of a tunnel can be modeled by the equation $y = -0.0355x^2 - 0.923x - 10$ where x is the horizontal distance in feet from one wall of the tunnel to the other and y is the height in feet of the ceiling from the floor of the tunnel. How many feet from the walls of the tunnel does the ceiling reach its maximum height? What is the maximum height of the tunnel?

(For use after Examples 5 and 6)

Standardized Test Practice

Multi-Step Problem A golf ball is hit from ground level into the air following the path of the equation $y = -0.2x^2 + 12x$. (Assume the x-axis is ground level.)

a. If you assume the point at which the golf ball is hit is (0, 0). at what point does the ball come down and hit the ground?

b. If you assume all points to be in terms of yards, how far was the ball from the golfer when it hit the ground?

c. At what point did the golf ball reach its maximum height?

d. What was the maximum height of the golf ball in terms of yards?

e. **Critical Thinking** Find the equation for the path of the golf ball if it still lands the same distance from the golfer as in part (b) but reaches a maximum height of 90 yards instead of the maximum height found in part (d).

LESSON 5.1

NAME _____ DATE _____

Practice A

For use with pages 249–255

Write the quadratic function in standard form. Determine whether the graph of the function opens up or down.

1. $y = 2x^2 - x - 1$
2. $y = 3 \quad x - x^2$
3. $y - 4 - 3x - 5x^2$
4. $y = \quad 2x + 1 + x^2$
5. $y - 4 - 3x^2$
6. $y - x + 9x^2$
7. $y - x^2 + 3 - 5x$
8. $y = -3x^2 + 1 - 4x$
9. $y = 3x \quad 2x^2 \cdot 3$

Find the axis of symmetry of the parabola.

10. $y - 2x^2 + 4x - 1$
11. $y - -x^2 + 2x + 5$
12. $y = 3x^2 \quad 8x + 2$
13. $y - x^2 + 6x$
14. $y = 2x^2 - 2x - 3$
15. $y - 3x^2 - 5$

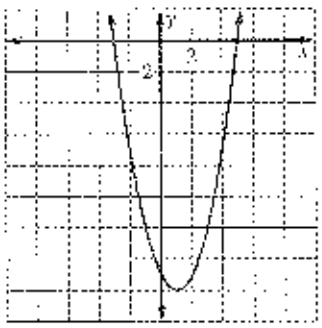
Find the vertex of the parabola.

16. $y - x^2 + 2x - 1$
17. $y = 2x^2 - 8x + 3$
18. $y - -x^2 - 6x + 8$
19. $y = x^2 \quad 5$
20. $y - -x^2 + 4$
21. $y = 2x^2 + 4x$

Match the quadratic function with its graph.

22. $y = x^2 - 2x - 15$
23. $y = (x + 3)(x - 5)$
24. $y - -(x + 1)^2 - 12$

A.



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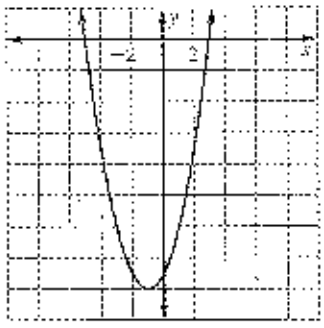

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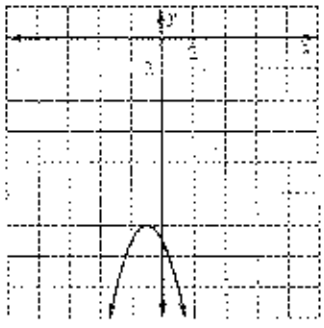


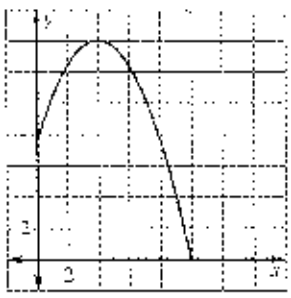
Write the quadratic function in standard form.

25. $y = 3(x - 2)^2 + 1$
26. $y - (x + 1)^2 + 2$
27. $y = \quad 2(x + 3)^2 \cdot 1$
28. $y = \quad 2(x - 3)(x - 1)$
29. $y - (x - 3)(x \quad 6)$
30. $y - 4(x + 1)(x + 2)$

Graph the quadratic function. Label the vertex and axis of symmetry.

31. $y = (x - 1)^2 + 3$
32. $y = (x + 2)^2 - 1$
33. $y - -(x - 2)^2 - 1$

34. ***Maximum Height*** The path that a diver follows is given by $y - -0.4(x - 4)^2 + 14$ where x is the horizontal distance (in feet) from the edge of the diving board and y is the height (in feet). What is the maximum height of the diver?



Practice A

1. $y = 2x^2 + x - 1$; opens up

2. $y = -x^2 - x - 3$; opens down

3. $y = -5x^2 + 3x + 4$; opens down

4. $y = x^2 - 2x - 1$; opens up

5. $y = -3x^2 - 4$; opens down

6. $y = 9x^2 + x$; opens up

7. $y = x^2 - 5x + 3$; opens up

8. $y = -3x^2 - 4x + 1$; opens down

9. $y = -2x^2 - 3x + 3$; opens down

10. $x = -1$ **11.** $x = 1$ **12.** $x = \frac{4}{2}$

13. $x = -3$ **14.** $x = -\frac{1}{2}$ **15.** $x = 0$

16. $(-1, -2)$ **17.** $(2, -5)$ **18.** $(-3, 17)$

19. $(0, -5)$ **20.** $(0, 4)$ **21.** $(-1, -2)$ **22.** B

23. A **24.** C **25.** $y = 3x^2 - 12x + 13$

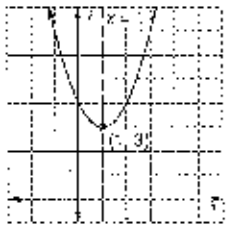
26. $y = x^2 + 2x - 3$

27. $y = -2x^2 - 12x - 19$

28. $y = -2x^2 - 4x + 6$ **29.** $y = x^2 - 9x + 18$

30. $y = 4x^2 + 12x + 8$

31.



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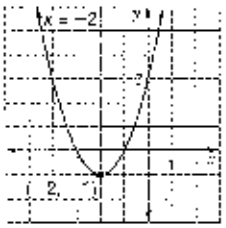

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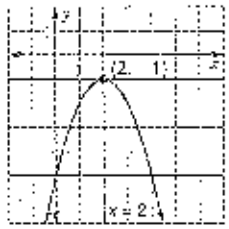


34. 14 ft

LESSON 5.1

NAME _____ DATE _____

Practice B

For use with pages 249–255

Write the quadratic function in standard form. Determine whether the graph of the function opens up or down.

1. $y = 3 \quad 2x \quad x^2$
2. $y = 3x + 3x^2 - 4$
3. $y = -5 - 4x^2$

Find the vertex and axis of symmetry of the parabola.

4. $y = x^2 \quad 4x + 8$
5. $y = -3x^2 + x$
6. $y = x^2 - x + 4$

Graph the quadratic function. Label the vertex and axis of symmetry.

7. $y = x^2$
8. $y = x^2 + 1$
9. $y = -x^2 - 2$
10. $y = x^2 - 2x$
11. $y = 2x^2 \quad 12x$
12. $y = -x^2 + 8x + 2$
13. $y = x^2 + 14x - 9$
14. $y = -2x^2 - 4x - 7$
15. $y = 3x^2 + 3x - 1$

Graph the quadratic function. Label the vertex and axis of symmetry.

16. $y = -(x + 1)^2 + 3$
17. $y = (x - 3)^2 + 2$
18. $y = (x \quad 2)^2 \quad 5$
19. $y = -(x + 2)^2 + 1$
20. $y = -2(x + 2)^2 - 3$
21. $y = -3(x - 1)^2 - 4$

Graph the quadratic function. Label the vertex and axis of symmetry.

22. $y = (x + 3)(x + 4)$
23. $y = (x - 4)(x - 1)$
24. $y = (x - 2)(x - 4)$
25. $y = \quad (x + 4)(x + 1)$
26. $y = -2(x - 3)(x - 1)$
27. $y = -3x(x + 2)$

Minimum Cost A manufacturer of lighting fixtures has daily production costs modeled by $y = 0.25x^2 - 10x + 800$ where y is the total cost in dollars and x is the number of fixtures produced.

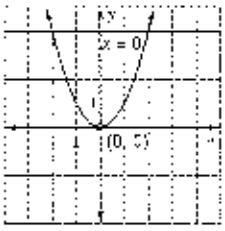
28. Sketch the graph of the model. Label the vertex.
29. What is the minimum daily production cost, y?
30. How many fixtures should be produced each day to yield a minimum cost?

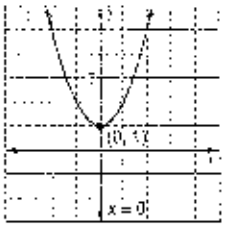
Price of Gasoline The price of gasoline at a local station throughout the month of March is modeled by $y = -0.014x^2 + 0.448x - 2.324$ where $x = 1$ corresponds to March 1.

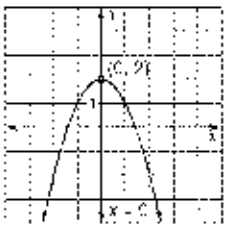
31. On what day in March did the price of gasoline reach its maximum?
32. What was the highest price of gasoline in March?

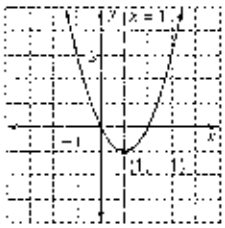
Practice B

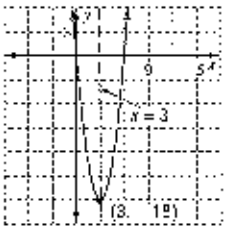
1. $y = -x^2 - 2x - 3$; opens down
2. $y = 3x^2 + 3x - 4$; opens up
3. $y = -4x^2 - 5$; opens down
4. $(2, 4)$; $x = 2$ 5. $\left(\frac{1}{6}, -\frac{1}{6}\right)$; $x = \frac{1}{6}$
6. $\left(\frac{3}{2}, \frac{15}{4}\right)$; $x = \frac{3}{2}$

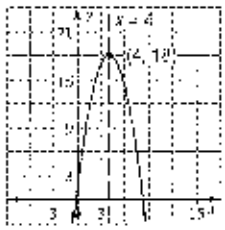
7. 

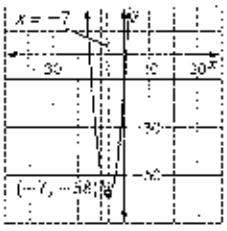
8. 

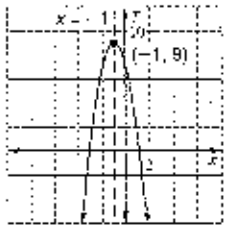
9. 

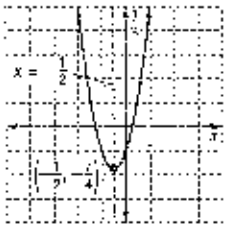
10. 

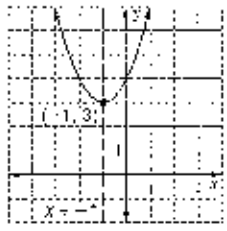
11. 

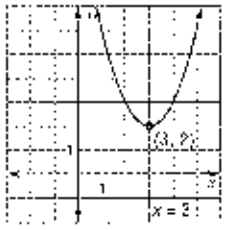
12. 

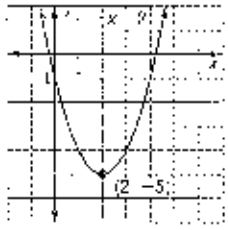
13. 

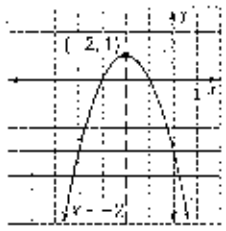
14. 

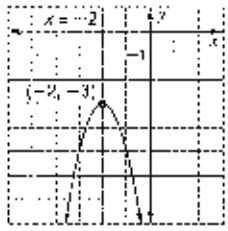
15. 

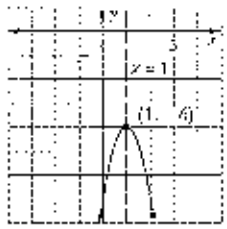
16. 

17. 

18. 

19. 

20. 

21. 

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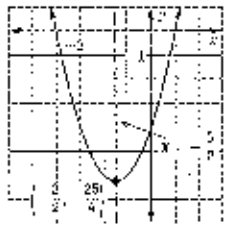
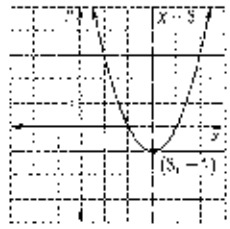
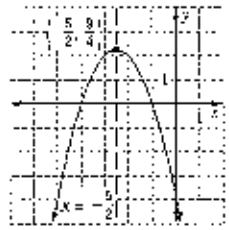
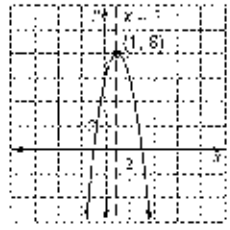
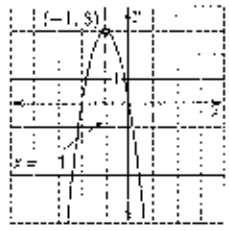
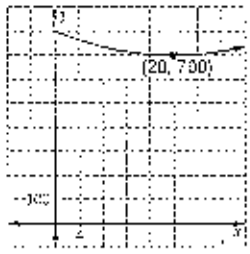
23. 

24. 

25. 

26. 

27. 

28. 

29. \$700 30. 20 31. March 16 32. \$1.26

LESSON 5.2

NAME _____ DATE _____

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WARM-UP EXERCISES

For use before Lesson 5.2, pages 256–263

Solve the equation.

1. $3x - 4 = 0$
2. $2x - 11 = -15$
3. $-3x - 5 = 2x$
4. $2(x - 3) = 6$

DAILY HOMEWORK QUIZ

For use after Lesson 5.1, pages 249–255

1. Graph $y = 2x^2 - 4x + 2$.
2. Graph $y = -\frac{1}{2}(x - 3)^2 + 5$.
3. Graph $y = -(x - 3)(x + 1)$.

Write the quadratic function in standard form.

4. $y = -2(x - 4)^2 + 3$
5. $y = -(x + 7)(x - 2)$

5.2 Solving Quadratic Equations by Factoring

Goals
- Factor quadratic expressions and solve quadratic equations by factoring.
- Find zeros of quadratic functions.

Your Notes

VOCABULARY

Binomial

Trinomial

Factoring

Monomial

Quadratic equation in one variable

Zero of a function

Example 1 *Factoring a Trinomial of the Form $x^2 + bx + c$*

Factor $x^2 - 9x + 14$.

Solution

You want $x^2 - 9x + 14 = (x + m)(x + n)$ where $mn =$ ____ and $m + n =$ ____.

Factors of 14 (m, n)	1, ____	-1, ____	2, ____	-2, ____
Sum of factors ($m + n$)	____	____	____	____

The table shows that $m =$ ____ and $n =$ ____. So, $x^2 - 9x + 14 =$ (____)(____).

Your Notes

Example 2 *Factoring a Trinomial of the Form $ax^2 + bx + c$*

Factor $2x^2 + 13x + 6$.

