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Chapter 10 Resource Masters

Algebra 1

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CONSUMABLE WORKBOOKS Many of the worksheets contained in the Chapter Resource Masters booklets are available as consumable workbooks in both English and Spanish.

	MHID	ISBN
Study Guide and Intervention Workbook	0-07-660292-3	978-0-07-660292-6
Homework Practice Workbook	0-07-660291-5	978-0-07-660291-9
Spanish Version		
Homework Practice Workbook	0-07-660294-X	978-0-07-660294-0

Answers For Workbooks The answers for Chapter 10 of these workbooks can be found in the back of this Chapter Resource Masters booklet.

ConnectED All of the materials found in this booklet are included for viewing, printing, and editing at connected.mcgraw-hill.com.

Spanish Assessment Masters (MHID: 0-07-660289-3, ISBN: 978-0-07-660289-6) These masters contain a Spanish version of Chapter 10 Test Form 2A and Form 2C.

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1 2 3 4 5 6 7 8 9 DOH 16 15 14 13 12 11

Contents

Teacher's Guide to Using the *Chapter 10 Resource Masters*

The *Chapter 10 Resource Masters* includes the core materials needed for Chapter 10. These materials include worksheets, extensions, and assessment options. The answers for these pages appear at the back of this booklet.

All of the materials found in this booklet are included for viewing, printing, and editing at connectED.mcgraw-hill.com.

Chapter Resources

Student-Built Glossary (pages 1–2) These masters are a student study tool that presents up to twenty of the key vocabulary terms from the chapter. Students are to record definitions and/or examples for each term. You may suggest that students highlight or star the terms with which they are not familiar. Give this to students before beginning Lesson 10-1. Encourage them to add these pages to their mathematics study notebooks. Remind them to complete the appropriate words as they study each lesson.

Anticipation Guide (pages 3–4) This master, presented in both English and Spanish, is a survey used before beginning the chapter to pinpoint what students may or may not know about the concepts in the chapter. Students will revisit this survey after they complete the chapter to see if their perceptions have changed.

Lesson Resources

Study Guide and Intervention These masters provide vocabulary, key concepts, additional worked-out examples and Check Your Progress exercises to use as a reteaching activity. It can also be used in conjunction with the Student Edition as an instructional tool for students who have been absent.

Skills Practice This master focuses more on the computational nature of the lesson. Use as an additional practice option or as homework for second-day teaching of the lesson.

Practice This master closely follows the types of problems found in the Exercises section of the Student Edition and includes word problems. Use as an additional practice option or as homework for second-day teaching of the lesson.

Word Problem Practice This master includes additional practice in solving word problems that apply the concepts of the lesson. Use as an additional practice or as homework for second-day teaching of the lesson.

Enrichment These activities may extend the concepts of the lesson, offer an historical or multicultural look at the concepts, or widen students' perspectives on the mathematics they are learning. They are written for use with all levels of students.

Graphing Calculator, TI-Nspire, or Spreadsheet Activities These activities present ways in which technology can be used with the concepts in some lessons of this chapter. Use as an alternative approach to some concepts or as an integral part of your lesson presentation.

Assessment Options

The assessment masters in the ***Chapter 10 Resource Masters*** offer a wide range of assessment tools for formative (monitoring) assessment and summative (final) assessment.

Student Recording Sheet This master corresponds with the standardized test practice at the end of the chapter.

Extended Response Rubric This master provides information for teachers and students on how to assess performance on open-ended questions.

Quizzes Four free-response quizzes offer assessment at appropriate intervals in the chapter.

Mid-Chapter Test This 1-page test provides an option to assess the first half of the chapter. It parallels the timing of the Mid-Chapter Quiz in the Student Edition and includes both multiple-choice and free-response questions.

Vocabulary Test This test is suitable for all students. It includes a list of vocabulary words and 11 questions to assess students' knowledge of those words. This can also be used in conjunction with one of the leveled chapter tests.

Leveled Chapter Tests

- ***Form 1*** contains multiple-choice questions and is intended for use with below grade level students.
- ***Forms 2A and 2B*** contain multiple-choice questions aimed at on grade level students. These tests are similar in format to offer comparable testing situations.
- ***Forms 2C and 2D*** contain free-response questions aimed at on grade level students. These tests are similar in format to offer comparable testing situations.
- ***Form 3*** is a free-response test for use with above grade level students.

All of the above mentioned tests include a free-response Bonus question.

Extended-Response Test Performance assessment tasks are suitable for all students. Sample answers and a scoring rubric are included for evaluation.

Standardized Test Practice These three pages are cumulative in nature. It includes three parts: multiple-choice questions with bubble-in answer format, griddable questions with answer grids, and short-answer free-response questions.

Answers

- The answers for the Anticipation Guide and Lesson Resources are provided as reduced pages.
- Full-size answer keys are provided for the assessment masters.

10 Student-Built Glossary

This is an alphabetical list of the key vocabulary terms you will learn in Chapter 10. As you study the chapter, complete each term's definition or description. Remember to add the page number where you found the term. Add these pages to your Algebra Study Notebook to review vocabulary at the end of the chapter.

Vocabulary Term	Found on Page	Definition/Description/Example
conjugate KAHN • jih • guht		
converse		
cosine		
hypotenuse hy • PAH • tn • oos		
inverse cosine		
inverse sine		
inverse tangent		
legs		

(continued on the next page)

10 Student-Built Glossary *(continued)*

Vocabulary Term	Found on Page	Definition/Description/Example
radical equations		
radical functions		
radicand RA • duh • KAND		
tangent		
trigonometry		

NAME ______________________ DATE ____________ PERIOD ____________

10 Anticipation Guide

Radical Expressions and Triangles

Step 1 *Before you begin Chapter 10*

- Read each statement.
- Decide whether you Agree (A) or Disagree (D) with the statement.
- Write A or D in the first column OR if you are not sure whether you agree or disagree, write NS (Not Sure).

STEP 1 A, D, or NS	Statement	STEP 2 A or D
	1. An expression that contains a square root is called a radical expression.	
	2. It is always true that $\sqrt{xy}$ will equal $\sqrt{x} \cdot \sqrt{y}$.	
	3. $\frac{1}{\sqrt{3}}$ is in simplest form because $\sqrt{3}$ is not a whole number.	
	4. The sum of $3\sqrt{3}$ and $2\sqrt{3}$ will equal $5\sqrt{3}$.	
	5. Before multiplying two radical expressions with different radicands the square roots must be evaluated.	
	6. When solving radical equations by squaring each side of the equation, it is possible to obtain solutions that are not solutions to the original equation.	
	7. The longest side of any triangle is called the hypotenuse.	
	8. Because $5^2 = 4^2 + 3^2$, a triangle whose sides have lengths 3, 4, and 5 will be a right triangle.	
	9. On a coordinate plane, the distance between any two points can be found using the Pythagorean Theorem.	
	10. The missing measures of a triangle can be found if the measure of one of its sides is known.	

Step 2 *After you complete Chapter 10*

- Reread each statement and complete the last column by entering an A or a D.
- Did any of your opinions about the statements change from the first column?
- For those statements that you mark with a D, use a piece of paper to write an example of why you disagree.

10 Ejercicios preparatorios

Expresiones radicales y triángulos

Paso 1 *Antes de comenzar el Capítulo 10*

- Lee cada enunciado.
- Decide si estás de acuerdo (A) o en desacuerdo (D) con el enunciado.
- Escribe A o D en la primera columna O si no estás seguro(a) de la respuesta, escribe NS (No estoy seguro(a)).

PASO 1 A, D o NS	Enunciado	PASO 2 A o D
	1. Una expresión que contiene una raíz cuadrada se denomina expresión radical.	
	2. Siempre es verdadero que $\sqrt{xy}$ será igual a $\sqrt{x} \cdot \sqrt{y}$.	
	3. $\frac{1}{\sqrt{3}}$ está en forma reducida porque $\sqrt{3}$ no es un número entero.	
	4. La suma de $3\sqrt{3}$ y $2\sqrt{3}$ será igual a $5\sqrt{3}$.	
	5. Antes de multiplicar dos expresiones radicales con radicandos diferentes, se debe evaluar las raíces cuadradas.	
	6. Cuando se resuelven ecuaciones radicales mediante la elevación al cuadrado de cada lado de la ecuación, es posible obtener soluciones que no son soluciones para la ecuación original.	
	7. El lado más largo de cualquier triángulo se llama hipotenusa.	
	8. Debido a que $5^2 = 4^2 + 3^2$, un triángulo cuyos lados tienen longitudes 3, 4 y 5 será un triángulo rectángulo.	
	9. En el plano de coordenadas, la distancia entre cualesquiera dos puntos se puede encontrar usando el teorema de Pitágoras.	
	10. Las medidas ausentes de un triángulo pueden ser encontradas si la medida de uno de sus lados es conocida.	

Paso 2 *Después de completar el Capítulo 10*

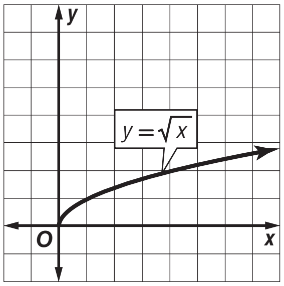
- Vuelve a leer cada enunciado y completa la última columna con una A o una D.
- ¿Cambió cualquiera de tus opiniones sobre los enunciados de la primera columna?
- En una hoja de papel aparte, escribe un ejemplo de por qué estás en desacuerdo con los enunciados que marcaste con una D.

10-1 Study Guide and Intervention

Square Root Functions

Dilations of Radical Functions A **square root function** contains the square root of a variable. Square root functions are a type of **radical function**.

In order for a square root to be a real number, the **radicand**, or the expression under the radical sign, cannot be negative. Values that make the radicand negative are not included in the domain.

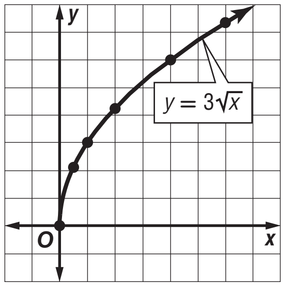
Square Root Function	Parent function: $f(x) = \sqrt{x}$ Type of graph: curve Domain: $\{x \mid x \geq 0\}$ Range: $\{y \mid y \geq 0\}$	

Example **Graph $y = 3\sqrt{x}$. State the domain and range.**

Step 1 Make a table. Choose nonnegative values for x.

x	y
0	0
0.5	≈2.12
1	3
2	≈4.24
4	6
6	≈7.35

Step 2 Plot points and draw a smooth curve.

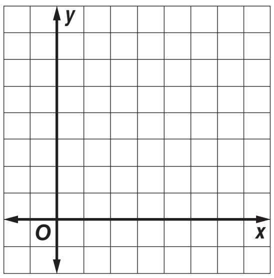


The domain is $\{x \mid x \geq 0\}$ and the range is $\{y \mid y \geq 0\}$.

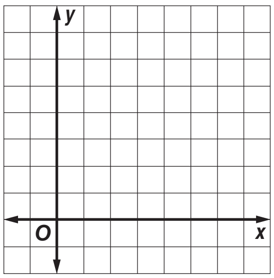
Exercises

Graph each function, and compare to the parent graph. State the domain and range.

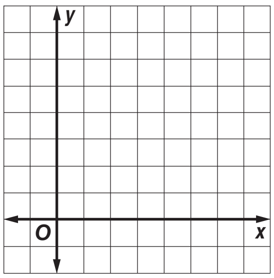
1. $y = \frac{3}{2}\sqrt{x}$



2. $y = 4\sqrt{x}$



3. $y = \frac{5}{2}\sqrt{x}$



10-1 Study Guide and Intervention *(continued)*

Square Root Functions

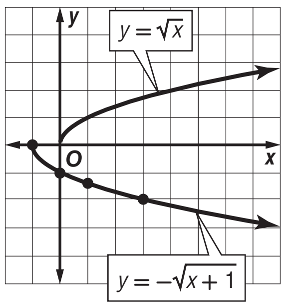
Reflections and Translations of Radical Functions Radical functions, like quadratic functions, can be translated horizontally and vertically, as well as reflected across the x-axis. To draw the graph of $y = a\sqrt{x + h} + k$, follow these steps.

Graphs of Square Root Functions	**Step 1** Draw the graph of $y = a\sqrt{x}$. The graph starts at the origin and passes through the point at $(1, a)$. If $a > 0$, the graph is in the 1st quadrant. If $a < 0$, the graph is reflected across the x-axis and is in the 4th quadrant. **Step 2** Translate the graph $\|k\|$ units up if k is positive and down if k is negative. **Step 3** Translate the graph $\|h\|$ units left if h is positive and right if h is negative.

Example **Graph $y = -\sqrt{x + 1}$ and compare to the parent graph. State the domain and range.**

Step 1 Make a table of values.

x	–1	0	1	3	8
y	0	–1	–1.41	–2	–3

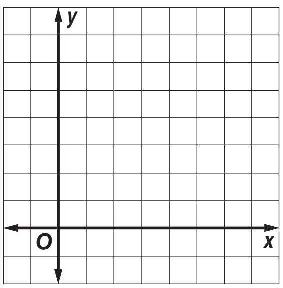


Step 2 This is a horizontal translation 1 unit to the left of the parent function and reflected across the x-axis. The domain is $\{x \mid x \geq -1\}$ and the range is $\{y \mid y \leq 0\}$.

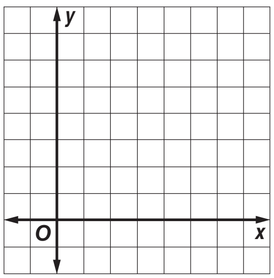
Exercises

Graph each function, and compare to the parent graph. State the domain and range.

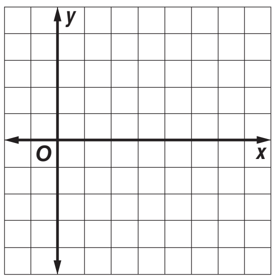
1. $y = \sqrt{x} + 3$



2. $y = \sqrt{x - 1}$



3. $y = -\sqrt{x - 1}$

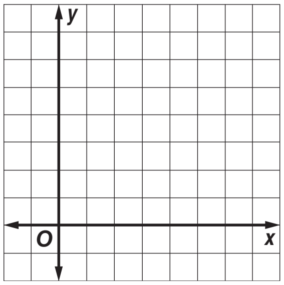


10-1 Skills Practice

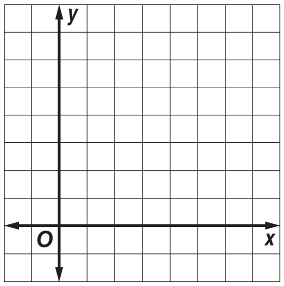
Square Root Functions

Graph each function, and compare to the parent graph. State the domain and range.

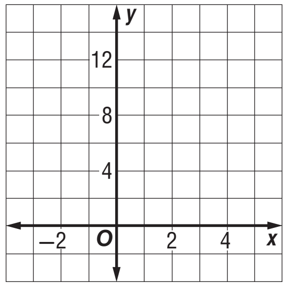
1. $y = 2\sqrt{x}$



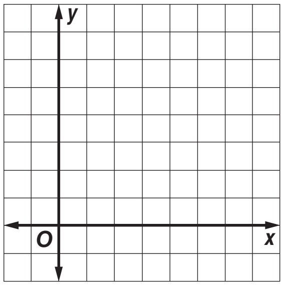
2. $y = \frac{1}{2}\sqrt{x}$



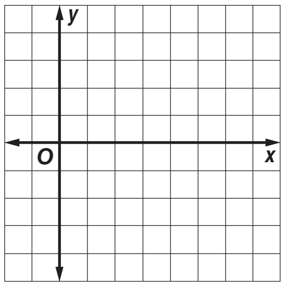
3. $y = 5\sqrt{x}$



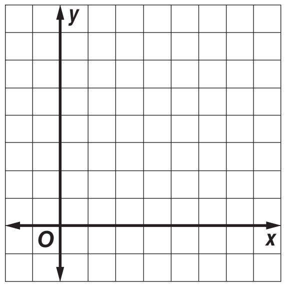
4. $y = \sqrt{x} + 1$



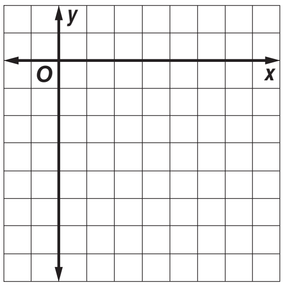
5. $y = \sqrt{x} - 4$



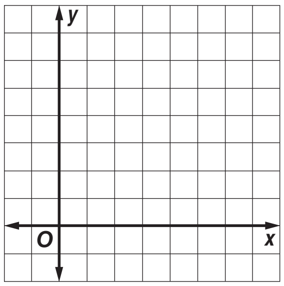
6. $y = \sqrt{x - 1}$



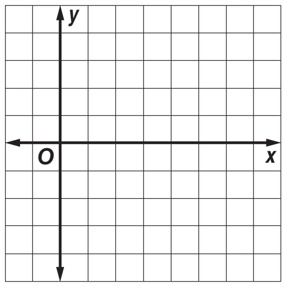
7. $y = -\sqrt{x - 3}$



8. $y = \sqrt{x - 2} + 3$



9. $y = -\frac{1}{2}\sqrt{x - 4} + 1$



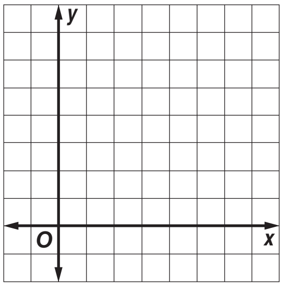
NAME ______________________ DATE ____________ PERIOD ____________

10-1 Practice

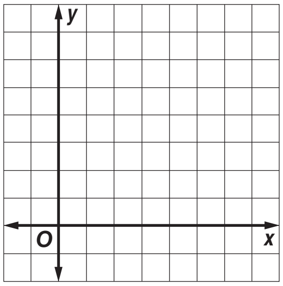
Square Root Functions

Graph each function, and compare to the parent graph. State the domain and range.

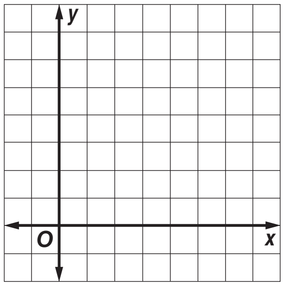
1. $y = \frac{4}{3}\sqrt{x}$



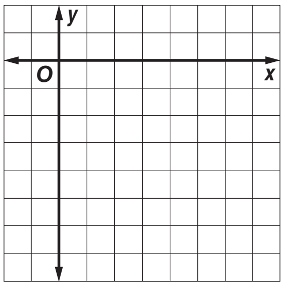
2. $y = \sqrt{x} + 2$



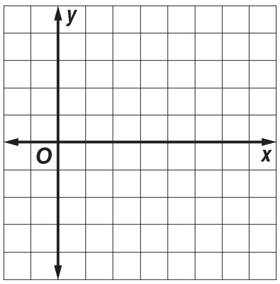
3. $y = \sqrt{x - 3}$



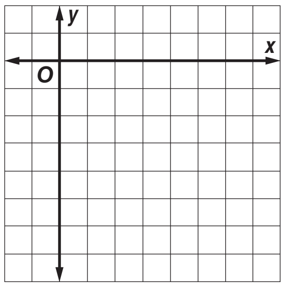
4. $y = -\sqrt{x} + 1$



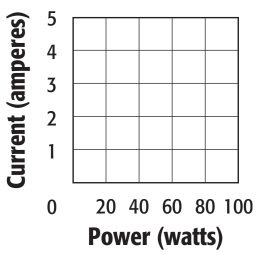
5. $y = 2\sqrt{x - 1} + 1$



6. $y = -\sqrt{x - 2} + 2$



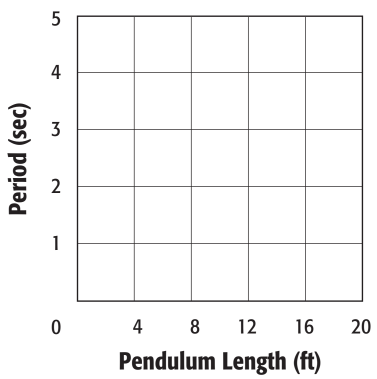
7. OHM'S LAW In electrical engineering, the resistance of a circuit can be found by the equation $I = \sqrt{\frac{P}{R}}$, where I is the current in amperes, P is the power in watts, and R is the resistance of the circuit in ohms. Graph this function for a circuit with a resistance of 4 ohms.



10-1 Word Problem Practice

Square Root Functions

1. PENDULUM MOTION The period T of a pendulum in seconds, which is the time for the pendulum to return to the point of release, is given by the equation $T = 1.11\sqrt{L}$. The length of the pendulum in feet is given by L. Graph this function.



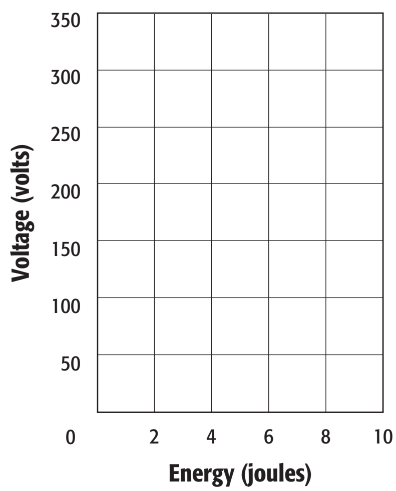
2. EMPIRE STATE BUILDING The roof of the Empire State Building is 1250 feet above the ground. The velocity of an object dropped from a height of h meters is given by the function $V = \sqrt{2gh}$, where g is the gravitational constant, 32.2 feet per second squared. If an object is dropped from the roof of the building, how fast is it traveling when it hits the street below?

3. ERROR ANALYSIS Gregory is drawing the graph of $y = -5\sqrt{x + 1}$. He describes the range and domain as $\{x \mid x \geq -1\}$, $\{y \mid y \geq 0\}$. Explain and correct the mistake that Gregory made.

4. CAPACITORS A capacitor is a set of plates that can store energy in an electric field. The voltage V required to store E joules of energy in a capacitor with a capacitance of C farads is given by $V = \sqrt{\frac{2E}{C}}$.

a. Rewrite and simplify the equation for the case of a 0.0002 farad capacitor.

b. Graph the equation you found in part **a**.



c. How would the graph differ if you wished to store $E + 1$ joules of energy in the capacitor instead?

d. How would the graph differ if you applied a voltage of $V + 1$ volts instead?

Lesson 10-1

NAME ______________________ DATE __________ PERIOD __________

10-1 Enrichment

Cube Root Functions

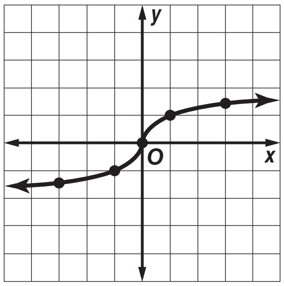
A **cube root function** contains the cube root of a variable. The **cube roots** of a number x are the numbers y that satisfy the equation $y \cdot y \cdot y = x$, or alternatively, $y = \sqrt[3]{x}$. Unlike square root functions, cube root functions return real numbers when the radicand is negative.

Example **Graph $y = \sqrt[3]{x}$.**

Step 1 Make a table. Round to the nearest hundredth.

x	y
–5	–1.71
–3	–1.44
–1	–1
0	0
1	1
3	1.44
5	1.71

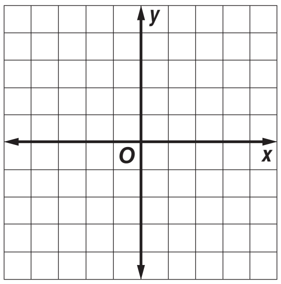
Step 2 Plot points and draw a smooth curve.



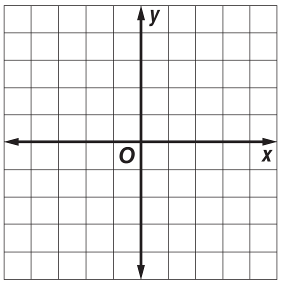
Exercises

Graph each function, and compare to the parent graph.

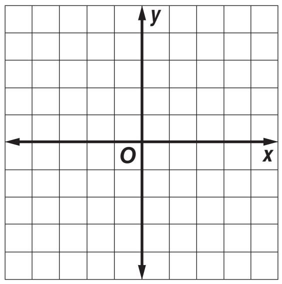
1. $y = 2\sqrt[3]{x}$



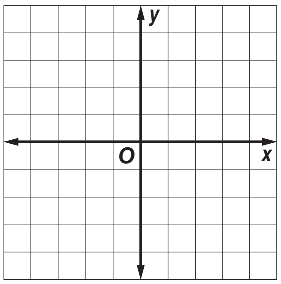
2. $y = \sqrt[3]{x} + 1$



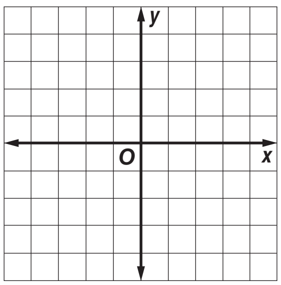
3. $y = \sqrt[3]{x + 1}$



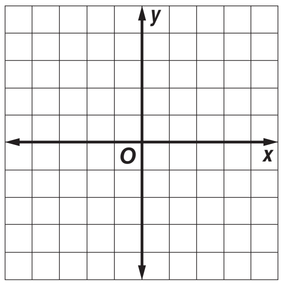
4. $y = \sqrt[3]{x - 1} + 2$



5. $y = 3\sqrt[3]{x - 2}$



6. $y = -\sqrt[3]{x} + 3$



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10-2 Study Guide and Intervention

Simplifying Radical Expressions

Product Property of Square Roots The **Product Property of Square Roots** and prime factorization can be used to simplify expressions involving irrational square roots. When you simplify radical expressions with variables, use absolute value to ensure nonnegative results.

Product Property of Square Roots	For any numbers a and b, where $a \geq 0$ and $b \geq 0$, $\sqrt{ab} = \sqrt{a} \cdot \sqrt{b}$.

Example 1 **Simplify $\sqrt{180}$.**

$\sqrt{180} = \sqrt{2 \cdot 2 \cdot 3 \cdot 3 \cdot 5}$ Prime factorization of 180

$= \sqrt{2^2} \cdot \sqrt{3^2} \cdot \sqrt{5}$ Product Property of Square Roots

$= 2 \cdot 3 \cdot \sqrt{5}$ Simplify.

$= 6\sqrt{5}$ Simplify.

Example 2 **Simplify $\sqrt{120a^2 \cdot b^5 \cdot c^4}$.**

$\sqrt{120a^2 \cdot b^5 \cdot c^4}$

$= \sqrt{2^3 \cdot 3 \cdot 5 \cdot a^2 \cdot b^5 \cdot c^4}$

$= \sqrt{2^2} \cdot \sqrt{2} \cdot \sqrt{3} \cdot \sqrt{5} \cdot \sqrt{a^2} \cdot \sqrt{b^4 \cdot b} \cdot \sqrt{c^4}$

$= 2 \cdot \sqrt{2} \cdot \sqrt{3} \cdot \sqrt{5} \cdot |a| \cdot b^2 \cdot \sqrt{b} \cdot c^2$

$= 2|a|b^2c^2\sqrt{30b}$

Exercises

Simplify each expression.

1. $\sqrt{28}$

2. $\sqrt{68}$

3. $\sqrt{60}$

4. $\sqrt{75}$

5. $\sqrt{162}$

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

7. $\sqrt{2} \cdot \sqrt{5}$

8. $\sqrt{5} \cdot \sqrt{10}$

9. $\sqrt{4a^2}$

10. $\sqrt{9x^4}$

11. $\sqrt{300a^4}$

12. $\sqrt{128c^6}$

13. $4\sqrt{10} \cdot 3\sqrt{6}$

14. $\sqrt{3x^2} \cdot 3\sqrt{3x^4}$

15. $\sqrt{20a^2b^4}$

16. $\sqrt{100x^3y}$

17. $\sqrt{24a^4b^2}$

18. $\sqrt{81x^4y^2}$

19. $\sqrt{150a^2b^2c}$

20. $\sqrt{72a^6b^3c^2}$

21. $\sqrt{45x^2y^5z^8}$

22. $\sqrt{98x^4y^6z^2}$

Lesson 10-2

10-2 Study Guide and Intervention *(continued)*

Simplifying Radical Expressions

Quotient Property of Square Roots A fraction containing radicals is in simplest form if no radicals are left in the denominator. The **Quotient Property of Square Roots** and **rationalizing the denominator** can be used to simplify radical expressions that involve division. When you rationalize the denominator, you multiply the numerator and denominator by a radical expression that gives a rational number in the denominator.

Quotient Property of Square Roots	For any numbers a and b, where $a \geq 0$ and $b > 0$, $\sqrt{\frac{a}{b}} = \frac{\sqrt{a}}{\sqrt{b}}$.

Example **Simplify $\sqrt{\frac{56}{45}}$.**

$\sqrt{\frac{56}{45}} = \sqrt{\frac{4 \cdot 14}{9 \cdot 5}}$ Factor 56 and 45.

$= \frac{2 \cdot \sqrt{14}}{3 \cdot \sqrt{5}}$ Simplify the numerator and denominator.

$= \frac{2\sqrt{14}}{3\sqrt{5}} \cdot \frac{\sqrt{5}}{\sqrt{5}}$ Multiply by $\frac{\sqrt{5}}{\sqrt{5}}$ to rationalize the denominator.

$= \frac{2\sqrt{70}}{15}$ Product Property of Square Roots

Exercises

Simplify each expression.

1. $\frac{\sqrt{9}}{\sqrt{18}}$

2. $\frac{\sqrt{8}}{\sqrt{24}}$

3. $\frac{\sqrt{100}}{\sqrt{121}}$

4. $\frac{\sqrt{75}}{\sqrt{3}}$

5. $\frac{8\sqrt{2}}{2\sqrt{8}}$

6. $\sqrt{\frac{2}{5}} \cdot \sqrt{\frac{6}{5}}$

7. $\sqrt{\frac{3}{4}} \cdot \sqrt{\frac{5}{2}}$

8. $\sqrt{\frac{5}{7}} \cdot \sqrt{\frac{2}{5}}$

9. $\sqrt{\frac{3a^2}{10b^6}}$

10. $\sqrt{\frac{x^6}{y^4}}$

11. $\sqrt{\frac{100a^4}{144b^8}}$

12. $\sqrt{\frac{75b^3c^6}{a^2}}$

13. $\frac{\sqrt{4}}{3 - \sqrt{5}}$

14. $\frac{\sqrt{8}}{2 + \sqrt{3}}$

15. $\frac{\sqrt{5}}{5 + \sqrt{5}}$

16. $\frac{\sqrt{8}}{2\sqrt{7} + 4\sqrt{10}}$

10-2 Skills Practice

Simplifying Radical Expressions

Simplify each expression.

1. $\sqrt{28}$

2. $\sqrt{40}$

3. $\sqrt{72}$

4. $\sqrt{99}$

5. $\sqrt{2} \cdot \sqrt{10}$

6. $\sqrt{5} \cdot \sqrt{60}$

7. $3\sqrt{5} \cdot \sqrt{5}$

8. $\sqrt{6} \cdot 4\sqrt{24}$

9. $2\sqrt{3} \cdot 3\sqrt{15}$

10. $\sqrt{16b^4}$

11. $\sqrt{81a^2d^4}$

12. $\sqrt{40x^4y^6}$

13. $\sqrt{75m^5P^2}$

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

15. $\sqrt{\frac{1}{6}}$

16. $\sqrt{\frac{6}{7}} \cdot \sqrt{\frac{1}{3}}$

17. $\sqrt{\frac{q}{12}}$

18. $\sqrt{\frac{4h}{5}}$

19. $\sqrt{\frac{12}{b^2}}$

20. $\sqrt{\frac{45}{4m^4}}$

21. $\frac{2}{4 + \sqrt{5}}$

22. $\frac{3}{2 - \sqrt{3}}$

23. $\frac{5}{7 + \sqrt{7}}$

24. $\frac{4}{3 - \sqrt{2}}$

NAME ______________________________ DATE ____________ PERIOD ____________

10-2 Practice

Simplifying Radical Expressions

Simplify.