Solution

You want $2x^2 + 13x + 6 = (kx + m)(lx + n)$ where k and l are factors of ___ and m and n are (_____) factors of ___. Check possible factorizations by multiplying.

$(2x + 3)(x + 2) =$ _____

$(2x + 2)(x + 3) =$ _____

$(2x + 6)(x + 1) =$ _____

$(2x + 1)(x + 6)$ _____

The correct factorization is

$2x^2 + 13x + 6 =$ _____.

SPECIAL FACTORING PATTERNS

Difference of Two Squares — **Example**

$a^2 - b^2 = (a + b)(a - b)$ — $x^2 - 9 =$ (_____)(_____)

Perfect Square Trinomial — **Example**

$a^2 + 2ab + b^2 = (a + b)^2$ — $x^2 + 12x + 36 =$ (_____)^2

$a^2 - 2ab + b^2 = (a - b)^2$ — $x^2 - 8x + 16 =$ (_____)^2

Example 3 *Factoring with Special Patterns*

Factor the quadratic expression.

a. $9x^2 - 16 =$ (___)$^2 -$ ___^{2} — **Difference of two squares**

$=$ (_____)(_____)

b. $16y^2 - 40y + 25$ — **Perfect square trinomial**

$=$ (___)$^2 + 2$(___)(___) + ___^{2}

$=$ (_____)^2

c. $64x^2 - 32x + 4$ — **Perfect square trinomial**

$=$ (___)^2 2(___)(___) + ___^{2}

$=$ (_____)^2

Your Notes

Example 4 *Factoring Monomials First*

Factor the quadratic expression.

a. $12x^2 \quad 3 = 3$_____ $= 3$_____

b. $3u^2 \cdots 9u \cdot \ 6 = 3$_____ $= 3$_____

c. $7v^2 - 42v = 7v$_____

d. $2x^2 + 8x + 2 = 2$_____

Checkpoint **Factor the expression.**

1. $6c^2 \cdots 48c \cdots 54$

2. $81x^2 \cdots 1$

3. $49h^2 + 42h + 9$

4. $16x^2 \quad 4$

ZERO PRODUCT PROPERTY

Let A and B be real numbers or algebraic expressions. If $AB = 0$, then $A =$ __ or $B =$ __.

Example 5 *Solving Quadratic Equations*

Solve $4x^2 + 13x \div 11 = \cdots 3x \cdot \ 5$.

Solution

$4x^2 + 13x + 11 = -3x - 5$	**Write original equation.**
_____ $\cdots 0$	**Write in standard form.**
_____ $= 0$	**Divide each side by** __.
_____ $= 0$	**Factor.**
_____ $= 0$	**Use zero product property.**
$x =$ ____	**Solve for x.**

The solution is ____. Check this in the original equation.

Your Notes

Checkpoint **Solve the quadratic equation.**

5. $x^2 - 15x + 26 = 0$

6. $2x^2 + x + 3 = 5x + 19 + x^2$

Example 6 ***Finding the Zeros of a Quadratic Function***

Find the zeros of $y = x^2 + 4x + 3$.

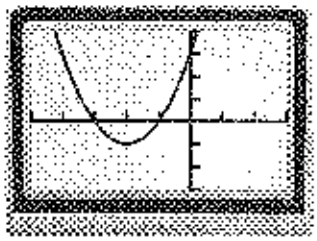
Use factoring to write the function in intercept form.

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

_____

The zeros of the function are ____ and ____.

Check Graph $y = x^2 + 4x + 3$. The graph passes through (____, 0) and (____, 0), so the zeros are ____ and ____.



Checkpoint **Complete the following exercise.**

7. Find the zeros of $y = 3x^2 + x - 2$.

Homework

Extra Examples for Lesson 5.2

Example 1

Factor $x^2 - 2x - 48$.

Example 2

Factor $4y^2 - 4y + 3$.

Example 3

Factor the quadratic expression.

a. $16y^2 - 225$

b. $4z^2 - 12z + 9$

c. $36w^2 - 60w + 25$

Example 4

Factor the quadratic expression.

a. $14x^2 + 2x - 12$

b. $3v^2 - 18v$

c. $12x^2 + 3x + 3$

d. $4u^2 - 36$

Checkpoint Exercises

1. Factor $5x^2 + 17x - 14$.

(For use after Examples 1 and 2)

2. Factor $64x^2 - 9$.

(For use after Example 3)

Extra Examples for Lesson 5.2 *continued*

3. Factor $16x^2 + 8x + 1$.

(For use after Example 3)

4. Factor $30u^2 - 57u + 21$.

(For use after Example 4)

Example 5

Solve.

a. $9t^2 - 12t + 4 = 0$

b. $3x - 6 = x^2 - 10$

Example 6

A painter is making a rectangular canvas for her next painting. She wants the length of the canvas to be 4 ft more than twice the width of the canvas. The area of the canvas must be 30 ft^2. What should the dimensions of the canvas be?

Checkpoint Exercises

1. Solve $2w^2 - 10w = 23w - w^2$.

(For use after Example 5)

2. A yearbook editor is designing a page layout. The outside dimensions of the page are 9 in. wide by 12 in. long. The white border around the rectangular printed matter on the page is twice as wide on the sides as it is at the top and bottom of the page. The area of the printed matter is 50 in.^{2}. What are the dimensions of the printed matter?

(For use after Example 6)

Extra Examples for Lesson 5.2 *continued*

Example 7

Find the zeros of $y = 3x^2 + 14x - 5$.

Example 8

You own an amusement park that averages 75,000 visitors per year who each pay a $12 admission charge. You plan to lower the admission price to attract new customers. It has been shown that each $1 decrease in price results in 15,000 new visitors. What admission should you charge to maximize your annual revenue? What is the maximum revenue?

Checkpoint Exercises

1. Find the zeros of $y = x^2 + 8x - 15$.

   (For use after Example 7)

2. Refer to Extra Example 8. Another study showed that for every $1 increase in price, there would be 5000 fewer visitors. What admission should you charge to maximize your annual revenue? What is the maximum revenue?

   (For use after Example 8)

Standardized Test Practice

Multiple Choice What is a correct factorization of $12x^2 - 5x - 2$?

(A) $(2x + 1)(6x - 2)$ (B) $(12x - 1)(x + 2)$

(C) $(2x - 1)(6x + 2)$ (D) $(3x + 2)(4x - 1)$

(E) $(3x - 2)(4x + 1)$

LESSON 5.2

NAME _____ DATE _____

Practice A

For use with pages 256–263

Factor the expression. If the expression cannot be factored, say so.

1. $x^2 - x - 6$
2. $x^2 - 6x + 5$
3. $x^2 - 4x + 3$
4. $x^2 - 5x + 6$
5. $x^2 + 9x - 18$
6. $x^2 - 4x + 3$
7. $x^2 - 6x + 8$
8. $x^2 - 3x - 4$
9. $x^2 + 3x - 4$
10. $x^2 - 16$
11. $x^2 + 4x - 4$
12. $x^2 + 6x + 9$
13. $x^2 - 2x + 1$
14. $x^2 - 6x - 9$
15. $x^2 - 4$
16. $x^2 - 64$
17. $x^2 + 8x - 16$
18. $x^2 - 16x + 64$

Factor the expression.

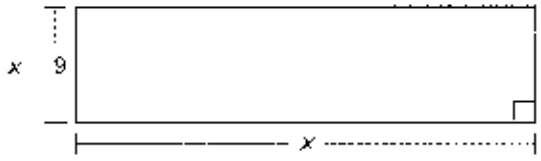
19. $2x^2 - 4x + 2$
20. $3x^2 - 12$
21. $-2x^2 + 2$
22. $3x^2 - 6x + 3$
23. $x^2 - 6x - 9$
24. $-2x^2 + 16x - 32$
25. $2x^2 - 2x - 4$
26. $3x^2 - 9x + 6$
27. $-x^2 + 5x - 6$

Solve the equation.

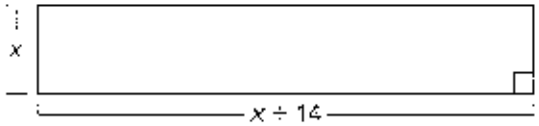
28. $x^2 - 2x - 3 = 0$
29. $x^2 + 3x + 2 = 0$
30. $x^2 - 9x + 20 = 0$
31. $x^2 + 4x - 4 = 0$
32. $x^2 + 2x + 1 = 0$
33. $x^2 - 6x - 9 = 0$
34. $x^2 - 10x + 25 = 0$
35. $x^2 - 16 = 0$
36. $x^2 - 81 = 0$
37. $x^2 + 3x - 10$
38. $x^2 - 36$
39. $x^2 - 14x = -49$

Find the dimensions of the figure.

40. Area of rectangle = 36 square feet



41. Area of rectangle = 51 square feet



Find the time (in seconds) it takes an object to hit the ground when it is dropped from a height of s feet. Use the falling-object model $h = -16t^2 + s$.

42. $s = 64$
43. $s = 16$
44. $s = 144$

Practice A

1. $(x + 2)(x - 3)$ **2.** $(x - 5)(x - 1)$
3. $(x + 3)(x - 1)$ **4.** $(x + 3)(x - 2)$
5. $(x + 6)(x - 3)$ **6.** $(x - 3)(x - 1)$
7. $(x - 4)(x - 2)$ **8.** $(x - 4)(x + 1)$
9. $(x + 4)(x - 1)$ **10.** $(x + 4)(x - 4)$
11. $(x + 2)(x + 2)$ **12.** $(x + 3)(x + 3)$
13. $(x - 1)(x - 1)$ **14.** $(x - 3)(x - 3)$
15. $(x - 2)(x + 2)$ **16.** $(x - 8)(x + 8)$
17. $(x - 4)(x + 4)$ **18.** $(x - 8)(x - 8)$
19. $2(x + 1)(x + 1)$ **20.** $3(x - 2)(x + 2)$
21. $-2(x + 1)(x - 1)$ **22.** $3(x - 1)(x - 1)$
23. $(x + 3)(x + 3)$ **24.** $2(x - 4)(x - 4)$
25. $2(x - 1)(x - 2)$ **26.** $3(x - 1)(x + 2)$
27. $-(x - 2)(x - 3)$ **28.** $-1, 3$ **29.** $2, 1$
30. $4, 5$ **31.** -2 **32.** -1 **33.** 3 **34.** 5
35. $-4, 4$ **36.** $-9, 9$ **37.** $-5, 2$ **38.** $-6, 6$
39. 7 **40.** 12 ft by 3 ft **41.** 17 ft by 3 ft
42. 2 seconds **43.** 1 second **44.** 3 seconds

LESSON 5.2

NAME _____ DATE _____

Practice B

For use with pages 256–263

Factor the expression. If the expression cannot be factored, say so.

1. $x^2 + 4x - 21$
2. $x^2 + 6x - 2$
3. $x^2 + 8x + 15$
4. $x^2 + 9x + 14$
5. $x^2 + 11x + 28$
6. $x^2 - 10x + 24$
7. $x^2 + 3x + 1$
8. $2x^2 - 5x - 3$
9. $3x^2 - x - 2$
10. $3x^2 + 7x + 2$
11. $2x^2 + 5x + 3$
12. $10x^2 - 3x - 1$
13. $6x^2 - 13x - 2$
14. $15x^2 - 14x + 3$
15. $2x^2 + 7x + 1$
16. $x^2 + 16x - 64$
17. $x^2 - 6x + 9$
18. $x^2 - 49$
19. $4x^2 + 4x + 1$
20. $9x^2 - 12x - 4$
21. $9x^2 - 1$
22. $x^2 + 8x - 5$
23. $4x^2 - 7$
24. $6x^2 - 17x + 5$

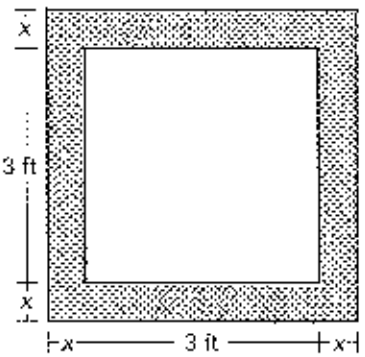
Factor the expression.

25. $2x^2 - 4x - 30$
26. $x^2 + 10x - 21$
27. $-3x^2 - 15x - 12$
28. $4x^2 + 14x + 6$
29. $6x^2 - 33x + 15$
30. $4x^2 + 10x - 24$
31. $12x^2 - 3$
32. $-8x^2 + 24x - 18$
33. $45x^2 + 30x - 5$

Solve the equation.

34. $x^2 + x - 30 = 0$
35. $x^2 + 10x + 9 = 0$
36. $x^2 - 12x + 32 = 0$
37. $2x^2 + 7x - 4 = 0$
38. $3x^2 + 8x - 3 = 0$
39. $5x^2 + 3x - 2 = 0$
40. $3x^2 - 8x + 5 = 0$
41. $25x^2 - 20x + 4 = 0$
42. $49x^2 - 14x + 1 = 0$
43. $25x^2 = 16$
44. $2x^2 - x = 21$
45. $8x^2 + 5x - 4 = 2x^2 - 8x + 1$

46. ***Furniture Manufacturing*** You are making a coffee table with a glass top surrounded by a cherry border. The glass is 3 feet by 3 feet. You want the cherry border to be a uniform width. You have 7 square feet of cherry to make the border. What should the width of the border be?



47. A magazine has a circulation of 140 thousand per month when they charge \$2.50 for a magazine. For each \$.10 increase in price, 5 thousand sales are lost. How much should be charged per magazine to maximize revenue?

Practice B

1. $(x + 7)(x - 3)$ **2.** cannot be factored
3. $(x - 3)(x + 5)$ **4.** $(x + 7)(x + 2)$
5. $(x - 7)(x - 4)$ **6.** $(x + 6)(x - 4)$
7. cannot be factored **8.** $(2x + 1)(x - 3)$
9. $(3x - 2)(x - 1)$ **10.** $(3x + 1)(x + 2)$
11. $(2x + 3)(x + 1)$ **12.** $(2x - 1)(5x + 1)$
13. $(6x - 1)(x + 2)$ **14.** $(5x - 3)(3x - 1)$
15. cannot be factored **16.** $(x + 8)(x - 8)$
17. $(x + 3)(x - 3)$ **18.** $(x - 7)(x + 7)$
19. $(2x + 1)(2x + 1)$ **20.** $(3x - 2)(3x + 2)$
21. $(3x + 1)(3x + 1)$ **22.** cannot be factored
23. cannot be factored **24.** $(2x - 5)(3x + 1)$
25. $2(x - 5)(x - 3)$ **26.** $(x + 3)(x - 7)$
27. $-3(x + 4)(x + 1)$ **28.** $2(2x + 1)(x + 3)$
29. $3(2x + 1)(x - 5)$ **30.** $-2(2x + 3)(x - 4)$
31. $3(2x + 1)(2x + 1)$
32. $-2(2x - 3)(2x + 3)$
33. $5(3x + 1)(3x + 1)$ **34.** $-6, 5$
35. $9, -1$ **36.** $4, 8$ **37.** $-4, \frac{1}{2}$ **38.** $3, \frac{1}{3}$
39. $-1, \frac{2}{3}$ **40.** $1, \frac{5}{3}$ **41.** $-\frac{2}{3}$ **42.** $\frac{1}{7}$ **43.** $-\frac{6}{5}, \frac{4}{3}$
44. $-3, \frac{7}{2}$ **45.** $-\frac{2}{2}, \frac{1}{3}$ **46.** $\frac{5}{2}$ ft **47.** $2.65

LESSON 5.3

NAME _____ DATE _____

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WARM-UP EXERCISES

For use before Lesson 5.3, pages 264–271

Solve the equation.

1. $5x - 3 = 17$

2. $0 = -12 + 3t$

Find the value of y when $x = 0$, 1, and 2.

3. $y = -16x^2 + 24$

4. $y = -18x^2 + 321$

DAILY HOMEWORK QUIZ

For use after Lesson 5.2, pages 256–263

Factor the quadratic expression.

1. $x^2 - 14x - 15$

2. $5x^2 + 4x - 12$

3. $36x^2 - 49$

4. $25x^2 - 10x + 1$

Solve.

5. $16x^2 + 24x + 9 = 0$

6. $14x^2 + 11x + 3 = 2x^2 - 3x + 3$

7. Find the zeros of $y = 8x^2 - 18x$.

5.3 Solving Quadratic Equations by Finding Square Roots

Goals • Solve quadratic equations.
• Use quadratic equations to solve real-life problems.

Your Notes

VOCABULARY

Square root

Radical sign

Radicand

Radical

Rationalizing the denominator

PROPERTIES OF SQUARE ROOTS ($a > 0, b > 0$)

Product Property: $\sqrt{ab} =$ ____ • ____

Quotient Property: $\sqrt{\frac{a}{b}} =$ $\frac{\sqrt{\quad}}{\sqrt{\quad}}$

Your Notes

Example 1 *Using Properties of Square Roots*

Simplify the expression.

a. $\sqrt{27}$ ____ · ____ = ____

b. $\sqrt{5} \cdot \sqrt{15}$ ____ = ____ · ____ = ____

c. $\sqrt{\frac{5}{36}}$ $\frac{\sqrt{\quad}}{\quad} = \frac{\quad}{\quad}$

d. $\sqrt{\frac{13}{3}} = \frac{\sqrt{\quad}}{\sqrt{\quad}} \cdot \frac{\sqrt{\quad}}{\sqrt{\quad}} =$ ____

Checkpoint **Simplify the expression.**

1. $\sqrt{5} \cdot \sqrt{8}$

2. $\sqrt{\frac{3}{5}}$

Example 2 *Solving a Quadratic Equation*

Solve $\frac{1}{2}(x-2)^2 = 8$.

Solution

$\frac{1}{2}(x-2)^2 = 8$ **Write original equation.**

____ = ____ **Multiply each side by ___.**

____ = ____ **Take square roots of each side.**

x = ____ **Add ___ to each side.**

The solutions are ____.

Check Check the solutions either by substituting them into the original equation or by graphing $y =$ ____ and observing the x-intercepts.

Your Notes

Example 3 *Modeling a Falling Object's Height*

An acorn falls out of a tree from a height of 40 feet. How many seconds does the acorn take to reach the ground?

Solution

The initial height is $h_0 =$ ____ feet, so the height as a function of time is $h = \quad 16t^2 + 40$. Find the value of t for which $h = 0$ to determine how long it takes the acorn to reach the ground.

Method 1: Make a table of values.

t	0	1	2
h			

The table shows that $h = 0$ has a value of t between $t =$ ___ and $t =$ ___. It takes between _____ _____ for the acorn to reach the ground.

Method 2: Solve a quadratic equation.

$h = -16t^2 + 40$	**Write height function.**
$\_\_ = -16t^2 - 40$	**Substitute ___ for h.**
_____	**Subtract ____ from each side.**
_____	**Divide each side by _____.**
_____	**Take positive square root.**
_____	**Use a calculator.**

The acorn takes about _____ to reach the ground.

Checkpoint **Complete the following exercises.**

3. Solve $5x^2 - 30 = 70$.

4. Solve $\frac{1}{3}(x + 7)^2 = 8$.

5. You drop a football from a window 20 feet above the ground. For how much time is the football falling if your friend catches it at a height of 4 feet?

Homework

Extra Examples for Lesson 5.3

Example 1

Simplify the expression.

a. $\sqrt{500}$

b. $3\sqrt{12} \cdot \sqrt{6}$

c. $\sqrt{\frac{25}{3}}$

d. $\sqrt{\frac{2}{11}}$

Example 2

Solve $3 - 5x^2 = -9$.

Example 3

Solve $3(x - 2)^2 = 21$.

Checkpoint Exercises

1. Simplify the expression.
   $\sqrt{6} \cdot \sqrt{8}$
2. Simplify the expression.
   $\sqrt{\frac{49}{5}}$

(For use after Example 1)

3. Solve $4x^2 - 6 = 42$.
4. Solve $\frac{1}{5}(x - 4)^2 = 6$.

(For use after Examples 2 and 3)

Extra Examples for Lesson 5.3 *continued*

Example 4

The tallest building in the United States is in Chicago, Illinois. It is 1450 ft tall.

a. How long would it take a penny to drop from the top of this building?

b. How fast would the penny be traveling when it hits the ground if the speed is given by $s = 32t$ where t is the number of seconds since the penny was dropped?

Checkpoint Exercises

1. How long will it take an object dropped from a 550-foot tall tower to land on the roof of a 233-foot tall building?

(For use after Example 4)

Standardized Test Practice

Quantitative Comparison Choose the statement below that is true about the given quantities.

(A) The number in column A is greater.

(B) The number in column B is greater.

(C) The two numbers are equal.

(D) The relationship cannot be determined from the given information.

Column A	*Column B*
The solution(s) of $(x - 7)^2 = 0$	The solution(s) of $(x - 5)^2 = 0$

LESSON 5.3

NAME _____ DATE _____

Practice A

For use with pages 264–270

Simplify the expression.

1. $\sqrt{32}$
2. $\sqrt{12}$
3. $\sqrt{45}$
4. $\sqrt{125}$
5. $2\sqrt{18} \cdot \sqrt{2}$
6. $\sqrt{54} \cdot 2\sqrt{6}$
7. $\sqrt{\frac{49}{4}}$
8. $\sqrt{\frac{100}{9}}$
9. $\sqrt{\frac{1}{121}}$
10. $\sqrt{\frac{12}{25}}$
11. $\sqrt{\frac{72}{5}}$
12. $\sqrt{\frac{2}{3}} \cdot \sqrt{\frac{4}{3}}$

Solve the equation.

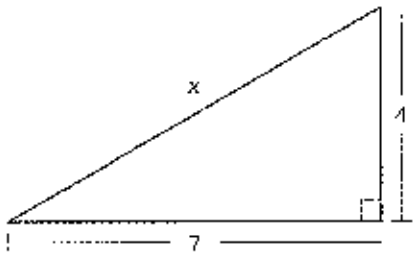
13. $x^2 = 9$
14. $x^2 - 144$
15. $x^2 = 128$
16. $x^2 \cdot 36 = 0$
17. $x^2 - 1 = 0$
18. $x^2 - 8 - 0$
19. $2x^2 - 2$
20. $4x^2 = 36$
21. $\frac{1}{3}x^2 = 32$
22. $x^2 \quad 3 = 1$
23. $x^2 + 2 - 7$
24. $16 \cdot x^2 = 9$
25. $3x^2 - 1 = 5$
26. $\frac{1}{3}x^2 - 5 - 32$
27. $2x^2 - 11 - x^2 + 5$

Find the time it takes an object to hit the ground when it is dropped from a height of *s* feet. Use the falling-object model $h = -16t^2 + s$.

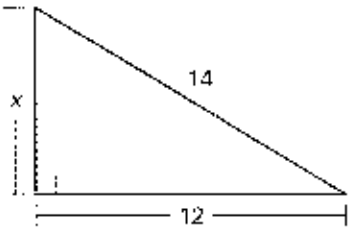
28. $s = 80$
29. $s - 160$
30. $s = 320$

Use the Pythagorean theorem to find *x*. Round your answer to the nearest hundredth.

31.



32.



33. *Cost of a New Car* From 1970 to 1990, the average cost of a new car, C (in dollars), can be approximated by the model $C = 30.5t^2 + 4192$, where t is the number of years since 1970. During which year was the average cost of a new car \$12,000?

Practice A

1. $4\sqrt{2}$ **2.** $2\sqrt{3}$ **3.** $3\sqrt{5}$ **4.** $5\sqrt{5}$ **5.** 12

6. 36 **7.** $\frac{7}{2}$ **8.** $\frac{10}{3}$ **9.** $\frac{1}{11}$ **10.** $\frac{2\sqrt{3}}{5}$

11. $\frac{6\sqrt{10}}{5}$ **12.** $\frac{2\sqrt{2}}{3}$ **13.** $-3, 3$ **14.** $-12, 12$

15. $-8\sqrt{2}, 8\sqrt{2}$ **16.** $-6, 6$ **17.** $-1, 1$

18. $-2\sqrt{2}, 2\sqrt{2}$ **19.** $-1, 1$ **20.** $-3, 3$

21. $-8, 8$ **22.** -2.2 **23.** $-\sqrt{5}, \sqrt{5}$

24. $-5, 5$ **25.** $-\sqrt{2}, \sqrt{2}$ **26.** $-9, 9$

27. $-4, 4$ **28.** 2.24 seconds **29.** 3.16 seconds

30. 4.47 seconds **31.** 8.06 **32.** 7.21

33. 1986

LESSON 5.3

NAME _____ DATE _____

Practice B

For use with pages 264–270

Simplify the expression.

1. $\sqrt{147}$
2. $\sqrt{60}$
3. $\sqrt{63}$
4. $4\sqrt{18} \cdot 2\sqrt{48}$
5. $\sqrt{8} \cdot \sqrt{18} \cdot 5\sqrt{4}$
6. $\sqrt{10} \cdot \sqrt{15}$
7. $\sqrt{\frac{225}{289}}$
8. $\sqrt{\frac{7}{3}} \cdot \sqrt{\frac{14}{3}}$
9. $\sqrt{15} \cdot \sqrt{\frac{35}{12}}$

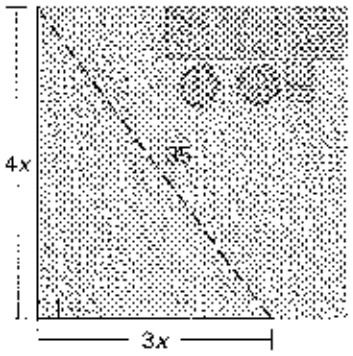
Solve the equation.

10. $x^2 = 324$
11. $x^2 - 81 = 0$
12. $5x^2 \quad 180 = 0$
13. $3x^2 - 100 = 332$
14. $\frac{2}{3}x^2 - 8 = 16$
15. $\frac{1}{2}x^2 - 5 = 5$
16. $x^2 + 1 = 3x^2 \quad 13$
17. $2(x^2 + 4) = 10$
18. $3(x^2 - 1) = 9$
19. $2(x - 3)^2 = 8$
20. $3(x \quad 2)^2 + 4 = 52$
21. $(3x + 1)^2 \quad 36 = 0$
22. $(2x - 3)^2 = 25$
23. $\frac{1}{2}(x - 4)^2 = 8$
24. $\frac{1}{4}(x - 1)^2 - 16 = 0$

25. ***Falling Object*** Use the falling-object model $h = -16t^2 + s$ where t is measured in seconds and h is measured in feet to find the time required for an object to reach the ground from a height of $s = 100$ feet and $s = 200$ feet. Does an object that is dropped from twice as high take twice as long to reach the ground? Explain your answer.

26. ***Truck Registrations*** From 1990 to 1993, the number of truck registrations (in millions) in the United States can be approximated by the model $R = 0.29t^2 + 45$ where t is the number of years since 1990. During which year were approximately 46.16 million trucks registered?

Short Cut Suppose your house is on a large corner lot. The children in the neighborhood cut across your lawn, as shown in the figure at the right. The distance across the lawn is 35 feet.



27. Use the Pythagorean theorem to find x.
28. Find the distance the children would have to travel if they did not cut across your lawn.
29. How many feet do the children save by taking the "short cut?"

Practice B

1. $7\sqrt{3}$ **2.** $2\sqrt{15}$ **3.** $3\sqrt{7}$ **4.** $96\sqrt{6}$

5. 120 **6.** $5\sqrt{6}$ **7.** $\frac{15}{17}$ **8.** $\frac{7\sqrt{2}}{3}$ **9.** $\frac{5\sqrt{7}}{2}$

10. $-18, 18$ **11.** $-9, 9$ **12.** $-6, 6$

13. $-12, 12$ **14.** $-6, 6$ **15.** $-2\sqrt{5}, 2\sqrt{5}$

16. $-\sqrt{7}, \sqrt{7}$ **17.** $-1, 1$ **18.** $-2, 2$

19. $-5, -1$ **20.** $-2, 6$ **21.** $-\frac{2}{3}, \frac{2}{3}$ **22.** $-1, 4$

23. $0, 8$ **24.** $-9, 7$ **25.** 2.5 seconds; ≈ 3.54 seconds; no; doubling the height increases the time by the factor $\sqrt{2}$. **26.** 1992 **27.** 7 **28.** 49 ft

29. 14 ft

LESSON 5.4

NAME _____ DATE _____

Available as a transparency

WARM-UP EXERCISES

For use before Lesson 5.4, pages 272–280

Simplify.

1. $\sqrt{200}$
2. $\sqrt{75}$
3. $\sqrt{20}$
4. $\sqrt{98}$

DAILY HOMEWORK QUIZ

For use after Lesson 5.3, pages 264–271

Simplify the expression.

1. $\sqrt{63}$
2. $\sqrt{\frac{3}{25}}$
3. $\sqrt{8} \cdot \sqrt{10}$
4. $\sqrt{\frac{5}{3}}$
5. Solve $3x^2 + 2 = 62$.
6. Solve $\frac{1}{2}(x + 3)^2 = 5$.

5.4 Complex Numbers

Goals • Perform operations with complex numbers.
• Apply complex numbers to fractal geometry.

Your Notes

VOCABULARY

Imaginary unit i

Complex number

Standard form of a complex number

Imaginary number

Pure imaginary number

Complex plane

Complex conjugates

Absolute value of a complex number

Your Notes

THE SQUARE ROOT OF A NEGATIVE NUMBER

Property	Example
1. If r is a positive real number, then $\sqrt{-r} = i\sqrt{r}$.	$\sqrt{-5} =$ _____
2. By Property (1), it follows that $(i\sqrt{r})^2 = -r$.	$(i\sqrt{5})^2 = i^2 \cdot 5 =$ ____

Example 1 *Solving a Quadratic Equation*

Solve $2x^2 - 3 = -15$.

Solution

$2x^2 - 3 = -15$	Write original equation.
_____	Subtract ___ from each side.
_____	Divide each side by ___.
_____	Take square roots of each side.
_____	Write in terms of i.
_____	Simplify the radical.

The solutions are _____.

Example 2 *Plotting Complex Numbers*

Plot the complex numbers in the complex plane.

a. $1 + i$ **b.** $-2 - 2i$ **c.** $3 - 3i$

Solution

a. To plot $1 + i$, start at the origin, move _____, and then _____.

b. To plot $-2 - 2i$, start at the origin, move _____, and then _____.

c. To plot $3 - 3i$, start at the origin, move _____, and then _____.

Your Notes

Example 3 *Adding and Subtracting Complex Numbers*

Write the expression $(5 + i) + (1 - 2i)$ as a complex number in standard form.