1. $\sqrt{24}$

2. $\sqrt{60}$

3. $\sqrt{108}$

4. $\sqrt{8} \cdot \sqrt{6}$

5. $\sqrt{7} \cdot \sqrt{14}$

6. $3\sqrt{12} \cdot 5\sqrt{6}$

7. $4\sqrt{3} \cdot 3\sqrt{18}$

8. $\sqrt{27tu^3}$

9. $\sqrt{50p^5}$

10. $\sqrt{108x^6y^4z^5}$

11. $\sqrt{56m^2n^4p^5}$

12. $\dfrac{\sqrt{8}}{\sqrt{6}}$

13. $\sqrt{\dfrac{2}{10}}$

14. $\sqrt{\dfrac{5}{32}}$

15. $\sqrt{\dfrac{3}{4}} \cdot \sqrt{\dfrac{4}{5}}$

16. $\sqrt{\dfrac{1}{7}} \cdot \sqrt{\dfrac{7}{11}}$

17. $\dfrac{\sqrt{3k}}{\sqrt{8}}$

18. $\sqrt{\dfrac{18}{x^3}}$

19. $\sqrt{\dfrac{4y}{3y^2}}$

20. $\sqrt{\dfrac{9ab}{4ab^4}}$

21. $\dfrac{3}{5 - \sqrt{2}}$

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

23. $\dfrac{5}{\sqrt{7} + \sqrt{3}}$

24. $\dfrac{3\sqrt{7}}{-1 - \sqrt{27}}$

25. SKY DIVING When a skydiver jumps from an airplane, the time t it takes to free fall a given distance can be estimated by the formula $t = \sqrt{\dfrac{2s}{9.8}}$, where t is in seconds and s is in meters. If Julie jumps from an airplane, how long will it take her to free fall 750 meters?

26. METEOROLOGY To estimate how long a thunderstorm will last, meteorologists can use the formula $t = \sqrt{\dfrac{d^3}{216}}$, where t is the time in hours and d is the diameter of the storm in miles.

a. A thunderstorm is 8 miles in diameter. Estimate how long the storm will last. Give your answer in simplified form and as a decimal.

b. Will a thunderstorm twice this diameter last twice as long? Explain.

10-2 Word Problem Practice

Simplifying Radical Expressions

1. **SPORTS** Jasmine calculated the height of her team's soccer goal to be $\frac{15}{\sqrt{3}}$ feet. Simplify the expression.

2. **NATURE** In 2010, an earthquake below the ocean floor initiated a devastating tsunami in Sumatra. Scientists can approximate the velocity V in feet per second of a tsunami in water of depth d feet with the formula $V = \sqrt{16d}$. Determine the velocity of a tsunami in 300 feet of water. Write your answer in simplified radical form.

3. **AUTOMOBILES** The following formula can be used to find the "zero to sixty" time for a car, or the time it takes for a car to accelerate from a stop to sixty miles per hour.

$$V = \sqrt{\frac{2PT}{M}}$$

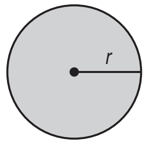
V is the velocity in meters per second, P is the car's average power in watts, M is the mass of the car in kilograms, and T is the time in seconds.

Find the time it takes for a 900-kilogram car with an average 60,000 watts of power to accelerate from stop to 60 miles per hour, which is 26.82 meters per second. Round your answer to the nearest tenth.

4. **PHYSICAL SCIENCE** When a substance such as water vapor is in its gaseous state, the volume and the velocity of its molecules increase as temperature increases. The average velocity V of a molecule with mass m at temperature T is given by the formula $V = \sqrt{\frac{3kT}{m}}$.

Solve the equation for k.

5. **GEOMETRY** Suppose Emeryville Hospital wants to build a new helipad on which medic rescue helicopters can land. The helipad will be circular and made of fire resistant rubber.



a. If the area of the helipad is A, write an equation for the radius r.

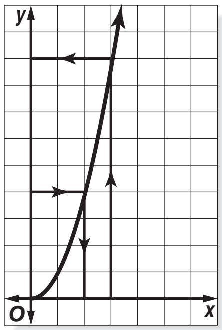
b. Write an expression in simplified radical form for the radius of a helipad with an area of 288 square meters.

c. Using a calculator, find a decimal approximation for the radius. Round your answer to the nearest hundredth.

Lesson 10-2

10-2 Enrichment

Squares and Square Roots From a Graph



The graph of $y = x^2$ can be used to find the squares and square roots of numbers.

To find the square of 3, locate 3 on the x-axis. Then find its corresponding value on the y-axis.

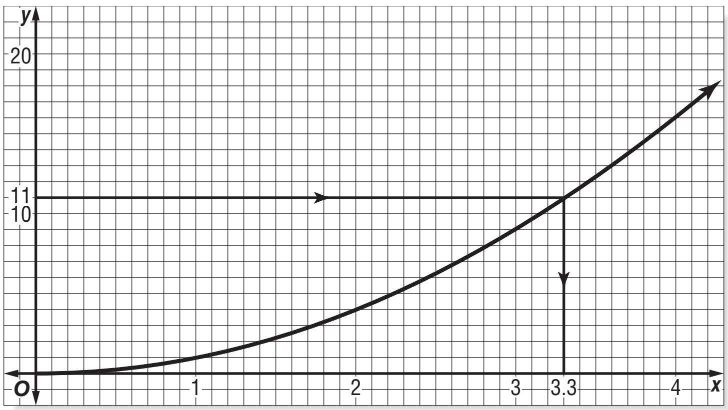
The arrows show that $3^2 = 9$.

To find the square root of 4, first locate 4 on the y-axis. Then find its corresponding value on the x-axis. Following the arrows on the graph, you can see that $\sqrt{4} = 2$.

A small part of the graph at $y = x^2$ is shown below. A 10:1 ratio for unit length on the y-axis to unit length on the x-axis is used.

Example **Find $\sqrt{11}$.**

The arrows show that $\sqrt{11} = 3.3$ to the nearest tenth.



Exercises

Use the graph above to find each of the following to the nearest whole number.

1. 1.5^2 **2.** 2.7^2 **3.** 0.9^2

4. 3.6^2 **5.** 4.2^2 **6.** 3.9^2

Use the graph above to find each of the following to the nearest tenth.

7. $\sqrt{15}$ **8.** $\sqrt{8}$ **9.** $\sqrt{3}$

10. $\sqrt{5}$ **11.** $\sqrt{14}$ **12.** $\sqrt{17}$

NAME ______________________ DATE __________ PERIOD __________

10-3 Study Guide and Intervention

Operations with Radical Expressions

Add or Subtract Radical Expressions When adding or subtracting radical expressions, use the Associative and Distributive Properties to simplify the expressions. If radical expressions are not in simplest form, simplify them.

Example 1 **Simplify $10\sqrt{6} - 5\sqrt{3} + 6\sqrt{3} - 4\sqrt{6}$.**

$10\sqrt{6} - 5\sqrt{3} + 6\sqrt{3} - 4\sqrt{6} = (10 - 4)\sqrt{6} + (-5 + 6)\sqrt{3}$ Associative and Distributive Properties

$= 6\sqrt{6} + \sqrt{3}$ Simplify.

Example 2 **Simplify $3\sqrt{12} + 5\sqrt{75}$.**

$3\sqrt{12} + 5\sqrt{75} = 3\sqrt{2^2 \cdot 3} + 5\sqrt{5^2 \cdot 3}$ Factor 12 and 75.

$= 3 \cdot 2\sqrt{3} + 5 \cdot 5\sqrt{3}$ Simplify.

$= 6\sqrt{3} + 25\sqrt{3}$ Multiply.

$= 31\sqrt{3}$ Distributive Property

Exercises

Simplify each expression.

1. $2\sqrt{5} + 4\sqrt{5}$

2. $\sqrt{6} - 4\sqrt{6}$

3. $\sqrt{8} - \sqrt{2}$

4. $3\sqrt{75} + 2\sqrt{5}$

5. $\sqrt{20} + 2\sqrt{5} - 3\sqrt{5}$

6. $2\sqrt{3} + \sqrt{6} - 5\sqrt{3}$

7. $\sqrt{12} + 2\sqrt{3} - 5\sqrt{3}$

8. $3\sqrt{6} + 3\sqrt{2} - \sqrt{50} + \sqrt{24}$

9. $\sqrt{8a} - \sqrt{2a} + 5\sqrt{2a}$

10. $\sqrt{54} + \sqrt{24}$

11. $\sqrt{3} + \sqrt{\frac{1}{3}}$

12. $\sqrt{12} + \sqrt{\frac{1}{3}}$

13. $\sqrt{54} - \sqrt{\frac{1}{6}}$

14. $\sqrt{80} - \sqrt{20} + \sqrt{180}$

15. $\sqrt{50} + \sqrt{18} - \sqrt{75} + \sqrt{27}$

16. $2\sqrt{3} - 4\sqrt{45} + 2\sqrt{\frac{1}{3}}$

17. $\sqrt{125} - 2\sqrt{\frac{1}{5}} + \sqrt{\frac{1}{3}}$

18. $\sqrt{\frac{2}{3}} + 3\sqrt{3} - 4\sqrt{\frac{1}{12}}$

10-3 Study Guide and Intervention *(continued)*

Operations with Radical Expressions

Multiply Radical Expressions Multiplying two radical expressions with different radicands is similar to multiplying binomials.

Example **Multiply $(3\sqrt{2} - 2\sqrt{5})(4\sqrt{20} + \sqrt{8})$.**

Use the FOIL method.

$$(3\sqrt{2} - 2\sqrt{5})(4\sqrt{20} + \sqrt{8}) = (3\sqrt{2})(4\sqrt{20}) + (3\sqrt{2})(\sqrt{8}) + (-2\sqrt{5})(4\sqrt{20}) + (-2\sqrt{5})(\sqrt{8})$$

$= 12\sqrt{40} + 3\sqrt{16} - 8\sqrt{100} - 2\sqrt{40}$ Multiply.

$= 12\sqrt{2^2 \cdot 10} + 3 \cdot 4 - 8 \cdot 10 - 2\sqrt{2^2 \cdot 10}$ Simplify.

$= 24\sqrt{10} + 12 - 80 - 4\sqrt{10}$ Simplify.

$= 20\sqrt{10} - 68$ Combine like terms.

Exercises

Simplify each expression.

1. $2(\sqrt{3} + 4\sqrt{5})$

2. $\sqrt{6}(\sqrt{3} - 2\sqrt{6})$

3. $\sqrt{5}(\sqrt{5} - \sqrt{2})$

4. $\sqrt{2}(3\sqrt{7} + 2\sqrt{5})$

5. $(2 - 4\sqrt{2})(2 + 4\sqrt{2})$

6. $(3 + \sqrt{6})^2$

7. $(2 - 2\sqrt{5})^2$

8. $3\sqrt{2}(\sqrt{8} + \sqrt{24})$

9. $\sqrt{8}(\sqrt{2} + 5\sqrt{8})$

10. $(\sqrt{5} - 3\sqrt{2})(\sqrt{5} + 3\sqrt{2})$

11. $(\sqrt{3} + \sqrt{6})^2$

12. $(\sqrt{2} - 2\sqrt{3})^2$

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

14. $(\sqrt{8} - \sqrt{2})(\sqrt{3} + \sqrt{6})$

15. $(\sqrt{5} - \sqrt{18})(7\sqrt{5} + \sqrt{3})$

16. $(2\sqrt{3} - \sqrt{45})(\sqrt{12} + 2\sqrt{6})$

17. $(2\sqrt{5} - 2\sqrt{3})(\sqrt{10} + \sqrt{6})$

18. $(\sqrt{2} + 3\sqrt{3})(\sqrt{12} - 4\sqrt{8})$

10-3 Skills Practice

Operations with Radical Expressions

Simplify each expression.

1. $7\sqrt{7} - 2\sqrt{7}$

2. $3\sqrt{13} + 7\sqrt{13}$

3. $6\sqrt{5} - 2\sqrt{5} + 8\sqrt{5}$

4. $\sqrt{15} + 8\sqrt{15} - 12\sqrt{15}$

5. $12\sqrt{r} - 9\sqrt{r}$

6. $9\sqrt{6a} - 11\sqrt{6a} + 4\sqrt{6a}$

7. $\sqrt{44} - \sqrt{11}$

8. $\sqrt{28} + \sqrt{63}$

9. $4\sqrt{3} + 2\sqrt{12}$

10. $8\sqrt{54} - 4\sqrt{6}$

11. $\sqrt{27} + \sqrt{48} + \sqrt{12}$

12. $\sqrt{72} + \sqrt{50} - \sqrt{8}$

13. $\sqrt{180} - 5\sqrt{5} + \sqrt{20}$

14. $2\sqrt{24} + 4\sqrt{54} + 5\sqrt{96}$

15. $5\sqrt{8} + 2\sqrt{20} - \sqrt{8}$

16. $2\sqrt{13} + 4\sqrt{2} - 5\sqrt{13} + \sqrt{2}$

17. $\sqrt{2}\left(\sqrt{8} + \sqrt{6}\right)$

18. $\sqrt{5}\left(\sqrt{10} - \sqrt{3}\right)$

19. $\sqrt{6}\left(3\sqrt{2} - 2\sqrt{3}\right)$

20. $3\sqrt{3}\left(2\sqrt{6} + 4\sqrt{10}\right)$

21. $\left(4 + \sqrt{3}\right)\left(4 - \sqrt{3}\right)$

22. $\left(2 - \sqrt{6}\right)^2$

23. $\left(\sqrt{8} + \sqrt{2}\right)\left(\sqrt{5} + \sqrt{3}\right)$

24. $\left(\sqrt{6} + 4\sqrt{5}\right)\left(4\sqrt{3} - \sqrt{10}\right)$

NAME ______________________ DATE ____________ PERIOD ____________

10-3 Practice

Operations with Radical Expressions

Simplify each expression.

1. $8\sqrt{30} - 4\sqrt{30}$

2. $2\sqrt{5} - 7\sqrt{5} - 5\sqrt{5}$

3. $7\sqrt{13x} - 14\sqrt{13x} + 2\sqrt{13x}$

4. $2\sqrt{45} + 4\sqrt{20}$

5. $\sqrt{40} - \sqrt{10} + \sqrt{90}$

6. $2\sqrt{32} + 3\sqrt{50} - 3\sqrt{18}$

7. $\sqrt{27} + \sqrt{18} + \sqrt{300}$

8. $5\sqrt{8} + 3\sqrt{20} - \sqrt{32}$

9. $\sqrt{14} - \sqrt{\frac{2}{7}}$

10. $\sqrt{50} + \sqrt{32} - \sqrt{\frac{1}{2}}$

11. $5\sqrt{19} + 4\sqrt{28} - 8\sqrt{19} + \sqrt{63}$

12. $3\sqrt{10} + \sqrt{75} - 2\sqrt{40} - 4\sqrt{12}$

13. $\sqrt{6}\left(\sqrt{10} + \sqrt{15}\right)$

14. $\sqrt{5}\left(5\sqrt{2} - 4\sqrt{8}\right)$

15. $2\sqrt{7}\left(3\sqrt{12} + 5\sqrt{8}\right)$

16. $\left(5 - \sqrt{15}\right)^2$

17. $\left(\sqrt{10} + \sqrt{6}\right)\left(\sqrt{30} - \sqrt{18}\right)$

18. $\left(\sqrt{8} + \sqrt{12}\right)\left(\sqrt{48} + \sqrt{18}\right)$

19. $\left(\sqrt{2} + 2\sqrt{8}\right)\left(3\sqrt{6} - \sqrt{5}\right)$

20. $\left(4\sqrt{3} - 2\sqrt{5}\right)\left(3\sqrt{10} + 5\sqrt{6}\right)$

21. SOUND The speed of sound V in meters per second near Earth's surface is given by $V = 20\sqrt{t + 273}$, where t is the surface temperature in degrees Celsius.

a. What is the speed of sound near Earth's surface at 15°C and at 2°C in simplest form?

b. How much faster is the speed of sound at 15°C than at 2°C?

22. GEOMETRY A rectangle is $5\sqrt{7} + 2\sqrt{3}$ meters long and $6\sqrt{7} - 3\sqrt{3}$ meters wide.

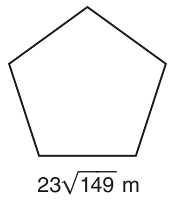
a. Find the perimeter of the rectangle in simplest form.

b. Find the area of the rectangle in simplest form.

10-3 Word Problem Practice

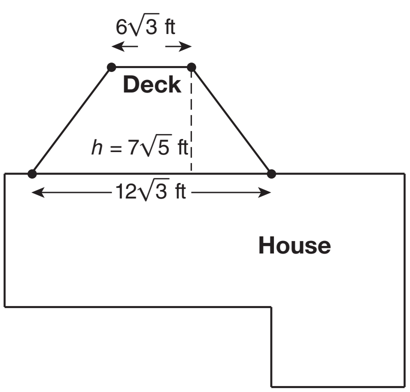
Operations with Radical Expressions

1. ARCHITECTURE The Pentagon is the building that houses the U.S. Department of Defense. Find the approximate perimeter of the building, which is a regular pentagon. Leave your answer as a radical expression.

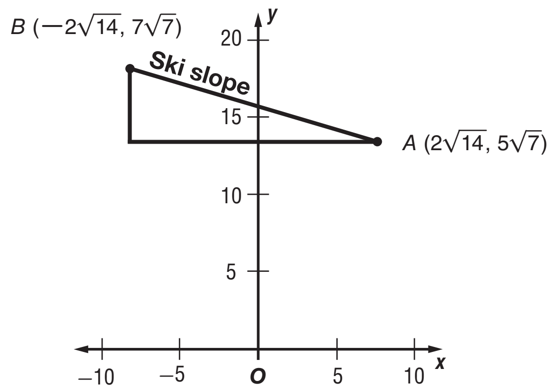


2. EARTH The surface area S of a sphere with radius r is given by the formula $S = 4\pi r^2$. Assuming that Earth is close to spherical in shape and has a surface area of about 5.1×10^8 square kilometers, what is the radius of Earth to the nearest ten kilometers?

3. GEOMETRY The area of a trapezoid is found by multiplying its height by the average length of its bases. Find the area of deck attached to Mr. Wilson's house. Give your answer as a simplified radical expression.



4. RECREATION Carmen surveyed a ski slope using a digital device connected to a computer. The computer model assigned coordinates to the top and bottom points of the hill as shown in the diagram. Write a simplified radical expression that represents the slope of the hill.



5. FREE FALL A ball is dropped from a building window 800 feet above the ground. A heavier ball is dropped from a lower window 288 feet high. Both balls are released at the same time. Assume air resistance is not a factor and use the following formula to find how many seconds t it will take a ball to fall h feet.

$$t = \frac{1}{4}\sqrt{h}$$

a. How much time will pass between when the first ball hits the ground and when the second ball hits the ground? Give your answer as a simplified radical expression.

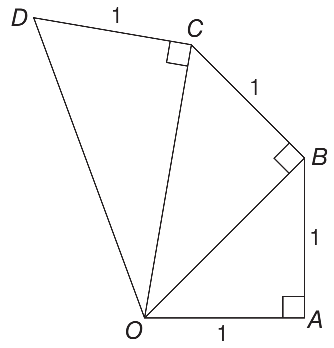
b. Which ball lands first?

c. Find a decimal approximation of the answer for part **a**. Round your answer to the nearest tenth.

Lesson 10-3

10-3 Enrichment

The Wheel of Theodorus



The Greek mathematicians were intrigued by problems of representing different numbers and expressions using geometric constructions.

Theodorus, a Greek philosopher who lived about 425 B.C., is said to have discovered a way to construct the sequence $\sqrt{1}, \sqrt{2}, \sqrt{3}, \sqrt{4}, \ldots$.

The beginning of his construction is shown. You start with an isosceles right triangle with sides 1 unit long.

Use the figure above. Write each length as a radical expression in simplest form.

1. line segment *AO*

2. line segment *BO*

3. line segment *CO*

4. line segment *DO*

5. Describe how each new triangle is added to the figure.

6. The length of the hypotenuse of the first triangle is $\sqrt{2}$. For the second triangle, the length is $\sqrt{3}$. Write an expression for the length of the hypotenuse of the nth triangle.

7. Show that the method of construction will always produce the next number in the sequence. (*Hint:* Find an expression for the hypotenuse of the $(n + 1)$th triangle.)

8. In the space below, construct a Wheel of Theodorus. Start with a line segment 1 centimeter long. When does the Wheel start to overlap?

10-4 Study Guide and Intervention

Radical Equations

Radical Equations Equations containing radicals with variables in the radicand are called **radical equations**. These can be solved by first using the following steps.

Step 1	Isolate the radical on one side of the equation.
Step 2	Square each side of the equation to eliminate the radical.

Example 1 **Solve $16 = \frac{\sqrt{x}}{2}$ for x.**

$16 = \frac{\sqrt{x}}{2}$	Original equation
$2(16) = 2\left(\frac{\sqrt{x}}{2}\right)$	Multiply each side by 2.
$32 = \sqrt{x}$	Simplify.
$(32)^2 = (\sqrt{x})^2$	Square each side.
$1024 = x$	Simplify.

The solution is 1024, which checks in the original equation.

Example 2 **Solve $\sqrt{4x - 7} + 2 = 7$.**

$\sqrt{4x - 7} + 2 = 7$	Original equation
$\sqrt{4x - 7} + 2 - 2 = 7 - 2$	Subtract 2 from each side.
$\sqrt{4x - 7} = 5$	Simplify.
$\left(\sqrt{4x - 7}\right)^2 = 5^2$	Square each side.
$4x - 7 = 25$	Simplify.
$4x - 7 + 7 = 25 + 7$	Add 7 to each side.
$4x = 32$	Simplify.
$x = 8$	Divide each side by 4.

The solution is 8, which checks in the original equation.

Exercises

Solve each equation. Check your solution.

1. $\sqrt{a} = 8$

2. $\sqrt{a} + 6 = 32$

3. $2\sqrt{x} = 8$

4. $7 = \sqrt{26 - n}$

5. $\sqrt{-a} = 6$

6. $\sqrt{3r^2} = 3$

7. $2\sqrt{3} = \sqrt{y}$

8. $2\sqrt{3a} - 2 = 7$

9. $\sqrt{x - 4} = 6$

10. $\sqrt{2m + 3} = 5$

11. $\sqrt{3b - 2} + 19 = 24$

12. $\sqrt{4x - 1} = 3$

13. $\sqrt{3r + 2} = 2\sqrt{3}$

14. $\sqrt{\frac{x}{2}} = \frac{1}{2}$

15. $\sqrt{\frac{x}{8}} = 4$

16. $\sqrt{6x^2 + 5x} = 2$

17. $\sqrt{\frac{x}{3}} + 6 = 8$

18. $2\sqrt{\frac{3x}{5}} + 3 = 11$

10-4 Study Guide and Intervention *(continued)*

Radical Equations

Extraneous Solutions To solve a radical equation with a variable on both sides, you need to square each side of the equation. Squaring each side of an equation sometimes produces **extraneous solutions**, or solutions that are not solutions of the original equation. Therefore, it is very important that you check each solution.

Example 1 **Solve $\sqrt{x+3} = x - 3$.**

$\sqrt{x+3} = x - 3$	Original equation
$\left(\sqrt{x+3}\right)^2 = (x-3)^2$	Square each side.
$x + 3 = x^2 - 6x + 9$	Simplify.
$0 = x^2 - 7x + 6$	Subtract x and 3 from each side.
$0 = (x-1)(x-6)$	Factor.
$x - 1 = 0$ or $x - 6 = 0$	Zero Product Property
$x = 1$ $\quad$ $x = 6$	Solve.

CHECK

$\sqrt{x+3} = x - 3$	$\sqrt{x+3} = x - 3$
$\sqrt{1+3} \stackrel{?}{=} 1 - 3$	$\sqrt{6+3} \stackrel{?}{=} 6 - 3$
$\sqrt{4} \stackrel{?}{=} -2$	$\sqrt{9} \stackrel{?}{=} 3$
$2 \neq -2$	$3 = 3$ ✓

Since $x = 1$ does not satisfy the original equation, $x = 6$ is the only solution.

Exercises

Solve each equation. Check your solution.

1. $\sqrt{a} = a$

2. $\sqrt{a+6} = a$

3. $2\sqrt{x} = x$

4. $n = \sqrt{2-n}$

5. $\sqrt{-a} = a$

6. $\sqrt{10-6k} + 3 = k$

7. $\sqrt{y-1} = y - 1$

8. $\sqrt{3a-2} = a$

9. $\sqrt{x+2} = x$

10. $\sqrt{2b+5} = b - 5$

11. $\sqrt{3b+6} = b + 2$

12. $\sqrt{4x-4} = x$

13. $r + \sqrt{2-r} = 2$

14. $\sqrt{x^2+10x} = x + 4$

15. $-2\sqrt{\frac{x}{8}} = 15$

16. $\sqrt{6x^2-4x} = x + 2$

17. $\sqrt{2y^2-64} = y$

18. $\sqrt{3x^2+12x+1} = x + 5$

NAME ______________________ DATE ____________ PERIOD ____________

10-4 Skills Practice

Radical Equations

Solve each equation. Check your solution.

1. $\sqrt{f} = 7$

2. $\sqrt{-x} = 5$

3. $\sqrt{5p} = 10$

4. $\sqrt{4y} = 6$

5. $2\sqrt{2} = \sqrt{u}$

6. $3\sqrt{5} = \sqrt{-n}$

7. $\sqrt{g} - 6 = 3$

8. $\sqrt{5a} + 2 = 0$

9. $\sqrt{2t - 1} = 5$

10. $\sqrt{3k - 2} = 4$

11. $\sqrt{x + 4} - 2 = 1$

12. $\sqrt{4x - 4} - 4 = 0$

13. $\frac{\sqrt{d}}{3} = 4$

14. $\sqrt{\frac{m}{3}} = 3$

15. $x = \sqrt{x + 2}$

16. $d = \sqrt{12 - d}$

17. $\sqrt{6x - 9} = x$

18. $\sqrt{6p - 8} = p$

19. $\sqrt{x + 5} = x - 1$

20. $\sqrt{8 - d} = d - 8$

21. $\sqrt{r - 3} + 5 = r$

22. $\sqrt{y - 1} + 3 = y$

23. $\sqrt{5n + 4} = n + 2$

24. $\sqrt{3z - 6} = z - 2$

10-4 Practice

Radical Equations

Solve each equation. Check your solution.

1. $\sqrt{-b} = 8$

2. $4\sqrt{3} = \sqrt{x}$

3. $2\sqrt{4r} + 3 = 11$

4. $6 - \sqrt{2y} = -2$

5. $\sqrt{k + 2} - 3 = 7$

6. $\sqrt{m - 5} = 4\sqrt{3}$

7. $\sqrt{6t + 12} = 8\sqrt{6}$

8. $\sqrt{3j - 11} + 2 = 9$

9. $\sqrt{2x + 15} + 5 = 18$

10. $\sqrt{\frac{3d}{5}} - 4 = 2$

11. $6\sqrt{\frac{3x}{3}} - 3 = 0$

12. $6 + \sqrt{\frac{5r}{6}} = -2$

13. $y = \sqrt{y + 6}$

14. $\sqrt{15 - 2x} = x$

15. $\sqrt{w + 4} = w + 4$

16. $\sqrt{17 - k} = k - 5$

17. $\sqrt{5m - 16} = m - 2$

18. $\sqrt{24 + 8q} = q + 3$

19. $\sqrt{4t + 17} - t - 3 = 0$

20. $4 - \sqrt{3m + 28} = m$

21. $\sqrt{10p + 61} - 7 = p$

22. $\sqrt{2x^2 - 9} = x$

23. ELECTRICITY The voltage V in a circuit is given by $V = \sqrt{PR}$, where P is the power in watts and R is the resistance in ohms.

a. If the voltage in a circuit is 120 volts and the circuit produces 1500 watts of power, what is the resistance in the circuit?

b. Suppose an electrician designs a circuit with 110 volts and a resistance of 10 ohms. How much power will the circuit produce?

24. FREE FALL Assuming no air resistance, the time t in seconds that it takes an object to fall h feet can be determined by the equation $t = \frac{\sqrt{h}}{4}$.

a. If a skydiver jumps from an airplane and free falls for 10 seconds before opening the parachute, how many feet does the skydiver fall?

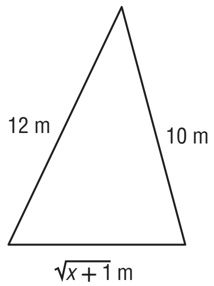
b. Suppose a second skydiver jumps and free falls for 6 seconds. How many feet does the second skydiver fall?

10-4 Word Problem Practice

Radical Equations

1. SUBMARINES The distance in miles that the lookout of a submarine can see is approximately $d = 1.22\sqrt{h}$, where h is the height in feet above the surface of the water. How far would a submarine periscope have to be above the water to locate a ship 6 miles away? Round your answer to the nearest tenth.

2. PETS Find the value of x if the perimeter of a triangular dog pen is 25 meters.



3. LOGGING Doyle's log rule estimates the amount of usable lumber in board feet that can be milled from a shipment of logs. It is represented by the equation $B = L\left(\frac{d-4}{4}\right)^2$, where d is the log diameter in inches and L is the log length in feet. Suppose the truck carries 20 logs, each 25 feet long, and that the shipment yields a total of 6000 board feet of lumber. Estimate the diameter of the logs to the nearest inch. Assume that all the logs have uniform length and diameter.

4. FIREFIGHTING Fire fighters calculate the flow rate of water out of a particular hydrant by using the following formula.

$$F = 26.9d^2\sqrt{p}$$

F is the flow rate in gallons per minute, p is the nozzle pressure in pounds per square inch, and d is the diameter of the hose in inches. In order to effectively fight a fire, the combined flow rate of two hoses needs to be about 2430 gallons per minute. The diameter of each of the hoses is 3 inches, but the nozzle pressure of one hose is 4 times that of the second hose. What are the nozzle pressures for each hose? Round your answers to the nearest tenth.

5. GEOMETRY The lateral surface area L of a right circular cone is the surface area not including the area of the base. The lateral surface area is represented by $L = \pi r\sqrt{r^2 + h^2}$, where r is the radius of the base and h is the height.

a. If the lateral surface area of a funnel is 127.54 square centimeters and its radius is 3.5 centimeters, find its height to the nearest tenth of a centimeter.

b. What is the area of the opening of the funnel, that is, the base of the cone?

Lesson 10-4

10-4 Enrichment

More Than One Square Root

You have learned that to remove the square root in an equation, you first need to isolate the square root, then square both sides of the equation, and finally, solve the resulting equation. However, there are equations that contain more that one square root and simply squaring once is not enough to remove all of the radicals.

Example **Solve $\sqrt{x+7} = \sqrt{x} + 1$.**

$\sqrt{x+7} = \sqrt{x} + 1$	One of the square roots is already isolated.
$\left(\sqrt{x+7}\right)^2 = \left(\sqrt{x}+1\right)^2$	Square each side to remove the square root.
$x + 7 = x + 2\sqrt{x} + 1$	Simplify. Use the FOIL method to square the right side.
$x + 7 - x - 1 = 2\sqrt{x}$	Isolate the square root term again.
$6 = 2\sqrt{x}$	Simplify.
$3 = \sqrt{x}$	Divide each side by 2.
$9 = x$	Square each side to remove the square root.