$(5 + i) + (1 - 2i)$

$= (\_\_\_\_\_) + (\_\_\_\_\_)i$ Complex addition

$= \_\_\_\_\_$ Standard form

Checkpoint **Complete the following exercises.**

1. Solve $5x^2 + 2 = -8$.

2. In which quadrant of the complex plane is $1 - 3i$?

3. Write $3 - (7 + 8i) + (5 - 6i)$ as a complex number in standard form.

Example 4 *Multiplying and Dividing Complex Numbers*

Write the expression as a complex number in standard form.

a. $(1 - 4i)(3 - 5i)$ **b.** $\dfrac{6 - 4i}{1 + i}$

Solution

a. $(1 - 4i)(3 - 5i)$ $\_\_\_\_\_$ Use FOIL.

$= \_\_\_\_\_$ Simplify and use $i^2 = \_\_\_\_$.

$= \_\_\_\_\_$ Standard form

b. $\dfrac{6 - 4i}{1 - i} \cdot \dfrac{6 - 4i}{1 + i} \cdot \_\_\_\_\_$ Multiply by $\_\_\_\_\_$, the conjugate of $1 + i$.

$= \_\_\_\_\_$ Use FOIL.

$= \_\_\_\_\_$ Simplify.

$= \_\_\_\_\_$ Write in standard form.

Your Notes

Checkpoint Write the expression in standard form.

4. $(4 - 5i)(4 + 5i)$

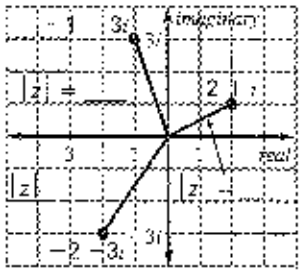
5. $\dfrac{3 + 2i}{2 - i}$

Example 5 *Finding Absolute Values of Complex Numbers*

Find the absolute value of each complex number. Which number is farthest from the origin in the complex plane?

a. $-2 - 3i$ b. $2 - i$ c. $-1 - 3i$

Solution



a. $|-2 - 3i|$

$= \sqrt{\quad\quad}$

$= \quad\quad \approx \quad\quad$

b. $|2 + i|$

$= \sqrt{\quad\quad}$

$= \quad\quad \approx \quad\quad$

c. $|-1 - 3i|$

$= \sqrt{\quad\quad}$

$= \quad\quad \approx \quad\quad$

Because _____ has the greatest absolute value, it is farthest from the origin in the complex plane.

Your Notes

COMPLEX NUMBERS IN THE MANDELBROT SET

To determine whether a complex number c is in the Mandelbrot set, consider the function $f(z) = z^2 + c$ and this infinite list of complex numbers: $z_0 = 0$, $z_1 = f(z_0)$, $z_2 = f(z_1)$, $z_3 = f(z_2)$, ...

- If the absolute values $|z_0|, |z_1|, |z_2|, |z_3|, \ldots$ are all _____ some fixed number N, then c _____ the Mandelbrot set.
- If the absolute values $|z_0|, |z_1|, |z_2|, |z_3|, \ldots$ become _____, then c _____ the Mandelbrot set.

Example 6 ***Complex Numbers in the Mandelbrot Set***

Tell whether $c = -i$ belongs to the Mandelbrot set.

Solution

Let $f(z) = z^2 - i$.

$z_0 = 0$ $\quad |z_0| =$ ___

$z_1 = f(\_\_) =$ _____ $\quad |z_1| =$ ___

$z_2 = f(\_\_\_) =$ _____ $\quad |z_2| =$ _____

$z_3 = f(\_\_\_\_\_) =$ _____ $\quad |z_3| =$ ___

$z_4 = f(\_\_) =$ _____ $\quad |z_4| =$ _____

The absolute values _____, so all the absolute values are _____. Therefore, $c = -i$ _____ to the Mandelbrot set.

Checkpoint **Complete the following exercises.**

6. Find the absolute value of $8 - 6i$.

7. Tell whether $c = 2$ belongs to the Mandelbrot set.

Homework

Extra Examples for Lesson 5.4

Example 1

Solve $2x^2 + 26 = -10$.

Example 2

Plot the complex numbers in the complex plane.

a. $4 - i$

b. 5

c. $1 + 3i$

Example 3

Write the expression as a complex number in standard form.

a. $(-1 + 2i) + (3 + 3i)$

b. $(2 - 3i) - (3 - 7i)$

c. $2i - (3 + i) + (2 - 3i)$

Checkpoint Exercises

1. Solve $-\frac{1}{2}(x + 1)^2 = 5$.

   (For use after Example 1)

2. In which quadrant of the complex plane is $-3 + 5i$?

   (For use after Example 2)

3. Write $(3 - 5i) - (9 + 2i)$ as a complex number in standard form.

   (For use after Example 3)

Extra Examples for Lesson 5.4 *continued*

Example 4

Write the expression as a complex number in standard form.

a. $-i(3 + i)$

b. $(2 + 3i)(-6 - 2i)$

c. $(1 + 2i)(1 \quad 2i)$

Example 5

Write the quotient $\frac{2 - 7i}{1 + i}$ in standard form.

Checkpoint Exercises

Write the expression as a complex number in standard form.

1. $3i(9 - i)$

2. $(-1 + 4i)(3 - 6i)$

(For use after Example 4)

3. Write the quotient $\frac{3 - 11i}{-1 - 2i}$ in standard form.

(For use after Example 5)

Example 6

Find the absolute value of each complex number. Which number is closest to the origin in the complex plane?

a. $-2 + 5i$

b. $-6i$

c. $5 - 3i$

Extra Examples for Lesson 5.4 *continued*

Checkpoint Exercises

1. Find the absolute value of $-3 - 7i$.

(For use after Example 6)

Example 7

Tell whether the complex number c belongs to the Mandelbrot set.

a. $c = -0.5i$

b. $c = -3$

c. $c = -2 + i$

Checkpoint Exercises

1. Tell whether $c = 2 - i$ belongs to the Mandelbrot set.

(For use after Example 7)

Standardized Test Practice

Multiple Choice What does the product $(-9 - i)(6 + 3i)$ equal?

(A) $-54 - 3i^2$ (B) $-51 + 33i$ (C) $-51 - 21i$

(D) $-51 - 33i$ (E) $-51 + 21i$

LESSON 5.4

NAME _____ DATE _____

Practice A

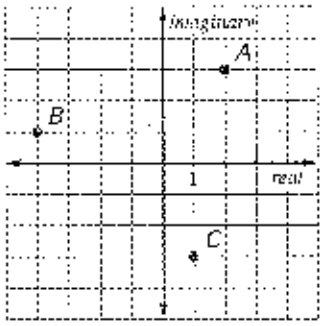
For use with pages 272–280

Solve the equation.

1. $x^2 = -16$
2. $x^2 = -81$
3. $x^2 + 144 = 0$
4. $x^2 + 5 = 4$
5. $x^2 - 1 = 3$
6. $x^2 - 7 = 4x^2 - 5$

Identify the complex numbers plotted in the complex plane.

7.



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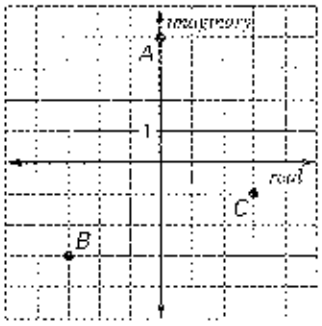

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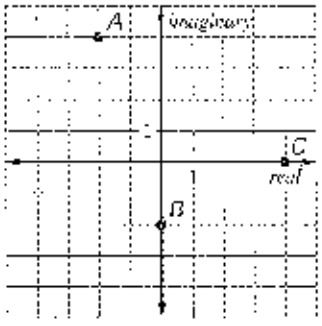


Write the expression as a complex number in standard form.

10. $(5 - 3i) + (2 - 4i)$
11. $(3 - 2i) + (1 + i)$
12. $(7 + 2i) - (3 + 3i)$
13. $(5 + i) - (3 - 8i)$
14. $i - (11 - 5i)$
15. $i - (6 - i) + (4 - 2i)$
16. $i(4 + i)$
17. $3i(-1 + 2i)$
18. $-4i(3 - 7i)$
19. $(1 + 3i)(1 - i)$
20. $(5 - i)(1 - 2i)$
21. $(2 + 3i)(3 + 4i)$
22. $\frac{3}{1 - i}$
23. $\frac{5}{2 - i}$
24. $\frac{3 - i}{2 + i}$

Find the absolute value of the complex number.

25. $1 - i$
26. $2 - i$
27. $6 - i$
28. $1 - 2i$
29. $3 + 4i$
30. $5 - 4i$

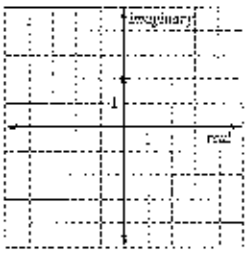
Plot the numbers in a complex plane.

31. $2i$
32. -3
33. $1 + 3i$
34. $4 - 3i$
35. $-1 - 2i$
36. $-2 - 4i$

Practice A

1. $4i, 4i$ 2. $-9i, 9i$ 3. $-12i, 12i$ 4. $-i, i$
5. $2, 2$ 6. $-2i, 2i$
7. $A = 2 + 3i, B = \quad 4 \quad i, C = 1 - 3i$
8. $A - 4i, B - -3 - 3i, C = 3 \quad i$
9. $A - -2 - 4i, B - -2i, C = 4$ 10. $7 + 7i$
11. $4 - i$ 12. $4 - i$ 13. $2 + 9i$ 14. $11 - 4i$
15. $2 \quad 2i$ 16. $-1 + 4i$ 17. $-6 - 3i$
18. $-28 \quad 12i$ 19. $4 + 2i$ 20. $3 - 11i$
21. $-6 - 17i$ 22. $\frac{3}{2} - \frac{3}{2}i$ 23. $2 + i$
24. $1 - i$ 25. $\sqrt{2}$ 26. $\sqrt{5}$ 27. $\sqrt{37}$
28. $\sqrt{5}$ 29. 5 30. $\sqrt{41}$

31.



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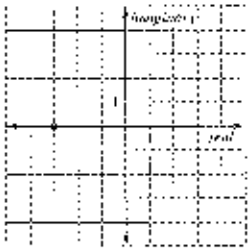

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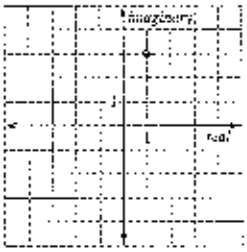

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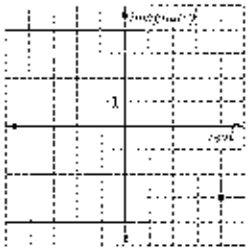

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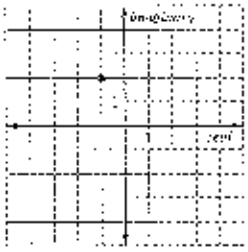

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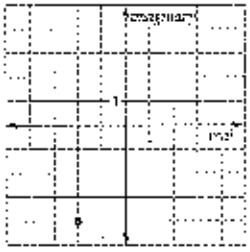


LESSON 5.4

NAME _____ DATE _____

Practice B

For use with pages 272–280

Solve the equation.

1. $x^2 = \cdot 64$
2. $x^2 - 1 = 0$
3. $x^2 + 5 = 14$
4. $x^2 = -12$
5. $x^2 = 48 = 0$
6. $x^2 + 3 = -24$
7. $2x^2 = 9 = 3x^2$
8. $x^2 = 16 = 5x^2$
9. $11x^2 + 1 = 2x^2$
10. $= 2(x \cdot 1)^2 = 72$
11. $4(x - 2)^2 = -1$
12. $3(x + 5)^2 \cdot 147 = 0$

Plot the number in a complex plane.

13. $3i$
14. -2
15. $2 + 4i$
16. $3 - 4i$
17. $-2 = i$
18. $-4 - 3i$

Write the expression as a complex number in standard form.

19. $(3 + 2i) + (\ 5 \cdot 8i)$
20. $(-2 - 4i) + (3 - 6i)$
21. $\left(\frac{1}{3}\right. \left.\frac{1}{2}i\right) \left(\frac{2}{3}\right. \left.2i\right)$
22. $(4 - 2i) - (-1 - 5i)$
23. $(5 \quad 8i) \quad (2 + 9i)$
24. $\left(\frac{1}{2} - \frac{2}{3}i\right) - \left(\frac{1}{3} - \frac{1}{4}i\right)$
25. $(5 \quad 4i)(3 = 6i)$
26. $(2 - 5i)^2$
27. $(4 + 8i)(4 = 8i)$
28. $\dfrac{6}{2 + 3i}$
29. $\dfrac{3 + i}{2 \quad i}$
30. $\dfrac{2 = i}{\sqrt{3} \cdot i}$
31. $2(2 + i) - (1 - i)^2$
32. $\dfrac{1}{3} \quad \dfrac{1}{5i} = (6 \quad 2i)$
33. $(1 - 5i)(2 + i) = i(3 \quad 4i)$

Find the absolute value of the complex number.

34. $4 + 3i$
35. $\sqrt{2} - i$
36. $\sqrt{3} + \sqrt{2}i$

Write the complex number in standard form.

37. i
38. i^2
39. i^3
40. i^4
41. i^5
42. i^6
43. i^7
44. i^8

45. ***Pattern Recognition*** Using the information from Exercises 37–44, write a general statement about the standard form of i^n where n is a positive integer. Use this statement to write i^{231} in standard form.

Practice B

1. $-8i, 8i$ **2.** $-i, i$ **3.** $-3, 3$

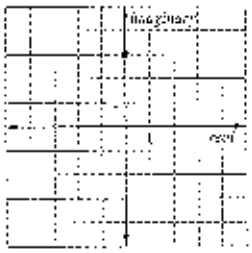
4. $-2i\sqrt{3}, 2i\sqrt{3}$ **5.** $4i\sqrt{3}, 4i\sqrt{3}$

6. $-3i\sqrt{3}, 3i\sqrt{3}$ **7.** $-3i, 3i$ **8.** $-2i, 2i$

9. $-\frac{1}{3}i, \frac{1}{3}i$ **10.** $1 \quad 6i, -1 + 6i$

11. $2 \quad \frac{1}{2}i, 2 + \frac{1}{2}i$ **12.** $-5 - 7i, -5 \quad 7i$

13.



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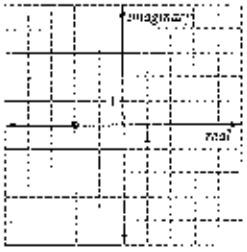

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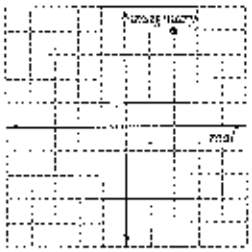

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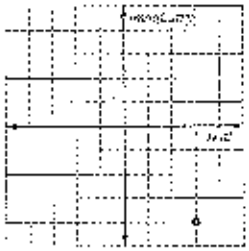

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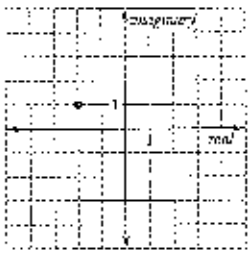
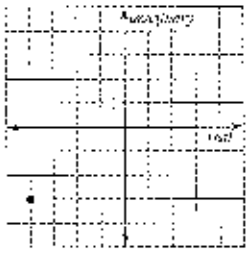


18.