Check: Substitute into the *original* equation to make sure your solution is valid.

$\sqrt{9+7} \stackrel{?}{=} \sqrt{9} + 1$	Replace *x* with 9.
$\sqrt{16} \stackrel{?}{=} 3 + 1$	Simpify.
$4 = 4$ ✓	The equation is true, so $x = 9$ is the solution.

Exercises

Solve each equation.

1. $\sqrt{x+13} - 2 = \sqrt{x+1}$

2. $\sqrt{x+11} = \sqrt{x+3} + 2$

3. $\sqrt{x+9} - 3 = \sqrt{x-6}$

4. $\sqrt{x+21} = \sqrt{x} + 3$

5. $\sqrt{x+9} + 3 = \sqrt{x+20} + 2$

6. $\sqrt{x-6} + 6 = \sqrt{x+1} + 5$

10-4 Graphing Calculator Activity

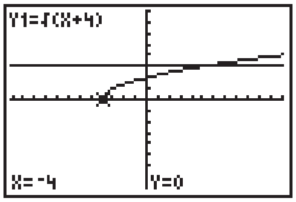
Radical Inequalities

The graphs of radical equations can be used to determine the solutions of radical inequalities through the **CALC** menu.

Example **Solve each inequality.**

a. $\sqrt{x + 4} \leq 3$

Enter $\sqrt{x + 4}$ in **Y1** and 3 in **Y2** and graph. Examine the graphs. Use TRACE to find the endpoint of the graph of the radical equation. Use **CALC** to determine the intersection of the graphs. This interval, −4 to 5, where the graph of $y = \sqrt{x + 4}$ is below the graph of $y = 3$, represents the solution to the inequality. Thus, the solution is $-4 \leq x \leq 5$.



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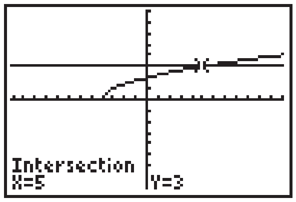

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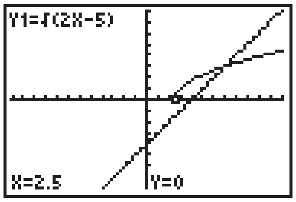
b. $\sqrt{2x - 5} > x - 4$

Graph each side of the inequality. Find the intersection and trace to the endpoint of the radical graph.

The graph of $y = \sqrt{2x - 5}$ is above the graph of $y = x - 4$ from 2.5 up to 7. Thus, the solution is $2.5 < x < 7$.



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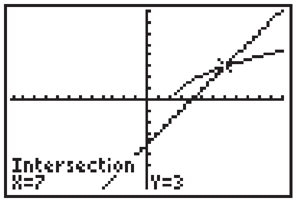

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Exercises

Solve each inequality.

1. $6 - \sqrt{2x + 1} < 3$

2. $\sqrt{4x - 5} \leq 7$

3. $\sqrt{5x - 4} \geq 4$

4. $-4 > \sqrt{3x - 2}$

5. $\sqrt{3x - 6} + 5 \geq -3$

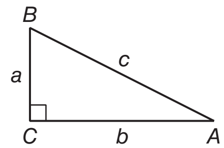
6. $\sqrt{6 - 3x} < x + 16$

NAME ______________________ DATE ____________ PERIOD ____________

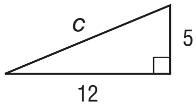
10-5 Study Guide and Intervention

The Pythagorean Theorem

The Pythagorean Theorem The side opposite the right angle in a right triangle is called the **hypotenuse**. This side is always the longest side of a right triangle. The other two sides are called the **legs** of the triangle. To find the length of any side of a right triangle, given the lengths of the other two sides, you can use the **Pythagorean Theorem**.

Pythagorean Theorem	If a and b are the measures of the legs of a right triangle and c is the measure of the hypotenuse, then $c^2 = a^2 + b^2$.	

Example **Find the missing length.**



$c^2 = a^2 + b^2$ Pythagorean Theorem

$c^2 = 5^2 + 12^2$ $a = 5$ and $b = 12$

$c^2 = 169$ Simplify.

$c = \sqrt{169}$ Take the square root of each side.

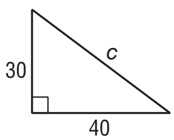
$c = 13$ Simplify.

The length of the hypotenuse is 13.

Exercises

Find the length of each missing side. If necessary, round to the nearest hundredth.

1.



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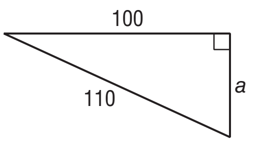

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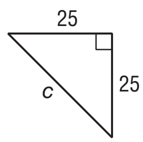

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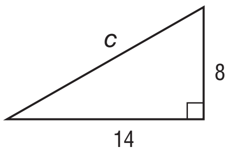
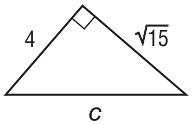
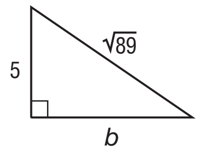


5.



6.



10-5 Study Guide and Intervention *(continued)*

The Pythagorean Theorem

Right Triangles If a and b are the measures of the shorter sides of a triangle, c is the measure of the longest side, and $c^2 = a^2 + b^2$, then the triangle is a right triangle.

Example **Determine whether each set of measures can be sides of a right triangle.**

a. 10, 12, 14

Since the greatest measure is 14, let $c = 14$, $a = 10$, and $b = 12$.

$c^2 = a^2 + b^2$	Pythagorean Theorem
$14^2 \stackrel{?}{=} 10^2 + 12^2$	$a = 10$, $b = 12$, $c = 14$
$196 \stackrel{?}{=} 100 + 144$	Multiply.
$196 \neq 244$	Add.

Since $c^2 \neq a^2 + b^2$, segments with these measures cannot form a right triangle.

b. 7, 24, 25

Since the greatest measure is 25, let $c = 25$, $a = 7$, and $b = 24$.

$c^2 = a^2 + b^2$	Pythagorean Theorem
$25^2 \stackrel{?}{=} 7^2 + 24^2$	$a = 7$, $b = 24$, $c = 25$
$625 \stackrel{?}{=} 49 + 576$	Multiply.
$625 = 625$	Add.

Since $c^2 = a^2 + b^2$, segments with these measures can form a right triangle.

Exercises

Determine whether each set of measures can be sides of a right triangle. Then determine whether they form a Pythagorean triple.

1. 14, 48, 50

2. 6, 8, 10

3. 8, 8, 10

4. 90, 120, 150

5. 15, 20, 25

6. 4, 8, $4\sqrt{5}$

7. 2, 2, $\sqrt{8}$

8. 4, 4, $\sqrt{20}$

9. 25, 30, 35

10. 24, 36, 48

11. 18, 80, 82

12. 150, 200, 250

13. 100, 200, 300

14. 500, 1200, 1300

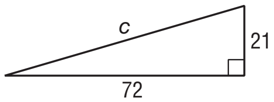
15. 700, 1000, 1300

10-5 Skills Practice

The Pythagorean Theorem

Find each missing length. If necessary, round to the nearest hundredth.

1.



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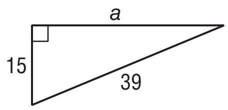

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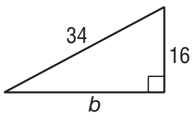

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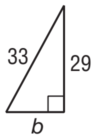

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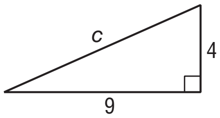

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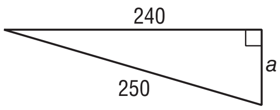


Determine whether each set of measures can be sides of a right triangle. Then determine whether they form a Pythagorean triple.

7. 7, 24, 25

8. 15, 30, 34

9. 16, 28, 32

10. 18, 24, 30

11. 15, 36, 39

12. 5, 7, $\sqrt{74}$

13. 4, 5, 6

14. 10, 11, $\sqrt{221}$

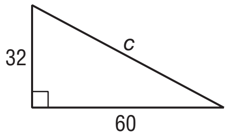
NAME ______________________ DATE ____________ PERIOD ____________

10-5 Practice

The Pythagorean Theorem

Find each missing length. If necessary, round to the nearest hundredth.

1.



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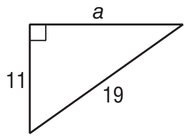

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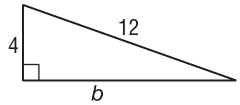


Determine whether each set of measures can be sides of a right triangle. Then determine whether they form a Pythagorean triple.

4. 11, 18, 21

5. 21, 72, 75

6. 7, 8, 11

7. 9, 10, $\sqrt{161}$

8. 9, $2\sqrt{10}$, 11

9. $\sqrt{7}$, $2\sqrt{2}$, $\sqrt{15}$

10. STORAGE The shed in Stephan's back yard has a door that measures 6 feet high and 3 feet wide. Stephan would like to store a square theater prop that is 7 feet on a side. Will it fit through the door diagonally? Explain.

11. SCREEN SIZES The size of a television is measured by the length of the screen's diagonal.

a. If a television screen measures 24 inches high and 18 inches wide, what size television is it?

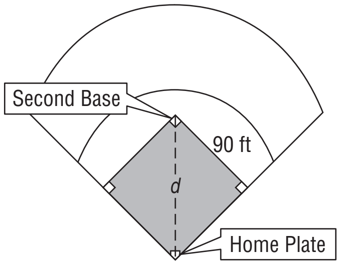
b. Darla told Tri that she has a 35-inch television. The height of the screen is 21 inches. What is its width?

c. Tri told Darla that he has a 5-inch handheld television and that the screen measures 2 inches by 3 inches. Is this a reasonable measure for the screen size? Explain.

10-5 Word Problem Practice

Pythagorean Theorem

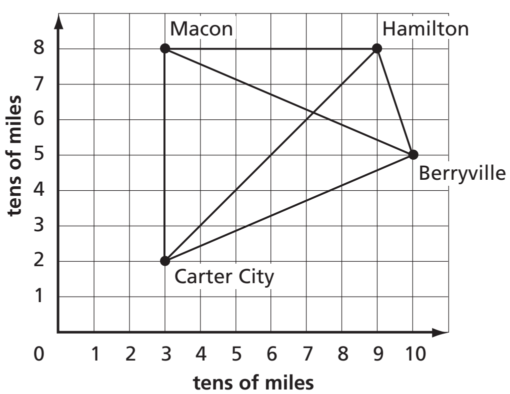
1. **BASEBALL** A baseball diamond is a square. Each base path is 90 feet long. After a pitch, the catcher quickly throws the ball from home plate to a teammate standing by second base. Find the distance the ball travels. Round your answer to the nearest tenth.



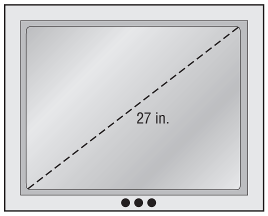
2. **TRIANGLES** Each student in Mrs. Kelly's geometry class constructed a unique right triangle from drinking straws. Mrs. Kelly made a chart with the dimensions of each triangle. However, Mrs. Kelly made a mistake when recording their results. Which result was recorded incorrectly?

Side Lengths							
Student	***a***	***b***	***c***	**Student**	***a***	***b***	***c***
Amy	3	4	5	Fran	8	14	16
Belinda	7	24	25	Gus	5	12	13
Emory	9	12	15				

3. **MAPS** Find the distance between Macon and Berryville. Round your answer to the nearest tenth.



4. **TELEVISION** Televisions are identified by the diagonal measurement of the viewing screen. For example, a 27-inch television has a diagonal screen measurement of 27 inches.

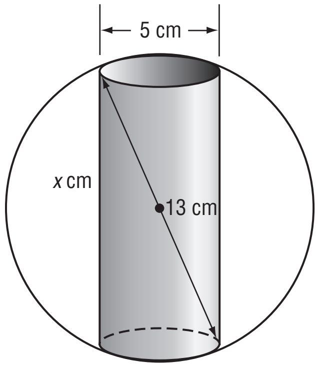


Complete the chart to find the screen height of each television given its size and screen width. Round your answers to the nearest whole number.

TV size	width (in.)	height (in.)
19-inch	15	
25-inch	21	
32-inch	25	
50-inch	40	

Source: Best Buy

5. **MANUFACTURING** Karl works for a company that manufactures car parts. His job is to drill a hole in spherical steel balls. The balls and the holes have the dimensions shown on the diagram.



a. How deep is the hole?

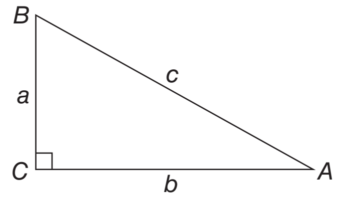
b. What would be the radius of a ball with a similar hole 7 centimeters wide and 24 centimeters deep?

10-5 Enrichment

Pythagorean Triples

Recall the Pythagorean Theorem:

In a right triangle, the square of the length of the hypotenuse is equal to the sum of the squares of the lengths of the legs.



$a^2 + b^2 = c^2$

Note that c is the length of the hypotenuse.

The integers 3, 4, and 5 satisfy the Pythagorean Theorem and can be the lengths of the sides of a right triangle.

$3^2 + 4^2 \stackrel{?}{=} 5^2$
$9 + 16 \stackrel{?}{=} 25$
$25 = 25$ ✓

Furthermore, for any positive integer n, the numbers $3n$, $4n$, and $5n$ satisfy the Pythagorean Theorem.

For $n = 2$: $6^2 + 8^2 \stackrel{?}{=} 10^2$
$36 + 64 \stackrel{?}{=} 100$
$100 = 100$ ✓

If three positive integers satisfy the Pythagorean Theorem, they are called a **Pythagorean triple**. Here is an easy way to find other Pythagorean triples.

The numbers a, b, and c are a Pythagorean triple if $a = m^2 - n^2$, $b = 2mn$, and $c = m^2 + n^2$, where m and n are relatively prime positive integers and $m > n$.

Example **Choose $m = 5$ and $n = 2$.**

$a = m^2 - n^2 = 5^2 - 2^2 = 25 - 4 = 21$

$b = 2mn = 2(5)(2) = 20$

$c = m^2 + n^2 = 5^2 + 2^2 = 25 + 4 = 29$

Check $20^2 + 21^2 \stackrel{?}{=} 29^2$
$400 + 441 \stackrel{?}{=} 841$
$841 = 841$ ✓

Exercises

Use the following values of *m* and *n* to find Pythagorean triples.

1. $m = 3$ and $n = 2$

2. $m = 4$ and $n = 1$

3. $m = 5$ and $n = 3$

4. $m = 6$ and $n = 5$

5. $m = 10$ and $n = 7$

6. $m = 8$ and $n = 5$

Lesson 10-5

NAME ______________________ DATE ____________ PERIOD ____________

10-5 Spreadsheet Activity

Pythagorean Triples

A **Pythagorean triple** is a set of three whole numbers that satisfies the equation $a^2 + b^2 = c^2$, where c is the greatest number. You can use a spreadsheet to investigate the patterns in Pythagorean triples. A **primitive Pythagorean triple** is a Pythagorean triple in which the numbers have no common factors other than 1. A **family of Pythagorean triples** is a primitive Pythagorean triple and its whole number multiples.

The spreadsheet at the right produces a family of Pythagorean triples.

Step 1 Enter a primitive Pythagorean triple into cells A1, B1, and C1.

Step 2 Use rows 2 through 10 to find 9 additional Pythagorean triples that are multiples of the primitive triple. Format the rows so that row 2 multiplies the numbers in row 1 by 2, row 3 multiplies the numbers in row 1 by 3, and so on.

Triples.xls

◇	A	B	C
1	3	4	5
2	6	8	10
3	9	12	15
4	12	16	20
5	15	20	25
6	18	24	30
7	21	28	35
8	24	32	40
9	27	36	45
10	30	40	50

Sheet 1 Sheet 2

The formula in cell A10 is A1 * 10.

Exercises

Use the spreadsheet of families of Pythagorean triples.

1. Choose one of the triples other than (3, 4, 5) from the spreadsheet. Verify that it is a Pythagorean triple.

2. Two polygons are **similar** if they are the same shape, but not necessarily the same size. For triangles, if two triangles have angles with the same measures then they are similar. Use a centimeter ruler to draw triangles with measures from the spreadsheet. Do the triangles appear to be similar?

Each of the following is a primitive Pythagorean triple. Use the spreadsheet to find two Pythagorean triples in their families.

3. (5, 12, 13)

4. (9, 40, 41)

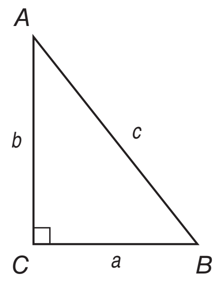
5. (20, 21, 29)

10-6 Study Guide and Intervention

Trigonometric Ratios

Trigonometric Ratios Trigonometry is the study of relationships of the angles and the sides of a right triangle. The three most common trigonometric ratios are the **sine**, **cosine**, and **tangent**.

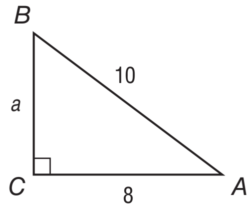
sine of $\angle A = \dfrac{\text{leg opposite } \angle A}{\text{hypotenuse}}$ sine of $\angle B = \dfrac{\text{leg opposite } \angle B}{\text{hypotenuse}}$	$\sin A = \frac{a}{c}$ $\sin B = \frac{b}{c}$
cosine of $\angle A = \dfrac{\text{leg adjacent to } \angle A}{\text{hypotenuse}}$ cosine of $\angle B = \dfrac{\text{leg adjacent to } \angle B}{\text{hypotenuse}}$	$\cos A = \frac{b}{c}$ $\cos B = \frac{a}{c}$
tangent of $\angle A = \dfrac{\text{leg opposite } \angle A}{\text{leg adjacent to } \angle A}$ tangent of $\angle B = \dfrac{\text{leg opposite } \angle B}{\text{leg adjacent to } \angle B}$	$\tan A = \frac{a}{b}$ $\tan B = \frac{b}{a}$



Example **Find the values of the three trigonometric ratios for angle *A*.**

Step 1 Use the Pythagorean Theorem to find *BC*.

$a^2 + b^2 = c^2$	Pythagorean Theorem
$a^2 + 8^2 = 10^2$	$b = 8$ and $c = 10$
$a^2 + 64 = 100$	Simplify.
$a^2 = 36$	Subtract 64 from each side.
$a = 6$	Take the positive square root of each side.



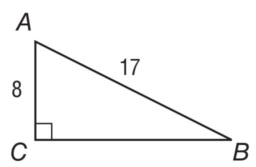
Step 2 Use the side lengths to write the trigonometric ratios.

$\sin A = \frac{\text{opp}}{\text{hyp}} = \frac{6}{10} = \frac{3}{5}$ $\quad \cos A = \frac{\text{adj}}{\text{hyp}} = \frac{8}{10} = \frac{4}{5}$ $\quad \tan A = \frac{\text{opp}}{\text{adj}} = \frac{6}{8} = \frac{3}{4}$

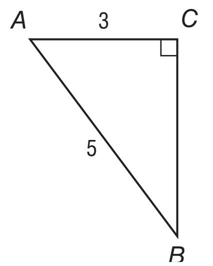
Exercises

Find the values of the three trigonometric ratios for angle *A*.

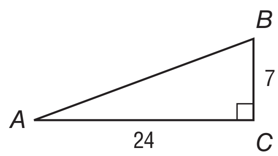
1.



2.



3.



Use a calculator to find the value of each trigonometric ratio to the nearest ten-thousandth.

4. sin 40°

5. cos 25°

6. tan 85°

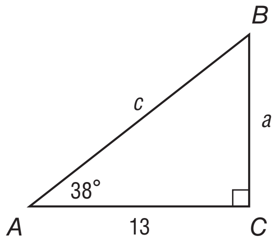
NAME ______________________ DATE ____________ PERIOD ____________

10-6 Study Guide and Intervention *(continued)*

Trigonometric Ratios

Use Trigonometric Ratios When you find all of the unknown measures of the sides and angles of a right triangle, you are **solving the triangle**. You can find the missing measures of a right triangle if you know the measure of two sides of the triangle, or the measure of one side and the measure of one acute angle.

Example **Solve the right triangle. Round each side length to the nearest tenth.**



Step 1 Find the measure of $\angle B$. The sum of the measures of the angles in a triangle is 180.
$180° - (90° + 38°) = 52°$
The measure of $\angle B$ is 52°.

Step 2 Find the measure of $\overline{AB}$. Because you are given the measure of the side adjacent to $\angle A$ and are finding the measure of the hypotenuse, use the cosine ratio.

$\cos 38° = \frac{13}{c}$ Definition of cosine

$c \cos 38° = 13$ Multiply each side by c.

$c = \frac{13}{\cos 38°}$ Divide each side by cos 38°.

So the measure of $\overline{AB}$ is about 16.5.

Step 3 Find the measure of $\overline{BC}$. Because you are given the measure of the side adjacent to $\angle A$ and are finding the measure of the side opposite $\angle A$, use the tangent ratio.

$\tan 38° = \frac{a}{13}$ Definition of tangent

$13 \tan 38° = a$ Multiply each side by 13.

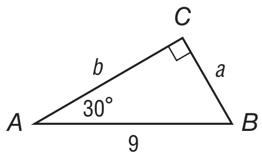
$10.2 \approx a$ Use a calculator.

So the measure of $\overline{BC}$ is about 10.2.

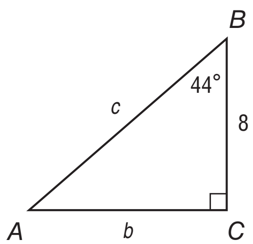
Exercises

Solve each right triangle. Round each side length to the nearest tenth.

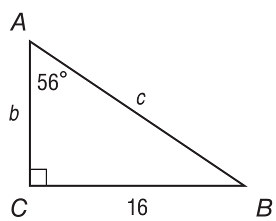
1.



2.



3.

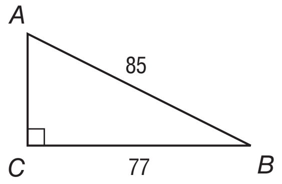


10-6 Skills Practice

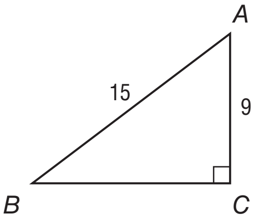
Trigonometric Ratios

Find the values of the three trigonometric ratios for angle *A*.

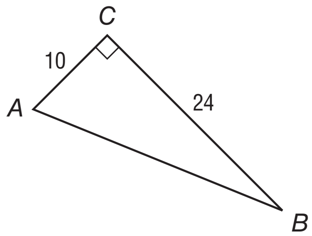
1.



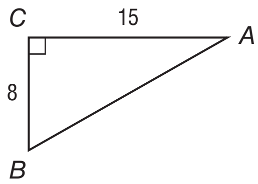
2.



3.



4.



Use a calculator to find the value of each trigonometric ratio to the nearest ten-thousandth.

5. sin 18°

6. cos 68°

7. tan 27°

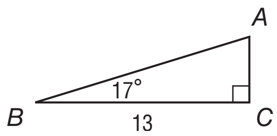
8. cos 60°

9. tan 75°

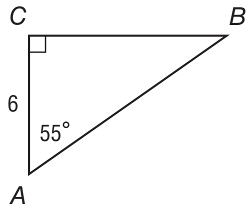
10. sin 9°

Solve each right triangle. Round each side length to the nearest tenth.

11.

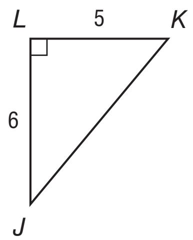


12.

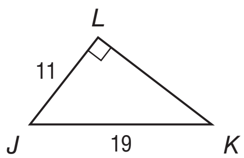


Find $m\angle J$ for each right triangle to the nearest degree.

13.



14.



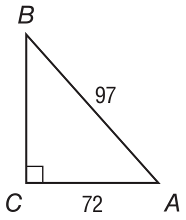
NAME ______________________________ DATE ____________ PERIOD ____________

10-6 Practice

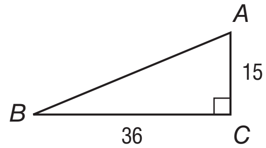
Trigonometric Ratios

Find the values of the three trigonometric ratios for angle *A*.

1.



2.



Use a calculator to find the value of each trigonometric ratio to the nearest ten-thousandth.

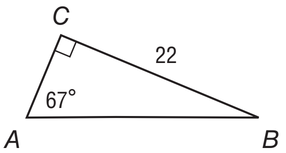
3. tan 26°

4. sin 53°

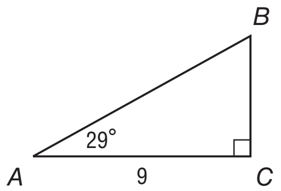
5. cos 81°

Solve each right triangle. Round each side length to the nearest tenth.

6.

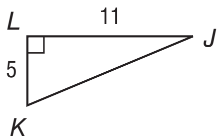


7.

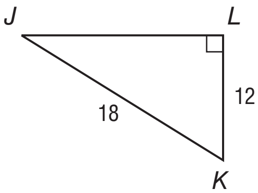


Find *m*∠*J* for each right triangle to the nearest degree.

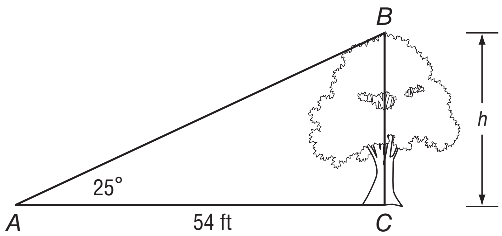
8.



9.



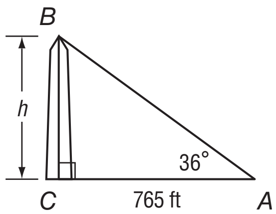
10. SURVEYING If point *A* is 54 feet from the tree, and the angle between the ground at point *A* and the top of the tree is 25°, find the height *h* of the tree.



10-6 Word Problem Practice

Trigonometric Ratios

1. **WASHINGTON MONUMENT** Jeannie is trying to determine the height of the Washington Monument. If point A is 765 feet from the monument, and the angle between the ground and the top of the monument at point A is 36°, find the height h of the monument to the nearest foot.

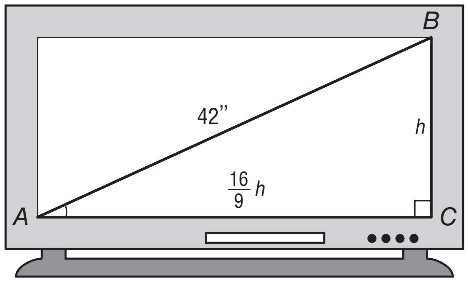


2. **AIRPLANES** A pilot takes off from a runway at an angle of 20º and maintains that angle until it is at its cruising altitude of 2500 feet. What horizontal distance has the plane traveled when it reaches its cruising altitude?

3. **TRUCK RAMPS** A moving company uses an 11-foot-long ramp to unload furniture from a truck. If the truck bed is 3 feet above the ground, what is the angle of incline of the ramp to the nearest degree?

4. **SPECIAL TRIANGLES** While investigating right triangle KLM, Mercedes finds that $\cos M = \sin M$. What is the measure of angle M?

5. **TELEVISIONS** Televisions are commonly sized by measuring their diagonal. A common size for widescreen plasma TVs is 42 inches.



a. A widescreen television has a 16:9 aspect ratio, that is, the screen width is $\frac{16}{9}$ times the screen height. Use the Pythagorean Theorem to write an equation and solve for the height h of the television in inches.

b. Use the information from part **a** to solve the right triangle.

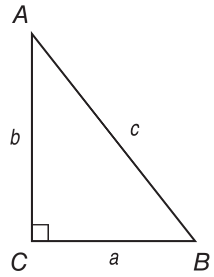
c. To the nearest degree what would the measure of angle BAC be on a standard television with a 4:3 aspect ratio?

NAME ______________________ DATE ____________ PERIOD ____________

10-6 Enrichment

More Trigonometric Ratios

In addition to the sine, cosine, and tangent, there are three other common trigonometric ratios. They are the **secant**, **cosecant**, and **cotangent**.

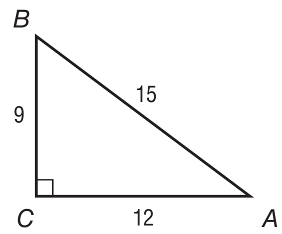
secant of $\angle A = \frac{\text{hypotenuse}}{\text{leg adjacent } \angle A}$ secant of $\angle B = \frac{\text{hypotenuse}}{\text{leg adjacent } \angle B}$	$\sec A = \frac{c}{b}$ $\sec B = \frac{c}{a}$	
cosecant of $\angle A = \frac{\text{hypotenuse}}{\text{leg opposite } \angle A}$ cosecant of $\angle B = \frac{\text{hypotenuse}}{\text{leg opposite } \angle B}$	$\csc A = \frac{c}{a}$ $\csc B = \frac{c}{b}$	
cotangent of $\angle A = \frac{\text{leg adjacent to } \angle A}{\text{leg opposite } \angle A}$ cotangent of $\angle B = \frac{\text{leg adjacent to } \angle B}{\text{leg opposite } \angle B}$	$\cot A = \frac{b}{a}$ $\cot B = \frac{a}{b}$	

Example **Find the secant, cosecant, and cotangent of angle *A*.**

Use the side lengths to write the trigonometric ratios.

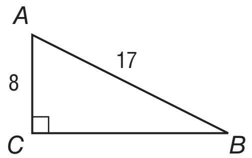
$$\sec A = \frac{\text{hyp}}{\text{adj}} = \frac{15}{12} = \frac{5}{4} \qquad \csc A = \frac{\text{hyp}}{\text{opp}} = \frac{15}{9} = \frac{5}{3}$$

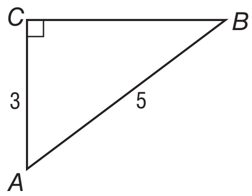
$$\cot A = \frac{\text{adj}}{\text{opp}} = \frac{12}{9} = \frac{4}{3}$$

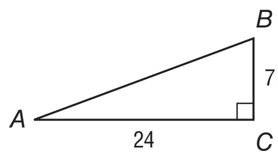


Exercises

Find the secant, cosecant, and cotangent of angle *A*.

1. 

2. 

3. 

4. How does the sine of an angle relate to the angle's cosecant? How does the cosine of an angle relate to the angle's secant? How does the cotangent of an angle relate to the angle's tangent?

Use the relations that you found in Exercise 4 and a calculator to find the value of each trigonometric ratio to the nearest ten-thousandth.

5. sec 17° **6.** csc 49° **7.** cot 81°

NAME ______________________ DATE ____________ PERIOD ____________

10 Student Recording Sheet

Use this recording sheet with pages 670–671 of the Student Edition.

Assessment

Multiple Choice

Read each question. Then fill in the correct answer.

1. Ⓐ Ⓑ Ⓒ Ⓓ
2. Ⓕ Ⓖ Ⓗ Ⓙ
3. Ⓐ Ⓑ Ⓒ Ⓓ
4. Ⓕ Ⓖ Ⓗ Ⓙ
5. Ⓐ Ⓑ Ⓒ Ⓓ
6. Ⓕ Ⓖ Ⓗ Ⓙ
7. Ⓐ Ⓑ Ⓒ Ⓓ

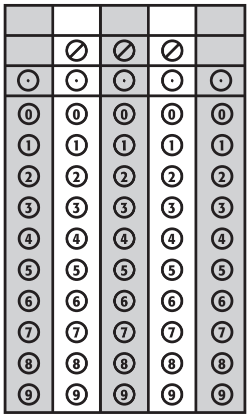
Short Response/Gridded Response

Record your answer in the blank.