19. $-2 + 10i$ **20.** $1 \quad 10i$ **21.** $1 - \frac{1}{2}i$

22. $5 - 3i$ **23.** $3 - 17i$ **24.** $\frac{1}{6} \quad \frac{5}{12}i$

25. $39 \quad 18i$ **26.** $-21 - 20i$ **27.** 80

28. $\frac{12}{13} - \frac{18}{13}i$ **29.** $1 - i$

30. $\frac{2\sqrt{3} - 1}{4} + \frac{2 - \sqrt{3}}{4}i$ **31.** 4

32. $-\frac{201}{34} - \frac{73}{34}i$ **33.** $3 \quad 12i$ **34.** 5

35. $\sqrt{3}$ **36.** $\sqrt{5}$ **37.** i **38.** -1 **39.** $-i$

40. 1 **41.** i **42.** -1 **43.** $-i$ **44.** 1

45. If the exponent of i is a factor of 4, the expression can be reduced to 1. Therefore, to simplify i raised to any natural number, factor out the multiples of 4 in the exponent and simplify the remaining expression; $i^{231} = i^{228} \cdot i^3 = (1)i^3 = -i$.

LESSON 5.6

NAME _____ DATE _____

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WARM-UP EXERCISES

For use before Lesson 5.6, pages 291–298

Evaluate the expression $b^2 - 4ac$ for the given values of a, b, and c.

1. $a = 1, b = 3, c = -1$
2. $a = 2, b = -2, c = 0$
3. $a = -1, b = 0, c = 5$
4. $a = -2, b = 2, c = -3$

DAILY HOMEWORK QUIZ

For use after Lesson 5.5, pages 281–290

1. Find the value of c that makes $x^2 - 8x + c$ a perfect square trinomial. Then write the expression as the square of a binomial.
2. Solve $x^2 - 12x + 4 = 0$ by completing the square.
3. Solve $2x^2 + 8x - 1 = 0$.
4. Write $y = x^2 - 4x + 4$ in vertex form. What is the vertex of the function's graph?

5.6 The Quadratic Formula and the Discriminant

Goals • Solve equations using the quadratic formula.
• Use the quadratic formula in real-life situations.

Your Notes

VOCABULARY

Discriminant of a quadratic equation

THE QUADRATIC FORMULA

Let a, b, and c be real numbers such that $a \neq 0$. The solutions of the quadratic equation $ax^2 + bx + c = 0$ are:

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

Example 1 *Quadratic Equation with Two Real Solutions*

Solve $3x^2 - 3x - 5 = 0$.

$3x^2 \quad 3x \quad 5 = 0$ — **Original equation**

$x = \frac{\quad + \sqrt{\quad\quad - 4\quad\quad}}{2\quad}$ — **Quadratic formula**

$x = \frac{\quad \pm \sqrt{\quad\quad - 4\quad\quad}}{2\quad}$ — **$a =$ __, $b =$ ____, $c =$ ____**

$x =$ _____ — **Simplify.**

The solutions are

$x =$ _____ and $x =$ _____ .

Your Notes

Example 2 *Quadratic Equation with One Real Solution*

Solve $x^2 + 4x + 11 = 7$.

$x^2 + 4x + 11 = 7$ — **Write original equation.**

$x^2 + 4x + 4 = 0$ — $a =$ ___, $b =$ ___, $c =$ ___

$x =$ _____ — **Quadratic formula**

$x =$ _____ — **Simplify.**

$x =$ ____ — **Simplify.**

The solution is ____.

Check Substitute ____ for x in the original equation.

(____)$^2 - 4($____$) - 11 \stackrel{?}{=} 7$

___ $= 7$

Example 3 *Quadratic Equation with Two Imaginary Solutions*

Solve $x^2 - 4x = -8$.

$x^2 - 4x = -8$ — **Write original equation.**

$x^2 - 4x + 8 = 0$ — $a =$ ___, $b =$ ____, $c =$ ___

$x =$ _____ — **Quadratic formula**

$x =$ _____ — **Simplify.**

$x =$ _____ — **Write using the imaginary unit *i*.**

$x =$ _____ — **Simplify.**

The solutions are _____.

Check Substitute an imaginary solution into the original equation.

(_____)$^2 - 4($_____$) \stackrel{?}{=} -8$

_____ $\stackrel{?}{=} 8$

___ $= -8$

Your Notes

Checkpoint Solve the quadratic equation.

1. $x^2 + 3x$ 10

2. x^2 7 = $8x$ 9

3. x^2 $6x$ − 3 = −7

NUMBER AND TYPE OF SOLUTIONS OF A QUADRATIC EQUATION

Consider the quadratic equation $ax^2 + bx + c = 0$.

- If b^2 $4ac > 0$, then the equation has _____.
- If b^2 $4ac = 0$, then the equation has _____.
- If $b^2 - 4ac < 0$, then the equation has _____.

Example 1 *Using the Discriminant*

Find the discriminant of the quadratic equation and give the number and type of solutions of the equation.

a. x^2 2x 3 = 0

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

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

Solution

	Discriminant	Solution(s)
	$b^2 - 4ac$	$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$
a.	_____	_____
b.	_____	_____
c.	_____	_____

Your Notes

Example 5 *Solving a Vertical Motion Problem*

A diver jumps from a height of 40 feet above the water with an initial velocity of 4 feet per second. For how long is the diver in the air?

Solution

Because the diver jumps, use the model $h = -16t^2 + v_0t + h_0$ with $v_0 =$ ___ and $h_0 =$ ___. To determine how long the diver is in the air, find the value of t for which $h =$ ___.

$h = -16t^2 + v_0t + h_0$ **Write original equation.**

_____ $h =$ ___, $v_0 =$ ___, $h_0 =$ ___

Quadratic formula: $a =$ _____, $b =$ ___, $c =$ ___

_____

_____ **Use a calculator.**

Reject the solution _____ because the time in the air cannot be _____. The diver is in the air for about _____ seconds.

Checkpoint **Complete the following exercises.**

4. Find the discriminant of $2x^2 + 4x = 2$ and give the number and type of solutions. Then find the solutions.

5. A ball is thrown from a height of 6 feet with an initial vertical velocity of 32 ft/sec. If the ball is caught at a height of 2 feet, for how long is the ball in the air?

Homework

Extra Examples for Lesson 5.6

Example 1

Solve $3x^2 + 8x = 35$.

Example 2

Solve $12x - 5 = 2x^2 + 13$.

Example 3

Solve $-2x^2 = -2x + 3$.

Checkpoint Exercises

1. Solve $2x^2 + x = x^2 - 2x + 4$.

(For use after Example 1)

2. Solve $x^2 + 64 = 16x$.

(For use after Example 2)

3. Solve $x^2 = 2x - 5$.

(For use after Example 3)

Example 4

Find the discriminant of the quadratic equation and give the number and type of solutions of the equation.

a. $9x^2 + 6x + 1 = 0$

b. $9x^2 + 6x - 4 = 0$

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

Extra Examples *for Lesson 5.6 continued*

Checkpoint Exercises

1. Find the discriminant of $5x^2 - 3x + 1 = 0$ and give the number and type of solutions of the equation.

(For use after Example 4)

Example 5

The water in a large fountain leaves the spout with a vertical velocity of 30 ft per second. After going up in the air it lands in a basin 6 ft below the spout. If the spout is 10 ft above the ground, how long does it take a single drop of water to travel from the spout to the basin? Use the model $h = -16t^2 + v_0t + h_0$.

Checkpoint Exercises

1. A man tosses a penny up into the air above a 100-feet deep well with a velocity of 5 ft/sec. The penny leaves the man's hand at a height of 4 ft. How long will it take the penny to reach the bottom of the well? Use the model $h = -16t^2 + v_0t + h_0$.

(For use after Example 5)

Standardized Test Practice

Multiple Choice How many real and imaginary solutions does the equation $7x^2 - 3x - 8 = 4x - 4$ have?

(A) 2 real solutions, no imaginary solutions
(B) 1 real solution, no imaginary solutions
(C) 1 real solution, 1 imaginary solution
(D) no real solutions, 2 imaginary solutions
(E) no real solutions, 1 imaginary solution

LESSON 5.6

NAME _____ DATE ____

Practice A

For use with pages 291–298

Write the equation in standard form. Identify *a*, *b*, and *c*.

1. $3x^2 - 4x + 3 = 0$
2. $x^2 = 3x - 2$
3. $3x - 4 = 3x^2$
4. $3x^2 + 5 = x^2 \quad 4x$
5. $2 \cdot x = 8x \quad x^2$
6. $5x^2 + 2 - x^2 - 1$

Find the discriminant of the quadratic equation.

7. $x^2 \cdot x + 3 = 0$
8. $-x^2 + 2x - 1 = 0$
9. $x^2 \quad 2x \quad 6 = 0$
10. $x^2 \quad 5x + 1 = 0$
11. $x^2 \quad 2x \quad 7 = 0$
12. $x^2 = 6x - 9 = 0$

Find the discriminant and use it to determine the number of real solutions of the equation.

13. $x^2 - 2x - 3 = 0$
14. $x^2 + 5x - 2 = 0$
15. $-x^2 + 3x - 5 = 0$
16. $x^2 \quad 5x \quad 6 = 0$
17. $2x^2 \quad x + 4 = 0$
18. $2x^2 = x = 5 - 0$
19. $x^2 + 18x + 81 - 0$
20. $x^2 - 4x + 4 - 0$
21. $-x^2 - 3x - 5 - 0$
22. $x^2 + 3 - 0$
23. $x^2 - 21 - 0$
24. $-5x^2 = 0$

Use the quadratic formula to solve the equation.

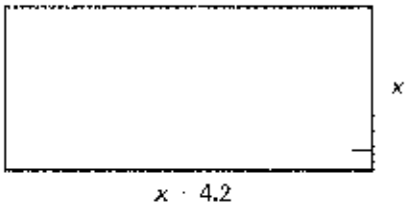
25. $x^2 - x - 1 = 0$
26. $x^2 + 3x - 1 - 0$
27. $x^2 - 6x + 2 = 0$
28. $x^2 \quad 7x = 0$
29. $x^2 + 3x = 0$
30. $x^2 + 6 = 0$
31. $x^2 - 36 - 0$
32. $x^2 + 3x + 5 - 0$
33. $x^2 + x - 14 - 0$

Write the equation in standard form. Use the quadratic formula to solve the equation.

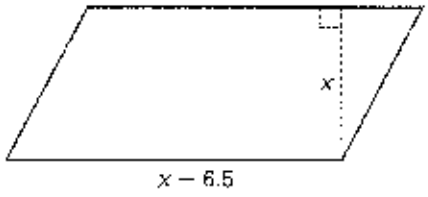
34. $x^2 = 5 = 2x = 1$
35. $3x^2 + 2x = 2x^2 - 1$
36. $x^2 + 2x = 15$
37. $x^2 + 11 = 6x$
38. $x^2 \quad 1 = x + \frac{3}{2}$
39. $x^2 - 3x - 2x^2$

Find the value of *x*. Round your answer to the nearest hundredth.

40. Area of rectangle = 24.5 square inches



41. Area of parallelogram = 63.9 square inches



Practice A

1. $3x^2 - 4x - 3 \quad 0; a - 3, b = \quad 4, c = 3$
2. $x^2 \quad 3x \div 2 = 0; a \quad 1. b - \cdots 3, c = 2$
3. $3x^2 \cdot 3x \quad 4 = 0: a = 3, b - 3, c \cdots -4$
4. $2e^2 - 4x + 5 = 0; a = 2, b = 4, c \cdot \ 5$
5. $x^2 - 9x + 2 \cdots 0; a = 1, b = \cdot 9, c = 2$
6. $6x^2 \cdots 3 = 0; a - 6, b \quad 0, c = \cdot \ 3$
7. $\cdot \ 11$ **8.** 0 **9.** 28 **10.** 21 **11.** -24
12. 0 **13.** 16; 2 **14.** 17; 2 **15.** -11; 0
16. 1; 2 **17.** -31; 0 **18.** 41; 2 **19.** 0; 1
20. 0; 1 **21.** -11; 0 **22.** $\cdot$ 12; 0 **23.** 84; 2
24. 0; 1 **25.** $\dfrac{1 - \sqrt{5}}{2}, \dfrac{1 + \sqrt{5}}{2}$
26. $\dfrac{3 \quad \sqrt{13}}{2}, \dfrac{-3 - \sqrt{13}}{2}$
27. $3 \quad \sqrt{7}, 3 + \sqrt{7}$ **28.** 0, 7 **29.** $\cdot$ 3, 0
30. $-i\sqrt{6}, i\sqrt{6}$ **31.** $\cdot$ 6, 6
32. $\dfrac{-3 - i\sqrt{11}}{2}, \dfrac{3 + i\sqrt{11}}{2}$
33. $\dfrac{-1 \quad i\sqrt{55}}{2}, \dfrac{-1 + i\sqrt{55}}{2}$
34. $x^2 \quad 2x \quad 4 = 0; 1 - \sqrt{5}, 1 + \sqrt{5}$
35. $x^2 \div 2x + 1 = 0; \quad 1$
36. $x^2 - 2x - 15 \cdots 0; 3, \quad 5$
37. $x^2 - 6x + 11 \cdots 0; 3 \quad i\sqrt{2}, 3 \ 1 \ i\sqrt{2}$
38. $x^2 - x - \dfrac{1}{4} \cdot 0; \dfrac{1}{2}$
39. $x^2 + 3x \cdot 0; -3, 0$
40. 3.28 in.
41. 5.38 in.

LESSON 5.6

NAME _____ DATE _____

Practice B

For use with pages 291–298

Find the discriminant of the quadratic equation.

1. $x^2 - 3x + 5 = 0$
2. $3x^2 - x - 2 = 0$
3. $4x^2 - 12x + 9 = 0$
4. $5x^2 - 2x + 4 = 0$
5. $-2x^2 + 3x + 5 = 0$
6. $-3x^2 - 2x + 8 = 0$

Find the discriminant and use it to determine the number of real solutions of the equation.

7. $x^2 + 3x + 2 = 0$
8. $-4x^2 + 20x - 25 = 0$
9. $3x^2 - 2x + 1 = 0$
10. $-3x^2 - x - 4 = 0$
11. $x^2 - 3x + 4 = 2x^2 - 3$
12. $4x^2 + 3x = 0$

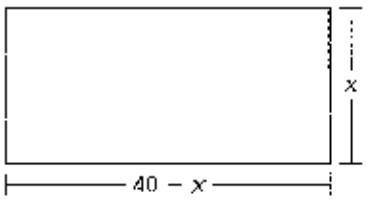
Use the quadratic formula to solve the equation.

13. $x^2 - x - 20 = 0$
14. $-2x^2 + 3x - 2 = 0$
15. $2x^2 + x - 4 = 0$
16. $4x^2 - 9x - 2 = 0$
17. $10x^2 - 2x - 5 = 0$
18. $8x^2 + 7x + 2 = 0$

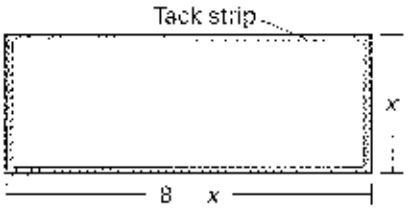
Write the equation in standard from. Use the quadratic formula to solve the equation.

19. $3x^2 - 4x = 2x^2 + 2$
20. $x^2 - 5 = 3x - 1$
21. $4 - 2x^2 = x - 3$
22. $x^2 - 3x + 2 = 4x^2 - 3$
23. $9x - x^2 = x^2 - 4x - 1$
24. $6x^2 + 5 = 2x^2 - 3x + 7$
25. $2(x - 3)^2 = 3x + 1$
26. $2.4x^2 - 3.5x = 2.2$
27. $6.8x - 2 = 4.2x^2$

28. ***Fencing Your Garden*** It takes 80 feet of fencing to enclose your garden. According to your calculations, you will need 350 square feet to plant everything you want. Is your garden big enough? Explain your answer.



29. ***New Carpeting*** You have new carpeting installed in a rectangular room. You are charged for 20 square yards of carpeting and 16 yards of tack strip. Do you think these figures are correct? Explain your answer.



Throwing an Object on the Moon An astronaut standing on the moon throws a rock upwards with an initial velocity of 27 feet per second. The astronaut's hand is 6 feet above the surface of the moon. The height of the rock is given by $h = -2.7t^2 + 27t + 6$.

30. How many seconds does it take for the rock to fall to the ground?
31. Suppose the astronaut had been standing on Earth. Write a vertical motion model for the height of the rock after it is thrown.
32. Use the model in Exercise 31 to determine how many seconds it takes for the rock to fall to the ground on Earth.

Practice B

1. 11 **2.** 25 **3.** 0 **4.** 76 **5.** 49

6. 100 **7.** 1; 2 **8.** 0; 1 **9.** 8; 0

10. −47; 0 **11.** 37; 2 **12.** 9; 2 **13.** −4, 5

14. $-\frac{1}{2}, 2$ **15.** $\frac{-1-\sqrt{33}}{4}, \frac{-1+\sqrt{33}}{4}$

16. $\frac{1}{4}, 2$ **17.** $\frac{-1-\sqrt{51}}{10}, \frac{-1+\sqrt{51}}{10}$

18. $\frac{-7-\sqrt{113}}{-16}, \frac{-7+\sqrt{113}}{-16}$

19. $x^2 - 4x - 2 = 0$; $2-\sqrt{6}, 2+\sqrt{6}$

20. $x^2 \quad 3x \quad 4 = 0$; $1, 4$

21. $2x^2 + x - 7 = 0$; $\frac{1-\sqrt{57}}{4}, \frac{1+\sqrt{57}}{4}$

22. $3x^2 + 3x - 5 = 0$; $\frac{-3-\sqrt{69}}{6}, \frac{-3-\sqrt{69}}{6}$

23. $2x^2 - 5x - 1 = 0$; $\frac{5-\sqrt{33}}{4}, \frac{5+\sqrt{33}}{4}$

24. $4x^2 + 3x - 2 = 0$; $\frac{-3-\sqrt{41}}{8}, \frac{-3+\sqrt{41}}{8}$

25. $2x^2 - 15x + 17 = 0$; $\frac{15-\sqrt{89}}{4}, \frac{15+\sqrt{89}}{4}$

26. $2.4x^2 - 3.5x - 2.2 = 0$; 1.933, −0.474

27. $4.2x^2 - 6.8x - 2 = 0$; 0.386, 1.233

28. Yes; Your garden should be approximately 12.93 ft by 27.07 ft. **29.** No; The area of the room can be expressed as $x(8 - x)$. The equation $x(8 \quad x) = 20$ has no real solution.

30. 10.22 seconds **31.** $h = -16t^2 - 27t + 6$

32. 1.89 seconds

LESSON 5.7

NAME _____ DATE _____

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WARM-UP EXERCISES

For use before Lesson 5.7, pages 298–305

Solve and graph.

1. $2x - 7 \leq 11$

2. $3 - 6(x - 1) > 9$

3. Graph the system:

   $y < 3x + 1$

   $y \geq -x$

Lesson 5.7

DAILY HOMEWORK QUIZ

For use after Lesson 5.6, pages 291–298

1. Solve $3x^2 + x - 8 = 0$.

2. Solve $8x^2 + 5x = -3x - 2$.

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

4. Find the discriminant of $x^2 - 4x + 7 = 0$ and give the number and type of solutions of the equation.

5.7 Graphing and Solving Quadratic Inequalities

Goals
- Graph quadratic inequalities in two variables.
- Solve quadratic inequalities in one variable.

Your Notes

VOCABULARY

Quadratic inequality in two variables

Quadratic inequality in one variable

GRAPHING A QUADRATIC INEQUALITY IN TWO VARIABLES

To graph one of the four types of quadratic inequalities, follow these steps:

Step 1 Draw the parabola with equation $y = ax^2 + bx + c$. Make the parabola _____ for inequalities with $<$ or $>$ and _____ for inequalities with $\leq$ or $\geq$.

Step 2 Choose a point (x, y) _____ the parabola and check whether the point is a solution of the inequality.

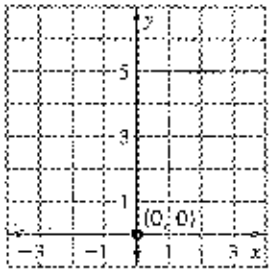
Step 3 If the point in Step 2 is a solution, shade the region _____ the parabola. If it is not a solution, shade the region _____ the parabola.

Your Notes

Example 1 *Graphing a Quadratic Inequality*

Graph $y \leq -x^2 + x + 5$.

1. Graph $y = -x^2 + x + 5$. The symbol is $\leq$, so make the parabola _____.



2. Test a point inside the parabola, such as (0, 0). _____

   _____

   So, (0, 0) _____ of the inequality.

3. Shade the region _____ the parabola.

Example 2 *Graph a System of Quadratic Inequalities*

Graph the system of quadratic inequalities.

$y \leq x^2 \quad 3x \cdots 1$ **Inequality 1**

$y > x^2 \cdots 3$ **Inequality 2**

Solution

Graph the inequality $y \leq -x^2 - 3x - 1$.

The graph is the region _____ and including the parabola $y =$ _____.

Graph the inequality $y > x^2 - 3$. The graph is the region _____ (but not including) the parabola $y =$ _____.

Identify the region where the two graphs overlap. This region is the graph of the system.

Checkpoint **Complete the following exercise.**

1. Graph the system:

$y < \cdots 2x^2 \ : \ 2x \ : \ 1$

$y > x^2 \quad x \quad 2$

Your Notes

Example 3 *Solving a Quadratic Inequality by Graphing*

Solve $-3x^2 + 4x + 2 \leq 0$.

Solution

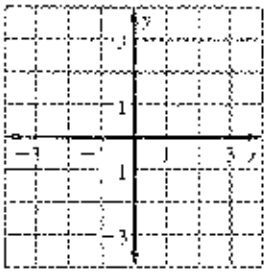
The solution consists of the x-values for which the graph of $y = -3x^2 + 4x + 2$ lies _____ the x-axis. Find the graph's x-intercepts by letting $y = 0$ and using _____ to solve for x.

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

$x =$ _____

$x =$ _____ _____

$x \approx$ _____ or $x \approx$ _____

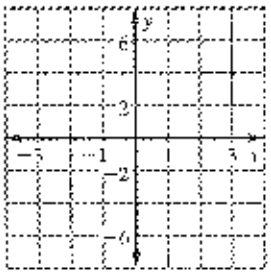


Sketch a parabola that opens _____ with _____ and _____ as x-intercepts. The graph lies _____ the x-axis to the left of (and including) $x =$ _____ and to the right of (and including) $x =$ _____.

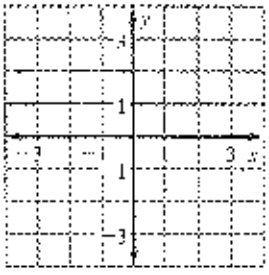
The solution is approximately _____.

Checkpoint **Solve the quadratic inequality.**

2. $2x^2 - 3x - 5 \leq 0$



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



Your Notes

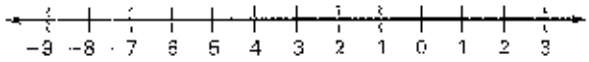
Example 4 *Solving a Quadratic Inequality Algebraically*

Solve $x^2 + 5x \geq 6$.

First write and solve the equation obtained by replacing the inequality symbol with _____.

$x^2 + 5x \geq 6$	**Write original inequality.**
_____	**Write corresponding equation.**
_____	**Write in standard form.**
_____	**Factor.**
_____	**Zero product property**

The numbers _____ are called the critical x-values of the inequality $x^2 + 5x \geq 6$. Plot _____ on a number line, using _____ dots. The critical x-values partition the number line into three intervals. Test an x-value in each interval to see if it satisfies the inequality.



Test x = ____: Test x ____:

_____ _____

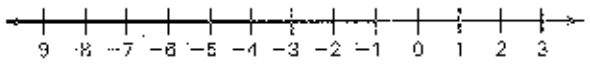
Test x = ____:

_____

The solution is _____.

Checkpoint **Solve the quadratic inequality algebraically.**

4. $2x^2 - x < 3$



Homework

Extra Examples for Lesson 5.7

Example 1

Graph $y \leq 2x^2 - 5x - 3$.

Example 2

You are making a photo album. Each album page needs to be able to hold 6 square pictures. If the length of one side of each picture is x, then $A \geq 6x^2$ is the area of one album page.

a. Graph this function.

b. If you have an album page that has an area of 70 square inches, will it be able to accommodate 6 pictures with 3-inch sides?

Example 3

Graph the system of inequalities.

$y \leq -x^2 + 9$

$y \geq x^2 + 5x - 6$

Example 4

Solve $x^2 - 5x + 6 \geq 0$.

Example 5

Solve $x^2 - 11x + 5 \leq 0$.

Extra Examples for Lesson 5.7 *continued*

Checkpoint Exercises

1. Is the point $(-1, 4)$ a solution to the system
   $y > x^2 + 4x$
   $y \leq 3x^2$?

   (For use after Examples 1–3)

2. Solve $-x^2 - 9x + 36 > 0$.

   (For use after Example 4)

3. Solve $-3x^2 + x + 7 < 0$.

   (For use after Example 5)

Example 6

Solve $2x^2 - x > 3$.

Example 7

Suppose a study was conducted to test the average reading comprehension of a person x years of age. The study found that the number of points $P(x)$ scored on a reading comprehension test could be modeled by $P(x) = -0.017x^2 + 1.9x + 31$, $5 \leq x \leq 95$. At what ages does the average person score greater than 60 points on the test?

Checkpoint Exercises

1. Solve $3x^2 - 11x \leq 4$ algebraically. Check your answer using a graph.

   (For use after Examples 6 and 7)

Extra Examples for Lesson 5.7 *continued*

STANDARDIZED TEST PRACTICE

Multiple Choice What is the solution of $x^2 - 3x - 70 < 0$?

(A) $x < -7$ or $x > 10$ (B) $-7 < x < 10$

(C) $x > -7$ or $x < 10$ (D) $x = -7$ or $x = 10$

(E) $-10 < x < 7$

LESSON 5.7

NAME _____ DATE _____

Practice A

For use with pages 299–305

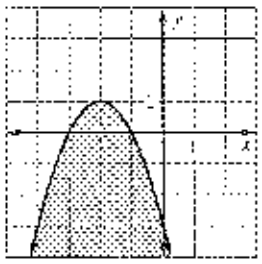
Determine whether the ordered pair is a solution of the inequality.

1. $y < x^2 - 2x + 4$, $(1, 2)$
2. $y > 2x^2 + x - 5$, $(-2, 1)$
3. $y \leq -2x^2 - 5x + 6$, $(4, -4)$
4. $y \geq -3x^2 - 4x + 1$, $(-3, -6)$
5. $y < 2x^2 + 3x - 4$, $(1, 1)$
6. $y \geq x^2 - 3x + 5$, $(2, 3)$

Match the inequality with its graph.

7. $y \geq -x^2 + 4x - 3$
8. $y < -x^2 - 4x - 3$
9. $y \leq x^2 + 2x - 3$
10. $y < x^2 - 4x + 3$
11. $y > -x^2 - 4x - 3$
12. $y > x^2 - 2x - 3$

A.



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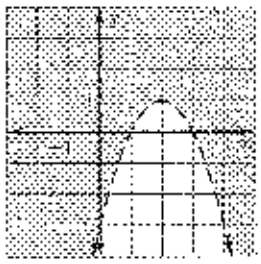

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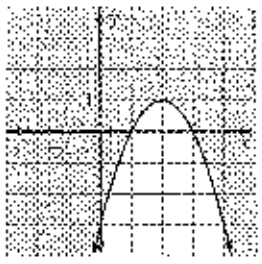

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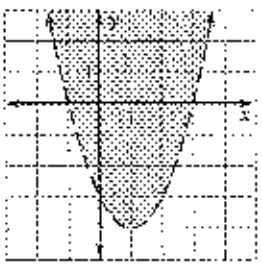

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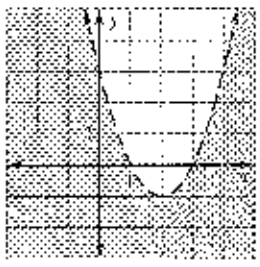

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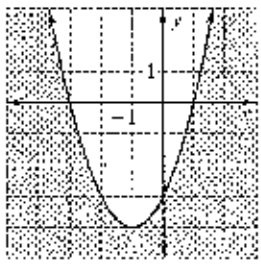


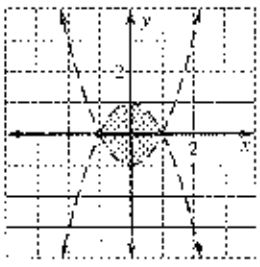
Graph the inequality.

13. $y < 2x^2 + 1$
14. $y \geq x^2 + 2x$
15. $y < x^2 - 3$
16. $y > 3x^2 - 2$
17. $y < x^2 + 5x$
18. $y > x^2 - 2x$
19. $y \geq x^2 + 5x + 6$
20. $y \leq x^2 - 2x + 1$
21. $y \leq x^2 - 6x + 8$

Match the system of inequalities with its graph.

22. $y < x^2 + 1$
    $y > -x^2 + 1$
23. $y < x^2 - 1$
    $y > -x^2 + 1$
24. $y > x^2 - 1$
    $y < -x^2 + 1$

A.



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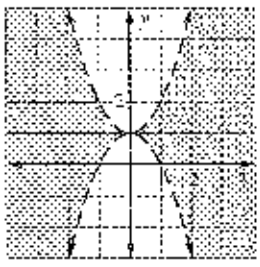

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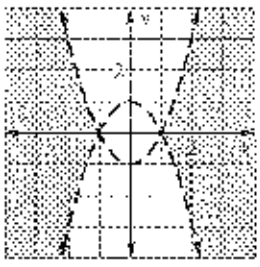

Practice A

1. (1, 2) is a solution **2.** (−2, 1) is not a solution **3.** (4, −4) is not a solution **4.** (−3, −6) is a solution **5.** (1, 1) is not a solution

6. (2, 3) is a solution **7.** C **8.** A **9.** F

10. E **11.** B **12.** D

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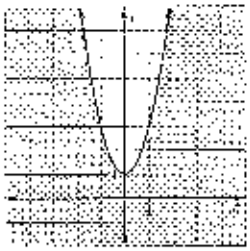

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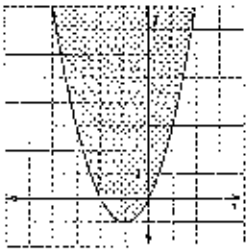

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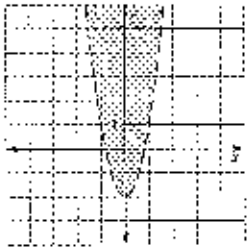
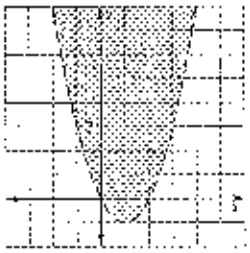


17.