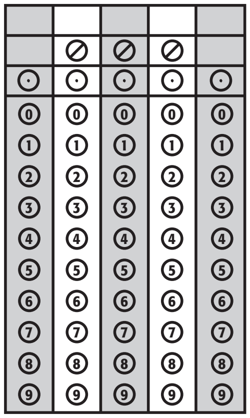
For gridded response questions, also enter your answer in the grid by writing each number or symbol in a box. Then fill in the corresponding circle for that number or symbol.

8. ____________ *(grid in)*
9. ____________
10. ____________ *(grid in)*
11. ____________
12. ____________ *(grid in)*
13. ____________
14. ____________
15. ____________ *(grid in)*

8.



10.



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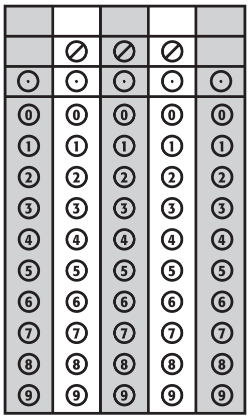
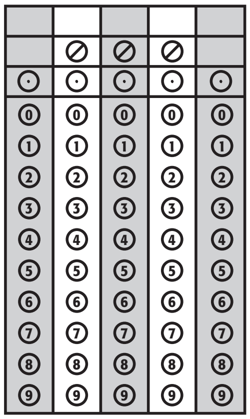


15.



Extended Response

Record your answers for Question 16 on the back of this paper.

10 Rubric for Scoring Extended Response

General Scoring Guidelines

- If a student gives only a correct numerical answer to a problem but does not show how he or she arrived at the answer, the student will be awarded only 1 credit. All extended response questions require the student to show work.
- A fully correct answer for a multiple-part question requires correct responses for all parts of the question. For example, if a question has three parts, the correct response to one or two parts of the question that required work to be shown is not considered a fully correct response.
- Students who use trial and error to solve a problem must show their method. Merely showing that the answer checks or is correct is not considered a complete response for full credit.

Exercise 16 Rubric

Score	Specific Criteria
4	A correct solution that is supported by well-developed, accurate explanations. The distance between Karen's school and the park is 25.1 miles. The coordinates of Karen's house are (0.5, 0.5). The student should show a working knowledge of the Pythagorean Theorem.
3	A generally correct solution, but may contain minor flaws in reasoning or computation.
2	A partially correct interpretation and/or solution to the problem.
1	A correct solution with no evidence or explanation.
0	An incorrect solution indicating no mathematical understanding of the concept or task, or no solution is given.

NAME ______________________ DATE ____________ PERIOD ____________

10 Chapter 10 Quiz 1

SCORE ________

(Lessons 10-1 and 10-2)

Assessment

1. Graph $y = 2\sqrt{x+1}$. State the domain and range.

2. MULTIPLE CHOICE Which function has a domain of $\{x \mid x \geq 4\}$?

A $y = \sqrt{x-4}$ **B** $y = \sqrt{x+4}$ **C** $y = \sqrt{x} - 4$ **D** $y = \sqrt{x} + 4$

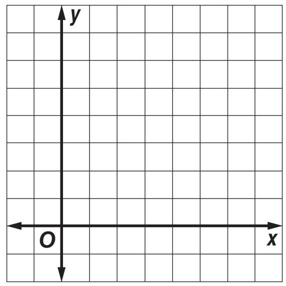
Simplify each expression.

3. $\sqrt{72}$

4. $\sqrt{8x^2y}$

5. $\dfrac{3}{4+\sqrt{2}}$

1.



2. ____________

3. ____________

4. ____________

5. ____________

NAME ______________________ DATE ____________ PERIOD ____________

10 Chapter 10 Quiz 2

SCORE ________

(Lessons 10-3 and 10-4)

Simplify each expression.

1. $6\sqrt{45} + 2\sqrt{80}$

2. $5\sqrt{6} - 4\sqrt{10} - \sqrt{6} + 12\sqrt{10}$

3. $\sqrt{10}(\sqrt{5} + 3\sqrt{2})$

4. $(\sqrt{6} - \sqrt{5})(\sqrt{10} + \sqrt{3})$

5. MULTIPLE CHOICE Find the perimeter of a rectangle with a width $2\sqrt{5} + 3\sqrt{11}$ and a length $3\sqrt{5} - \sqrt{11}$.

A $7\sqrt{55} - 3$ **B** $5\sqrt{5} + 2\sqrt{11}$ **C** $14\sqrt{55} - 6$ **D** $10\sqrt{5} + 4\sqrt{11}$

Solve each equation. Check your solution.

6. $\sqrt{2x+6} + 6 = 10$

7. $\sqrt{c+2} = c - 4$

8. $\sqrt{11x - 24} = x$

9. $3\sqrt{(m+5)} - 3 = 6$

10. $\sqrt{3a+4} = \sqrt{12a - 14}$

1. ____________

2. ____________

3. ____________

4. ____________

5. ____________

6. ____________

7. ____________

8. ____________

9. ____________

10. ____________

NAME ________________ DATE ________ PERIOD ________

10 Chapter 10 Quiz 3

SCORE ________

(Lesson 10-5)

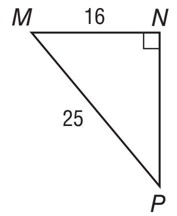
1. If c is the measure of the hypotenuse of a right triangle, find the missing measure. If necessary, round to the nearest hundredth. $b = 3$, $c = 15$, $a = ?$ **1.** ________

2. Determine whether the side measures 7, 9, and 12 form a right triangle. **2.** ________

3. **MULTIPLE CHOICE** What is the area of triangle *MNP*?

A 29.68 units^2 **B** 19.21 units^2

C 153.67 units^2 **D** 307.35 units^2 **3.** ________



Determine whether the following set of measures form a Pythagorean triple.

4. 48, 64, 82 **4.** ________

5. $\sqrt{4}, \sqrt{6}, \sqrt{10}$ **5.** ________

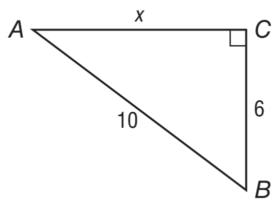
NAME ________________ DATE ________ PERIOD ________

10 Chapter 10 Quiz 4

SCORE ________

(Lesson 10-6)

Use the triangle for Questions 1–3.



1. Find x. **1.** ________

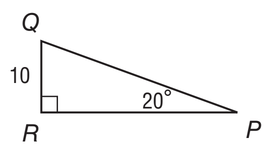
2. Find the values of the three trigonometric ratios for angle B. **2.** ________

3. Find the values of the three trigonometric ratios for angle A. **3.** ________

4. **MULTIPLE CHOICE** Which is not equal to 1?

A sin 45° **B** tan 45° **C** cos 0° **D** sin 90° **4.** ________

5. Solve the triangle. Round each side length to the nearest tenth. **5.** ________



10 Chapter 10 Mid-Chapter Test

SCORE ________

(Lessons 10-1 through 10-4)

Part I ***Write the letter for the correct answer in the blank at the right of each question.***

1. Which expression has a range of $\{y \mid y \geq 2\}$?

A $y = \sqrt{x - 2}$ **B** $y = \sqrt{x + 2}$ **C** $y = \sqrt{x} - 2$ **D** $y = \sqrt{x} + 2$ **1.** ________

2. Which expression has a domain of $\{x \mid x \geq 1\}$?

F $y = \sqrt{x - 1}$ **G** $y = \sqrt{x + 1}$ **H** $y = \sqrt{x} - 1$ **J** $y = \sqrt{x} + 1$ **2.** ________

For Questions 3–5, simplify each expression.

3. $\sqrt{288}$

A $4\sqrt{18}$ **B** $2\sqrt{12}$ **C** $4\sqrt{6}$ **D** $12\sqrt{2}$ **3.** ________

4. $\sqrt{20x^3y^2}$

F $5x|y|2\sqrt{x}$ **G** $2x|y|\sqrt{5x}$ **H** $2|x|y\sqrt{5x}$ **J** $5|x|y\sqrt{2x}$ **4.** ________

5. $\sqrt{\frac{t}{18}}$

A $\frac{\sqrt{t}}{3\sqrt{2}}$ **B** $\frac{|t|}{18}$ **C** $\frac{3t}{18}$ **D** $\frac{\sqrt{2t}}{6}$ **5.** ________

6. Solve $\sqrt{5n - 1} - n = 1$.

F 1, 2 **G** −1, −2 **H** $\frac{1}{4}$ **J** 1 **6.** ________

7. Solve $\sqrt{7 - 2b} = \sqrt{9 - b}$

A $\frac{1}{2}$ **B** 2 **C** $-\frac{1}{2}$ **D** −2 **7.** ________

Part II

Simplify each expression.

8. $\sqrt{15}(2\sqrt{3} - 4\sqrt{5})$

9. $(4\sqrt{3} + 5)(4\sqrt{3} - 5)$

10. $\sqrt{288} + 3\sqrt{162}$

11. $6\sqrt{5} - 2\sqrt{10} + \sqrt{5}$

12. $3\sqrt{50} - 2\sqrt{72} + \sqrt{24}$

For Questions 13 and 14, solve each equation.

13. $2\sqrt{5x} - 3 = 7$

14. $\sqrt{x - 4} = x - 24$

15. A square has an area of 90 square inches. The formula for the area A of a square with side length ℓ is $A = \ell^2$. Find the length of one side of the square.

8. ________________
9. ________________
10. ________________
11. ________________
12. ________________
13. ________________
14. ________________
15. ________________

NAME ______________________ DATE ____________ PERIOD ____________

10 Chapter 10 Vocabulary Test

SCORE ________

conjugates	inverse cosine	Pythagorean Theorem	solving the triangle
converse	inverse sine	radical equation	tangent
cosine	inverse tangent	radical function	trigonometry
hypotenuse	legs	radicand	

Choose from the terms above to complete each sentence.

1. If you exchange the hypothesis and conclusion of an if-then statement, the result is the ______________ of the statement. **1.** ______________

2. The trigonometric ratio equivalent to the leg adjacent to an angle divided by the hypotenuse is the ______________. **2.** ______________

3. If the lengths of two sides of a right triangle are given, the third side can be found using the ______________. **3.** ______________

4. The equation $8 = 3\sqrt{d}$ is an example of a ______________. **4.** ______________

5. The binomials $5\sqrt{3} + 2\sqrt{5}$ and $5\sqrt{3} - 2\sqrt{5}$ are ______________. **5.** ______________

6. In a right triangle, the side opposite the right angle is the ______________. **6.** ______________

7. The expression $7x$ under the radical symbol in $\sqrt{7x}$ is called the ______________. **7.** ______________

8. The two sides of a right triangle that are not the hypotenuse are called ______________. **8.** ______________

9. When you find all unknown measures of the sides and angles of a right triangle, you are ______________. **9.** ______________

Define each term in your own words.

10. trigonometry **10.** ______________

11. tangent **11.** ______________

10 Chapter 10 Test, Form 1

SCORE ________

Write the letter for the correct answer in the blank at the right of each question.

1. How does the graph of $y = \sqrt{x} + 2$ compare to the parent graph?

A translated up 2 **C** translated left 2
B translated down 2 **D** translated right 2 **1.** ________

2. Which expression has a domain of $\{x \mid x \geq -1\}$?

F $y = \sqrt{x+1}$ **G** $y = \sqrt{x-1}$ **H** $y = \sqrt{x} + 1$ **J** $y = \sqrt{x} - 1$ **2.** ________

For Questions 3–7, simplify each expression.

3. $\sqrt{90}$

A $9\sqrt{10}$ **B** $10\sqrt{9}$ **C** $3\sqrt{10}$ **D** $\sqrt{30}$ **3.** ________

4. $\dfrac{3}{5 - \sqrt{2}}$

F $\dfrac{15 + 3\sqrt{2}}{23}$ **G** $\dfrac{15 - 3\sqrt{2}}{23}$ **H** $15 + 3\sqrt{2}$ **J** $\dfrac{15 + 3\sqrt{2}}{3}$ **4.** ________

5. $6\sqrt{5} - 2\sqrt{5}$

A 4 **B** -12 **C** $-12\sqrt{5}$ **D** $4\sqrt{5}$ **5.** ________

6. $3\sqrt{12} + \sqrt{27} - 2\sqrt{20}$

F $14\sqrt{3} - 4\sqrt{5}$ **G** $3\sqrt{3} - \sqrt{2}$ **H** $9\sqrt{3} - 4\sqrt{5}$ **J** $21\sqrt{3} - 8\sqrt{5}$ **6.** ________

7. $\sqrt{2}(\sqrt{6} + 3\sqrt{2})$

A $3\sqrt{2} + 6$ **B** $6\sqrt{2}$ **C** $2\sqrt{3} + 3\sqrt{2}$ **D** $2\sqrt{3} + 6$ **7.** ________

8. Solve $\sqrt{2x - 5} = 3$.

F 4 **G** 7 **H** -8 **J** $\dfrac{11}{2}$ **8.** ________

9. Solve $\sqrt{2x + 8} = x$.

A $-2, 4$ **B** 4 **C** -2 **D** 2, 4 **9.** ________

10. Find the length of the hypotenuse of a right triangle if $a = 3$ and $b = 4$.

F 5 **G** $\sqrt{7}$ **H** 25 **J** 7 **10.** ________

11. Determine which side measures form a Pythagorean triple.

A 4, 5, 6 **B** 3, 4, 5 **C** 5, 11, 12 **D** 4, 8, 12 **11.** ________

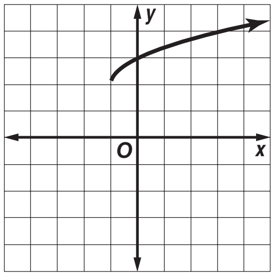
12. Find $m\angle A$ to the nearest tenth if $\cos A = \dfrac{3}{5}$.

F 0.9° **G** 31.0° **H** 36.9° **J** 53.1° **12.** ________

10 Chapter 10 Test, Form 1 *(continued)*

13. Determine which set of measures can be the lengths of the sides of a right triangle.

A 2, 3, 5 **B** 4, 6, 7 **C** 10, 12, 13 **D** $1, \sqrt{3}, 2$ **13.** ______



14. What is the equation of the graph?

F $y = \sqrt{x+2} + 1$ **H** $y = \sqrt{x+1} + 2$

G $y = \sqrt{x-2} + 1$ **J** $y = \sqrt{x-1} + 2$ **14.** ______

15. Simplify $2\sqrt{x} \cdot 5\sqrt{x} \cdot 3\sqrt{x}$.

A $30\sqrt{x}$ **B** $30x^2\sqrt{x}$ **C** $30|x|\sqrt{x}$ **D** $30x^3$ **15.** ______

16. What is the length of a diagonal of a rectangle with a length of 8 meters and a width of 6 meters?

F 10 m **G** 14 m **H** 48 m **J** 100 m **16.** ______

17. Determine which side measures form a right triangle.

A 10, 24, 28 **B** 13, 17, 21 **C** $\sqrt{3}, \sqrt{4}, \sqrt{5}$ **D** 5, 12, 13 **17.** ______

18. SAILING A 12-foot cable attached to the top of the mast of a sailboat is fastened to a point on the deck 4 feet from the base of the mast. What is the height of the mast?

F 9.56 ft **G** 22 ft **H** 11.31 ft **J** 128 ft **18.** ______

For Questions 19 and 20, the leg adjacent to $\angle A$ in a right triangle measures 8 units, and the hypotenuse measures 13 units.