18.



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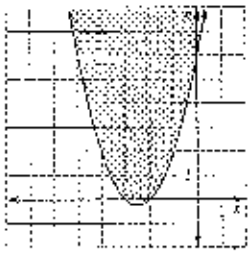

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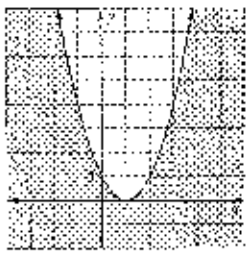

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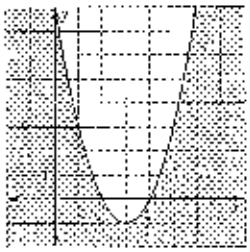


22. B **23.** C **24.** A

LESSON 5.7

NAME _____ DATE _____

Practice B

For use with pages 299–305

Determine whether the ordered pair is a solution of the inequality.

1. $y < 2x^2 - 2x - 5$, $(1, -1)$
2. $y > 5x^2 + 7x - 4$, $(-1, 6)$
3. $y \leq \frac{1}{2}x^2 + 3x - 1$, $(2, 7)$
4. $y > 3 - \frac{2}{3}x^2$, $(3, -3)$

Graph the inequality.

5. $y < x^2 + 10x + 9$
6. $y > x^2 - 4x - 21$
7. $y > 3x^2 - 6x$
8. $y < x^2 - 2x + 1$
9. $y \leq -x^2 + 6x - 7$
10. $y > 3x^2 + 6x + 2$
11. $y > -x^2 - 6x - 9$
12. $y \geq 2x^2 + 4x - 2$
13. $y < -2x^2 - 8x - 5$
14. $y > 3x^2 - 5x - 2$
15. $y \leq 4x^2 - 16$
16. $y < 12 - 3x^2$

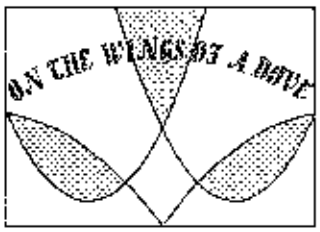
Graph the system of inequalities.

17. $y \geq x^2$
    $y \leq -x^2 + 3$
18. $y \geq 2x^2 - 4$
    $y \leq -x^2 - 1$
19. $y \leq -x^2 + 4$
    $y > x^2 - 2x + 1$
20. $y < -x^2 + 4$
    $y \geq x^2 + 2x + 1$
21. $y > x^2 - 4x + 1$
    $y < -x^2 - 2x + 1$
22. $y \geq 2x^2 - 12x + 16$
    $y < -x^2 + 2x + 3$

Solve the inequality algebraically.

23. $x^2 - 2x - 15 < 0$
24. $x^2 - 6x - 16 > 0$
25. $x^2 + 5x - 4 \leq 0$
26. $x^2 + 7x - 12 \geq 0$
27. $x^2 - 11x + 28 < 0$
28. $x^2 - 9x + 18 > 0$
29. $2x^2 - 5x - 3 \leq 0$
30. $3x^2 \geq 10x + 8$
31. $x^2 - 4x \leq 21$
32. $2x^2 \geq -8x - 4$
33. $3x^2 + 4 < 7x$
34. $2x^2 > 5x$

Gift Shop Logo You are using a computer to create a logo for a gift shop called *On the Wings of a Dove*. The logo you have designed is shown at the right.



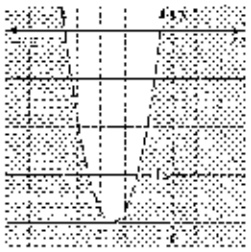
35. Sketch the intersections of the graphs of the inequalities.
    a. $y \geq 0.33x^2 - 2x + 4$
       $y < -0.09x^2 + 1.3x$
    b. $y \geq 0.33x^2 + 2x + 4$
       $y \leq -0.09x^2 - 1.3x$
36. Which region in Exercise 35 represents the dove's left wing?
37. Which region in Exercise 35 represents the dove's right wing?
38. Which two inequalities (when intersected) make up the dove's tail?

Practice B

1. $(1, \ -1)$ is not a solution **2.** $(\ -1, \ 6)$ is not a solution **3.** $(2, 7)$ is a solution

4. $(3, -3)$ is a solution

5.



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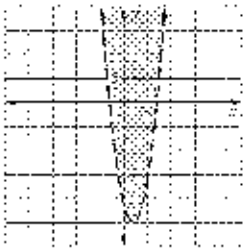

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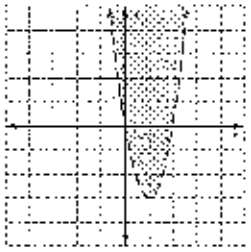

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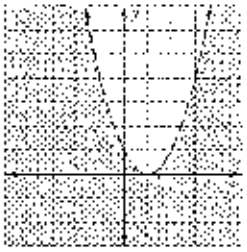

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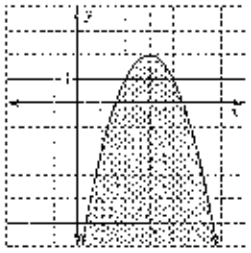

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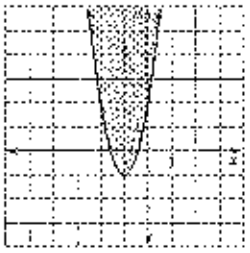

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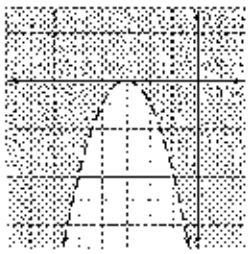

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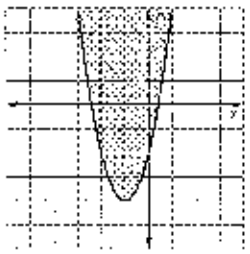

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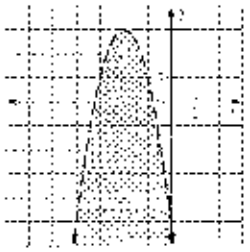

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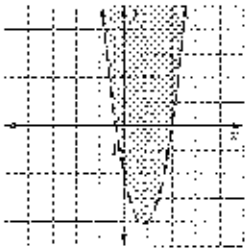

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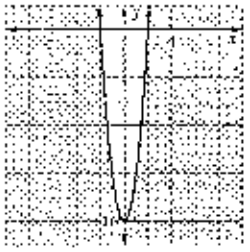

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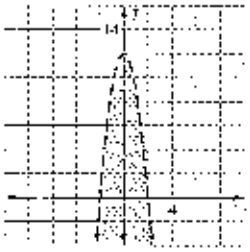

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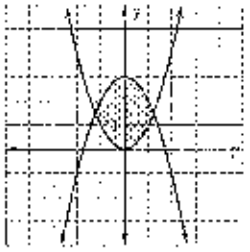

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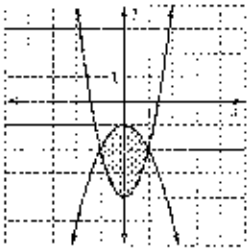

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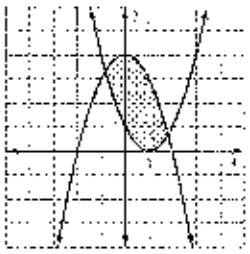

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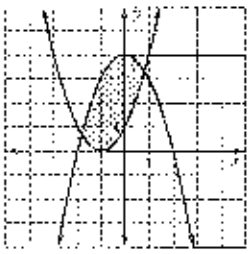

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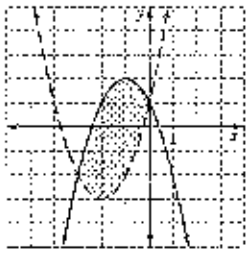

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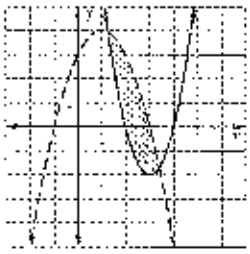


23. $3 < x < 5$ **24.** $x < -2$ or $x > 8$

25. $-4 \le x \le 1$ **26.** $x \le -4$ or $x \ge 3$

27. $4 < x < 7$ **28.** $x \le 3$ or $x \ge 6$

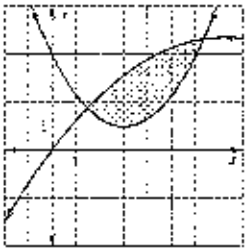
29. $-\frac{1}{2} \le x \le 3$ **30.** $x \le -\frac{2}{3}$ or $x \ge 4$

31. $-3 \le x \le 7$

32. $x \le -2 - \sqrt{2}$ or $x \ge -2 + \sqrt{2}$

33. $1 \le x < \frac{4}{3}$ **34.** $x < 0$ or $x > \frac{5}{2}$

35. a.



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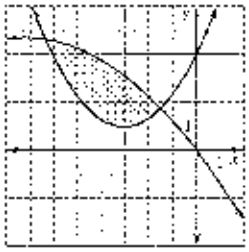


36. b **37.** a **38.** $y \ge 0.33x^2 - 2x - 4$, $y \ge 0.33x^2 + 2x + 4$

CHAPTER 5

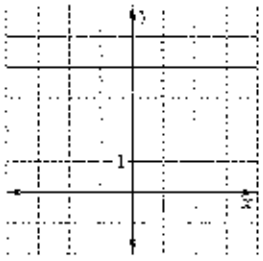
NAME _____ DATE _____

Chapter Test A

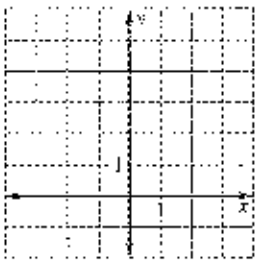
For use after Chapter 5

Graph the quadratic function.

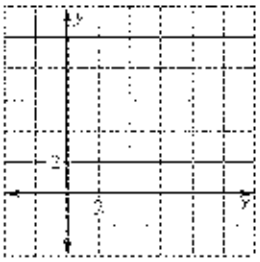
1. $y = x^2$



2. $y = x^2 - 1$



3. $y = x^2 - 10x + 25$



Solve the quadratic equation by factoring.

4. $x^2 - 4x = 0$ 5. $x^2 - 49 = 0$ 6. $3x^2 - 21x + 36 = 0$

Solve the quadratic equation using any appropriate method.

7. $x^2 = 144$ 8. $x^2 \quad 8 = 0$ 9. $4(x \quad 1)^2 = 64$

Simplify the expression.

10. $3 \div \sqrt{-4}$ 11. $(7 + 8i) - (3 + 6i)$ 12. $5 \div (7i)$

Solve the equation.

13. $x^2 = \quad 9$ 14. $2y^2 \; 6 = y^2$

Find the absolute value of the complex number.

15. $2 \; i$ 16. $3i \; 2$

Solve the equation by completing the square.

17. $x^2 - 4x - 3 = 0$ 18. $x^2 + 4x - 3 = 0$

Use the quadratic formula to solve the equation.

19. $x^2 + 10x + 9 = 0$ 20. $x^2 + 3x - 5 = 0$

Answers

1. Use grid at left.
2. Use grid at left.
3. Use grid at left.
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
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11. _____
12. _____
13. _____
14. _____
15. _____
16. _____
17. _____
18. _____
19. _____
20. _____

NAME _____ DATE _____

Chapter Test A

For use after Chapter 5

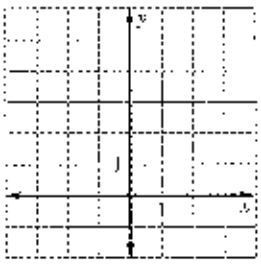
Find the discriminant of the equation and give the number and type of solutions of the equation.

21. $x^2 + 6x - 16 = 0$

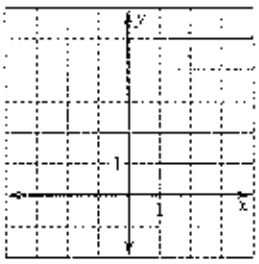
22. $2x^2 + 5x - 7 = 0$

Graph the quadratic inequality.

23. $y > x^2$



24. $y \leq 2x^2 - 1$



25. ***Ball Toss*** You toss a ball into the air at a height of 5 feet. The velocity of the ball is 30 feet per second. You catch the ball 6 feet from the ground. Use the model

$$6 = -16t^2 + 30t + 5$$

to find how long the ball was in the air.

21.

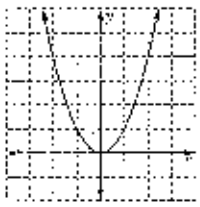
22. _____

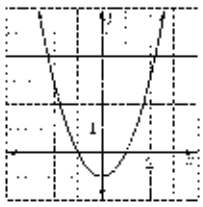
23. Use grid at left.

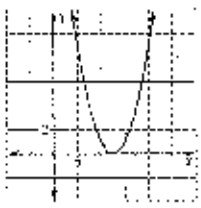
24. Use grid at left.

25. _____

Test A

1. 

2. 

3. 

4. 0, 4 **5.** 7, −7

6. 4, 3 **7.** 12, 12 **8.** $2\sqrt{2}$, $2\sqrt{2}$

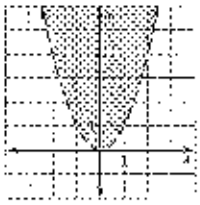
9. 3, −5 **10.** $3 + 2i$ **11.** $4 + 2i$

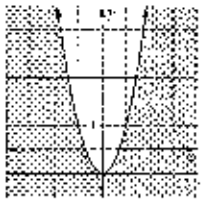
12. $-\frac{5i}{7}$ **13.** $3i, -3i$ **14.** $i\sqrt{6}, -i\sqrt{6}$

15. $\sqrt{5}$ **16.** $\sqrt{13}$ **17.** 3, 1 **18.** $-2 \pm \sqrt{7}$

19. −1, −9 **20.** $\frac{-3 + \sqrt{29}}{2}, \frac{-3 - \sqrt{29}}{2}$

21. 100; 2 real solutions **22.** 81; 2 real solutions

23. 

24. 

25. 1.84 seconds

CHAPTER 5

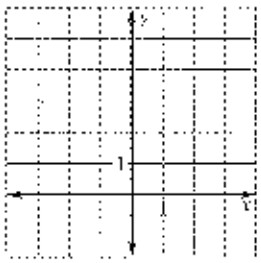
NAME _____ DATE _____

Chapter Test B

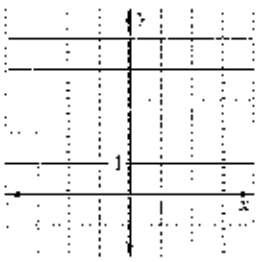
For use after Chapter 5

Graph the quadratic function.

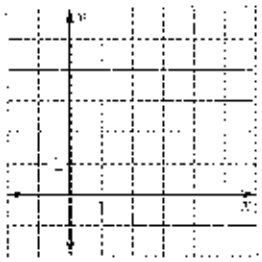
1. $y = x^2 - 1$



2. $y = 2x^2$



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



Solve the quadratic equation by factoring.

4. $x^2 - 8x = 0$ **5.** $3x^2 - 27 = 0$ **6.** $2x^2 + 4x - 30 = 0$

Solve the quadratic equation using any appropriate method.

7. $x^2 - 81 = 0$ **8.** $4x^2 = 48$ **9.** $4(x + 2)^2 = 16$

Simplify the expression.

10. $4 + \sqrt{-4} + i$ **11.** $(9 - 7i) - (10 - 6i)$

12. $\dfrac{3}{7 - i}$

Solve the equation.

13. $x^2 - 1 = 8$ **14.** $4y^2 + 8 = 2y^2$

Find the absolute value of the complex number.

15. $2 + 4i$ **16.** $i - 5$

Solve the equation by completing the square.

17. $x^2 - 7x - 12 = 0$ **18.** $x^2 - 4x + 2 = 0$

Answers

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

CHAPTER 5 CONTINUED

NAME _____ DATE _____

Chapter Test B

For use after Chapter 5

Use the quadratic formula to solve the equation.

19. $x^2 - 10x + 21 = 0$

20. $x^2 - 3x - 5 = 0$

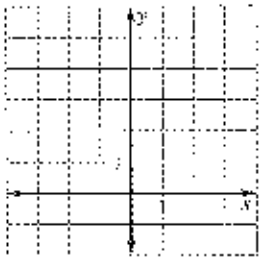
Find the discriminant of the equation and give the number and type of solutions of the equation.

21. $x^2 + 7 = 3x$

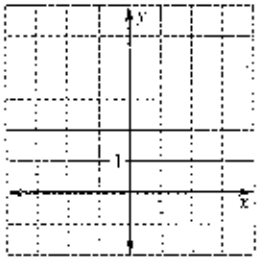
22. $4x^2 + 2x - 5 = 0$

Graph the quadratic inequality.

23. $y \geq x^2$



24. $y < 2x^2 - 3$



25. ***Vertical Motion*** An object is released into the air at an initial height of 6 feet and an initial velocity of 30 feet per second. The object is caught at a height of 7 feet. Use the vertical motion model,

$$h = -16t^2 + vt + s,$$

where h is the height, t is the time in motion, s is the initial height, and v is the initial velocity, to find how long the object is in motion.

19. _____

20. _____

21. _____

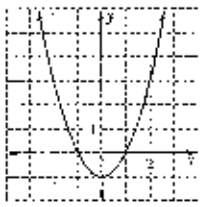
22.

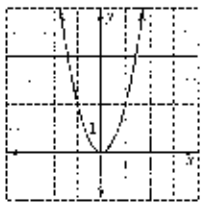
23. Use grid at left.

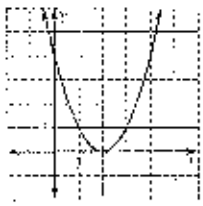
24. Use grid at left.

25. _____

Test B

1. 

2. 

3. 

4. 0, 8 **5.** 3, −3

6. 3, −5 **7.** 9, 9 **8.** $2\sqrt{3}, -2\sqrt{3}$

9. 0, −4 **10.** 4 + 3*i* **11.** 1 *i*

12. $\frac{21 + 3i}{50}$ **13.** 3*i*, −3*i* **14.** 2*i*, −2*i*

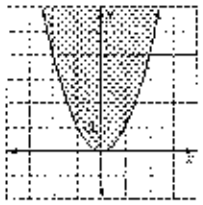
15. $2\sqrt{5}$ **16.** $\sqrt{26}$ **17.** 3, 4

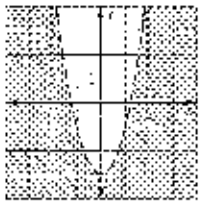
18. $2 + \sqrt{2}, 2 - \sqrt{2}$ **19.** 7, 3

20. $\frac{3 - i\sqrt{11}}{2}, \frac{3 - i\sqrt{11}}{2}$

21. −19; two imaginary solutions

22. 84; two real solutions

23. 

24. 

25. 1.84 seconds

CHAPTER 5

NAME _____ DATE _____

SAT/ACT Chapter Test

For use after Chapter 5

1. What are all solutions of $x^2 \quad 5x \quad 4 = 0$?

   (A) 4, 1 (B) $-4, -1$

   (C) 2, 2 (D) $-2, -2$

2. What are all solutions of $x^2 - 16$?

   (A) 4 (B) $-8, -2$

   (C) $4, -4$ (D) 0, 16

3. The graph of $y = x^2$ is a

   (A) circle. (B) line.

   (C) parabola. (D) rectangle.

4. In the quadratic formula

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

   $b^2 - 4ac$ is called the

   (A) denominator. (B) discriminant.

   (C) derivative. (D) domain.

5. $\sqrt{-9}$ is

   (A) rational. (B) irrational.

   (C) real. (D) imaginary.

6. If $\sqrt{\quad 1} = i$, then $i^2 =$

   (A) 1. (B) -1. (C) $\sqrt{1}$. (D) $\sqrt{\quad 1}$.

7. Which are all solutions of $x^2 + 6x - 3 = 0$?

   (A) $3, -3$

   (B) $3 + 2\sqrt{3}, 3 - 2\sqrt{3}$

   (C) $-3 + 2\sqrt{3}, -3 - 2\sqrt{3}$

   (D) $-3 - \sqrt{13}, -3 - \sqrt{13}$

Quantitative Comparison **In Exercises 8–10, choose the statement that is true about the given quantities.**

(A) The quantity in column A is greater.

(B) The quantity in column B is greater.

(C) The two quantities are equal.

(D) The relationship cannot be determined from the given information.

8.

Column A	*Column B*
$(\sqrt{9})^2$	$(3)^2$

(A) (B) (C) (D)

9.

Column A	*Column B*
$16i^2$	16

(A) (B) (C) (D)

10.

Column A	*Column B*
$b^2 \quad 4ac$ where $a = 1$, $b = -2$, $c = -3$	$b^2 - 4ac$ where $a = -1$, $b = 2$, $c = 3$

(A) (B) (C) (D)

Answer Key

SAT/ACT

1. A 2. C 3. C 4. B 5. D 6. B 7. C
8. C 9. B 10. C

CHAPTER 5

NAME _____ DATE _____

Cumulative Review

For use after Chapters 1–5

Evaluate the expression. (1.1)

1. $-3 + 3(-2 + 5)^2$
2. $(-5)^2$
3. -5^2

Simplify and evaluate the expression for the given value of the variable. (1.2)

4. $x^2 + 8 - x$ when $x = -2$
5. $3a^2 + a - 2a^2$ when $a = 3$
6. $2(n - 1) - 4(n - 2)$ when $n = -1$

Solve the equation. (1.3)

7. $\frac{3}{5}x + \frac{1}{5} = 2x - \frac{1}{5}$
8. $3(2x - 1) = -4(-x - 1) + 5$

Solve the inequality and draw its graph. (1.5)

9. $3x + 1 < 2x - 3$
10. $2x - 3 \geq 5x + 1$
11. $-4x + 3 > 3x$

Solve the compound inequality. (1.6)

12. $3x + 1 < 2x + 9$ or $5x + 3 < 53$
13. $-4 < -2x + 4 < 12$

Solve the absolute value equation or inequality. (1.7)

14. $|3x - 5| = 10$
15. $|4x - 2| > 10$
16. $|x - 2| < 6$

Evaluate the function when $x = 5$. (2.1)

17. $g(x) = x^2 + 2$
18. $f(x) = (x)^2 + 2$
19. $f(x) = (x - 3)^2 + 5$

Find the slope of the line passing through the points. (2.2)

20. $(4, -3)$ and $(6, 5)$
21. $(2, 0)$ and $(8, 0)$
22. $(5, 8)$ and $(5, 14)$

Tell whether the two lines are *parallel, perpendicular,* or *neither.* (2.2)

23. Line 1: through $(-5, 3)$ and $(8, 4)$
    Line 2: through $(2, 7)$ and $(1, 20)$
24. Line 1: through $(5, -9)$ and $(-2, 5)$
    Line 2: through $(6, 3)$ and $(9, 9)$

Write the equation with the given slope and *y*-intercept. (2.3)

25. $m = 5$; $b = 3$
26. $m = 0$; $b = 4$
27. $m = \frac{3}{5}$; $b = -2$

Graph the equation. (2.3)

28. $y = \frac{-2}{3}x + 5$
29. $y = 4x - 6$
30. $y = 5x$

Write the equation of the line that passes through the given point and has the given slope. (2.4)

31. $(5, -1)$; $m = \frac{1}{3}$
32. $(6, 0)$; $m = -2$
33. $(4, 5)$; $m = 1$

Graph the inequality. (2.6)

34. $y \geq \frac{2}{3}x - 3$
35. $y < -x - 5$
36. $2x - y < 4$

CHAPTER 5 CONTINUED

NAME _____ DATE

Cumulative Review

For use after Chapters 1–5

Solve the linear system. (3.2, 3.6)

37. $2x + 3y = 14$
$-x + 5y = 19$

38. $3x - 5y = 14$
$2x - 3y = 16$

39. $2x + 3y - z = 11$
$4x - y + 2z = 1$
$3x + 2y + 2z = 0$

Graph the system of linear inequalities. (3.5)

40. $y < x - 2$
$y > -3x - 1$

41. $y > 3x - 2$
$y > -2x + 1$

42. $3x - y \geq 5$
$2x + y \leq 3$

Perform the indicated operation. (4.1)

43. $\begin{bmatrix} 1 & -3 \\ 6 & 2 \end{bmatrix} + 3\begin{bmatrix} -3 & 5 \\ 2 & 0 \end{bmatrix}$

Use Cramer's Rule to solve the system. (4.3)

44. $2x + 3y = 11$
$x - 4y = -11$

45. $-2x + 2y = 0$
$5x - 3y = 4$

46. $4x - 2y + 3z = 14$
$2x - y - 5z = 5$
$-3x - 2y - 5z = -7$

Use matrices to solve the linear system. (4.5)

47. $2x + 4y = 22$
$3x - y = -13$

48. $3x - 2y = 7$
$5x - 4y = 3$

49. $x + 2y - 3z = 10$
$2x - 3y + 4z = -10$
$-2x + 3y - 5z = 13$

Graph the quadratic function. Label the vertex and the axis of symmetry. (5.1, 5.3)

50. $y = (x - 3)^2 - 5$

51. $y = 3(x - 1)(x + 1)$

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

Solve the equation. (5.3, 5.5)

53. $3(x - 5)^2 = 27$

54. $x^2 - 12x - 3 = 0$

55. $x^2 + 6x + 8 = 0$

Write the expression as a complex number in standard form. (5.4)

56. $(4 - 3i) - (2 + 5i)$

57. $(7 + 3i)(2 - i)$

58. $(-6 + 2i) + (3 - 5i)$

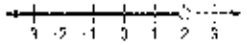
59. $(-3 - 2i)(4 - 5i)$

60. $\dfrac{3 + 2i}{4 - i}$

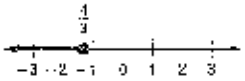
61. $\dfrac{4 - i}{4 - i}$

Cumulative Review

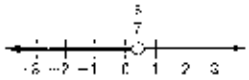
1. 24 **2.** 25 **3.** -25 **4.** 14 **5.** 12 **6.** 12
7. $\frac{-6}{45}$ **8.** 2
9. $x < 2$



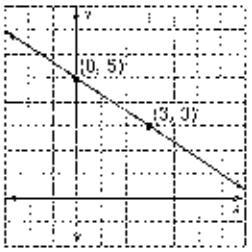
10. $x \leq \frac{4}{3}$



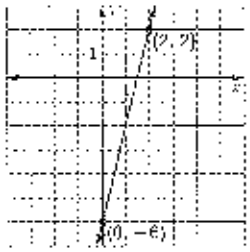
11. $x < \frac{5}{7}$



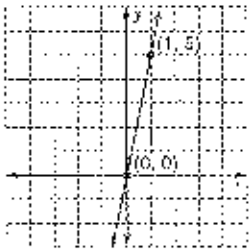
12. $x < 10$ **13.** $-4 < x < 4$
14. $5, \frac{-5}{3}$ **15.** $x > 3$ or $x < -2$
16. $-4 < x < 8$ **17.** -23 **18.** 27 **19.** 9
20. 4 **21.** 0 **22.** undefined
23. perpendicular **24.** neither **25.** $y = 5x + 3$
26. $y \quad 4$ **27.** $y - \frac{2}{3}x - 2$
28.



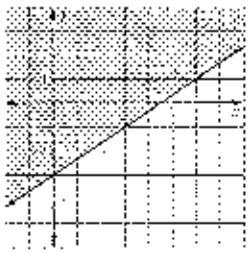
29.



30.



31. $y = \frac{1}{5}x - \frac{8}{5}$
32. $y - -2x + 12$ **33.** $y \cdot x + 1$
34.



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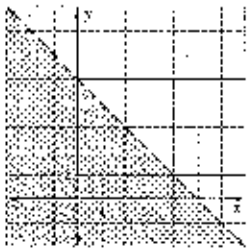
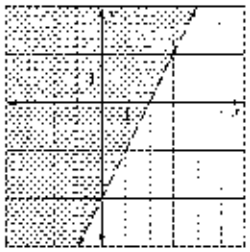
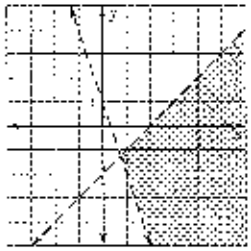


36.



37. (1, 4)
38. (2, 4)
39. (2, 1, 4)
40.



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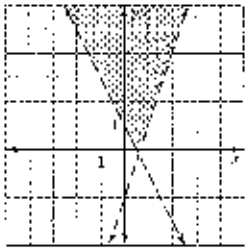

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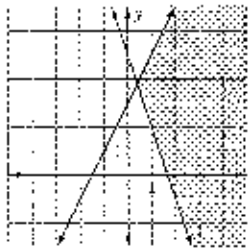
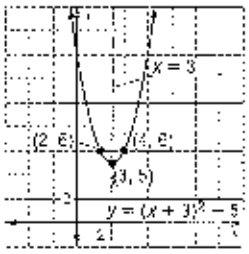


43. $\begin{bmatrix} 8 & 12 \\ 12 & 2 \end{bmatrix}$

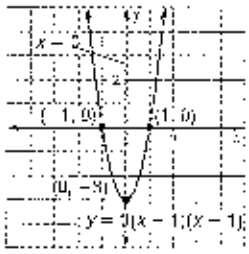
44. $(1, 3)$ **45.** $(2, 2)$ **46.** $(3, -1, 0)$

47. $(-3, 4)$ **48.** $(1, -2)$ **49.** $(1, 0, -3)$

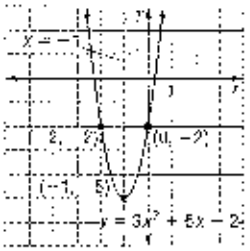
50.



51.



52.



53. $x < (8, 2)$

54. $-6 + \sqrt{33}, -6 - \sqrt{33}$ **55.** $4, \quad 2$

56. $2 - 8i$ **57.** $17 \quad i$ **58.** $-3 - 3i$

59. $2 \quad 23i$ **60.** $\frac{10}{17} + \frac{11}{17}i$ **61.** $\frac{28}{53} + \frac{8}{17}i$