19. What is cos A?

A $\frac{8}{13}$ **B** $\frac{13}{8}$ **C** 38° **D** 52° **19.** ______

20. What is $m\angle A$?

F 1° **G** 32° **H** 38° **J** 52° **20.** ______

Bonus Simplify $\sqrt{4x^2 + 4x + 1}$. **B:** ______

10 Chapter 10 Test, Form 2A

SCORE ________

Write the letter for the correct answer in the blank at the right of each question.

1. How does the graph of $y = \sqrt{x+3}$ compare to the parent graph?

A translated up 3 **C** translated right 3
B translated down 3 **D** translated left 3 **1.** ________

2. Which expression has a domain of $\{x \mid x \geq 2\}$?

F $y = \sqrt{x} + 2$ **G** $y = \sqrt{x} - 2$ **H** $y = \sqrt{x+2}$ **J** $y = \sqrt{x-2}$ **2.** ________

For Questions 3–7, simplify each expression.

3. $5\sqrt{3} \cdot 2\sqrt{21}$

A $70\sqrt{3}$ **B** $10\sqrt{63}$ **C** $49\sqrt{3}$ **D** $30\sqrt{7}$ **3.** ________

4. $\sqrt{\frac{x^2}{12}}$

F $\frac{x^2}{2\sqrt{3}}$ **G** $\frac{|x|\sqrt{3}}{6}$ **H** $\frac{x}{6}$ **J** $\frac{|x|}{\sqrt{12}}$ **4.** ________

5. $\frac{5}{\sqrt{11} - \sqrt{6}}$

A 1 **B** $\frac{5\sqrt{66}}{66}$ **C** $\sqrt{11} + \sqrt{6}$ **D** $\frac{5\sqrt{11} + 5\sqrt{6}}{17}$ **5.** ________

6. $\sqrt{18} - \sqrt{54} + 2\sqrt{50}$

F $13\sqrt{2} - 3\sqrt{6}$ **G** $-4\sqrt{3} + 4\sqrt{5}$ **H** $-4\sqrt{3} - 4\sqrt{5}$ **J** $8\sqrt{2} - 3\sqrt{6}$ **6.** ________

7. $(\sqrt{14} + \sqrt{3})(\sqrt{6} - \sqrt{7})$

A $2\sqrt{5} - \sqrt{21} + 3 - \sqrt{10}$ **C** $\sqrt{21}$
B $\sqrt{21} - 4\sqrt{2}$ **D** $\sqrt{21} + \sqrt{2}$ **7.** ________

8. Solve $\sqrt{3x - 2} + 4 = 8$.

F 12 **G** 6 **H** $\frac{2}{3}$ **J** $\frac{3}{2}$ **8.** ________

9. Solve $\sqrt{7a + 32} = a + 2$.

A -4 **B** 7 **C** $-4, 7$ **D** $-7, 4$ **9.** ________

10. A right triangle has one leg that is 7 centimeters. The hypotenuse is 25 centimeters. Find the length of the other leg.

F 15 cm **G** $\sqrt{674}$ cm **H** 24 cm **J** $5\sqrt{7}$ cm **10.** ________

11. Determine which side measures form a right triangle.

A 3, 8, 12 **B** 5, 9, 11 **C** 11, 13, 16 **D** 6, 8, 10 **11.** ________

12. Find $m\angle B$ to the nearest tenth if $\sin B = \frac{1}{3}$.

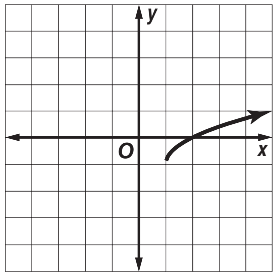
F 0.5° **G** 18.4° **H** 19.5° **J** 70.5° **12.** ________

10 Chapter 10 Test, Form 2A *(continued)*

13. Determine which set of measures can be the lengths of the sides of a right triangle.

A 3, 6, 9 **B** 1, 1, $\sqrt{2}$ **C** 3, 3, 4 **D** 1, 3, 7 **13.** ________

14. What is the equation of the graph?



F $y = \sqrt{x + 1} - 1$ **H** $y = \sqrt{x + 1} + 1$

G $y = \sqrt{x - 1} - 1$ **J** $y = \sqrt{x - 1} + 1$ **14.** ________

15. Simplify $2\sqrt{y} \cdot 5\sqrt{y} \cdot 2\sqrt{y}$.

A $20|y|\sqrt{y}$ **B** $20\sqrt{y}$ **C** $20y^2\sqrt{y}$ **D** $20y^3$ **15.** ________

16. What is the length of a diagonal of a rectangle with a length of 9 inches and a width of 3 inches?

F 3.5 in. **G** 9.5 in. **H** 18 in. **J** 90 in. **16.** ________

17. Determine which side measures form a right triangle.

A 1, 2, 3 **B** 2, 3, 4 **C** 3, 4, 5 **D** 4, 5, 6 **17.** ________

18. **LADDERS** A 16 foot ladder leans against a wall. The base of the ladder is 6 feet from where the wall meets the ground. How far up the wall does the ladder reach?

F 14.8 ft **G** 12.9 ft **H** 144 ft **J** 220 ft **18.** ________

For Questions 19 and 20, the leg opposite to $\angle A$ in a right triangle measures 12 units, and the hypotenuse measures 19 units.

19. What is sin A?

A $\frac{12}{19}$ **B** $\frac{19}{12}$ **C** 0.775 **D** 0.815 **19.** ________

20. What is $m\angle A$?

F 0.01° **G** 32° **H** 39° **J** 51° **20.** ________

Bonus Find the length of a diagonal of a square if its area is 72 square meters. **B:** ________

10 Chapter 10 Test, Form 2B

SCORE ________

Write the letter for the correct answer in the blank at the right of each question.

1. How does the graph of $y = \sqrt{x - 8}$ compare to the parent graph?

A translated up 8 **C** translated left 8

B translated down 8 **D** translated right 8 **1.** ________

2. Which expression has a range of $\{y \mid y \geq 1\}$?

F $y = \sqrt{x} + 1$ **G** $y = \sqrt{x} - 1$ **H** $y = \sqrt{x + 1}$ **J** $\sqrt{x - 1}$ **2.** ________

For Questions 3–7, simplify each expression.

3. $3\sqrt{6} \cdot 5\sqrt{2}$

A $24\sqrt{2}$ **B** $30\sqrt{3}$ **C** $45\sqrt{2}$ **D** $15\sqrt{12}$ **3.** ________

4. $\sqrt{\frac{18}{y}}$

F $\frac{3\sqrt{2y}}{y}$ **G** $\frac{3\sqrt{2}}{y}$ **H** $\frac{6}{y}$ **J** $3\sqrt{\frac{2}{y}}$ **4.** ________

5. $\frac{3}{\sqrt{8} + \sqrt{5}}$

A 1 **B** $\frac{3\sqrt{40}}{40}$ **C** $2\sqrt{2} - \sqrt{5}$ **D** $\frac{6\sqrt{2} - 3\sqrt{5}}{13}$ **5.** ________

6. $3\sqrt{32} - 2\sqrt{18} + \sqrt{54}$

F $4\sqrt{2} - 3\sqrt{6}$ **G** $2\sqrt{6} + 6\sqrt{3}$ **H** $2\sqrt{6} - 6\sqrt{3}$ **J** $6\sqrt{2} + 3\sqrt{6}$ **6.** ________

7. $(\sqrt{7} - \sqrt{10})(\sqrt{5} + \sqrt{14})$

A $2\sqrt{3} + \sqrt{21} - \sqrt{15} - 2\sqrt{6}$ **C** $2\sqrt{2} - \sqrt{35}$

B $-\sqrt{35}$ **D** $12\sqrt{2} + 3\sqrt{35}$ **7.** ________

8. Solve $\sqrt{3n + 1} + 3 = 7$.

F 13 **G** $\frac{1}{3}$ **H** $-1, \frac{1}{3}$ **J** 5 **8.** ________

9. Solve $\sqrt{5x + 39} = x + 3$.

A $-6, 5$ **B** -6 **C** 5 **D** $-5, 6$ **9.** ________

10. A right triangle has one leg that is 8 inches. The hypotenuse is 17 inches. Find the length of the other leg.

F 15 in. **G** $\sqrt{353}$ in. **H** 9 in. **J** $2\sqrt{34}$ in. **10.** ________

11. Determine which side measures form a right triangle.

A 4, 7, 8 **B** 9, 12, 15 **C** 3, 7, 9 **D** 10, 15, 20 **11.** ________

12. Find $m\angle B$ to the nearest tenth if $\sin B = \frac{2}{7}$.

F 1.3° **G** 16.6° **H** 23.1° **J** 73.4° **12.** ________

10 Chapter 10 Test, Form 2B *(continued)*

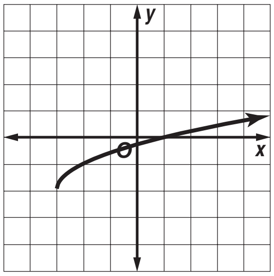
13. Determine which set of measures can be the lengths of the sides of a right triangle.

A 2, 2, 8 **B** 12, 14, 20 **C** 4, 16, 256 **D** 11, 60, 61 **13.** ______

14. What is the equation of the graph?

F $y = \sqrt{x - 3} - 2$ **H** $y = \sqrt{x - 2} - 3$

G $y = \sqrt{x + 2} - 3$ **J** $y = \sqrt{x + 3} - 2$ **14.** ______



15. Simplify $\sqrt{72x^3y}$.

A $6|x|\sqrt{2xy}$ **B** $6|x|\sqrt{2y}$ **C** $6|x|\sqrt{y}$ **D** $12|x|\sqrt{xy}$ **15.** ______

16. What is the length of a diagonal of a rectangle with a length of 14 inches and a width of 7 inches?

F 9.4 in. **G** 15.7 in. **H** 49 in. **J** 245 in. **16.** ______

17. Determine which side measures form a right triangle.

A 5, 12, 13 **B** 6, 13, 14 **C** 7, 14, 15 **D** 8, 15, 16 **17.** ______

18. LADDERS A 24-foot ladder leans against a wall. The base of the ladder is 9 feet from where the wall meets the ground. How far up the wall does the ladder reach?

F 495 ft **G** 20.9 ft **H** 81 ft **J** 22.2 ft **18.** ______

For Questions 19 and 20, the leg opposite to $\angle A$ in a right triangle measures 15 units, and the hypotenuse measures 28 units.

19. What is sin A?

A $\frac{15}{28}$ **B** $\frac{28}{15}$ **C** 0.634 **D** 0.844 **19.** ______

20. What is $m\angle A$?

F 0.01° **G** 28° **H** 32° **J** 58° **20.** ______

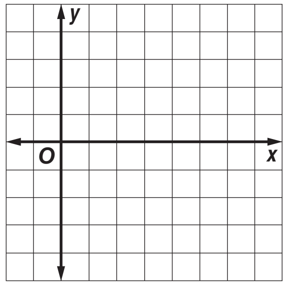
Bonus Find the length of a diagonal of a square if its area is 98 square feet. **B:** ______

NAME ________________________ DATE ____________ PERIOD ____________

10 Chapter 10 Test, Form 2C

SCORE ________

1. Graph $y = \sqrt{x - 2} + 1$.
State the domain and range.

1. 

2. State the domain and range of $y = -3\sqrt{x - 1} + 5$.

Simplify each expression.

3. $\sqrt{24} \cdot \sqrt{3}$

4. $\sqrt{75y^4w^3}$

5. $\dfrac{2\sqrt{3}}{\sqrt{6} - 2}$

6. $\sqrt{20} + 2\sqrt{45} + 3\sqrt{80}$

7. $(\sqrt{6} + \sqrt{7})(\sqrt{21} - \sqrt{2})$

Solve each equation. Check your solution.

8. $\sqrt{m} = 2\sqrt{3}$

9. $\sqrt{2a + 14} - 13 = -7$

10. $10 + \sqrt{x - 8} = x$

If *c* is the measure of the hypotenuse of a right triangle, find each missing measure. If necessary, round to the nearest hundredth.

11. $a = 6, b = 10, c = ?$

12. $b = 24, c = 25, a = ?$

Determine whether the following side measures form right triangles.

13. 14, 48, 50

14. 12, 24, 36

Use a calculator to find the value of each trigonometric ratio to the nearest ten-thousandth.

15. sin 48°

16. cos 7°

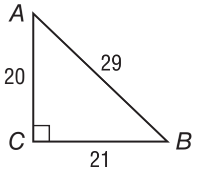
17. tan 71°

2. ____________
3. ____________
4. ____________
5. ____________
6. ____________
7. ____________
8. ____________
9. ____________
10. ____________
11. ____________
12. ____________
13. ____________
14. ____________
15. ____________
16. ____________
17. ____________

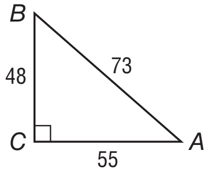
10 Chapter 10 Test, Form 2C *(continued)*

For Questions 18 and 19, find the values of the three trigonometric ratios for angle *A*.

18.



19.



18. ____________

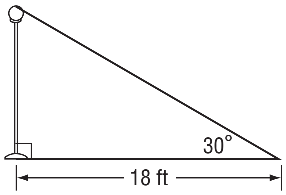
19. ____________

20. The perimeter of a square P with area A can be found using the formula $P = 4\sqrt{A}$. If a square has a perimeter of 29.3 inches, find the area to the nearest tenth of a square foot.

20. ____________

21. Find the height of the lamp post to the nearest tenth of a foot.

21. ____________



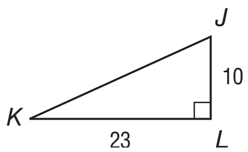
22. A boat leaves the harbor and sails 7 miles west and 2 miles north to an island. The next day it travels to a second island 5 miles south and 3 miles east of the harbor. How far is it from the first island to the second island?

22. ____________

23. What is the length of a rectangle if the width is 10 centimeters and the diagonal is 16 centimeters?

23. ____________

24. Solve $m\angle J$ for the right triangle to the nearest degree.



24. ____________

25. At a loading dock, a ramp is 55 feet long. The angle the ramp makes with the ground is 25°. Find the height reached by the ramp.

25. ____________

Bonus Solve $8 - 3x = \sqrt{4x^2 + 20} + 8$.

B: ____________

NAME ______________________ DATE ____________ PERIOD ____________

10 Chapter 10 Test, Form 2D

SCORE ________

1. Graph $y = \sqrt{x + 1} - 3$.
   State the domain and range.

2. State the domain and range of $y = -2\sqrt{x + 2} - 1$.

Simplify each expression.

3. $\sqrt{40} \cdot \sqrt{5}$

4. $\sqrt{50x^3y^2}$

5. $\dfrac{5\sqrt{2}}{\sqrt{10} - 3}$

6. $2\sqrt{24} + \sqrt{54} + 3\sqrt{150}$

7. $(\sqrt{11} - \sqrt{6})(\sqrt{2} + \sqrt{33})$

Solve each equation. Check your solution.

8. $\sqrt{7x - 3} = 5$

9. $\sqrt{\dfrac{4x}{3}} - 2 = 0$

10. $x + 3 = \sqrt{3x + 37}$

If c is the measure of the hypotenuse of a right triangle, find each missing measure. If necessary, round to the nearest hundredth.

11. $a = 4, b = 7, c = ?$

12. $b = 15, c = 17, a = ?$

Determine whether the following side measures form right triangles.

13. 15, 20, 25

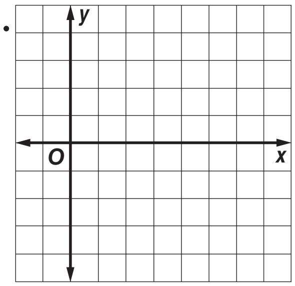
14. 16, 20, 30

Use a calculator to find the value of each trigonometric ratio to the nearest ten-thousandth.

15. sin 73°

16. cos 62°

17. tan 12°

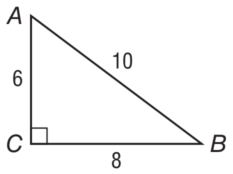
1.


2. ________
3. ________
4. ________
5. ________
6. ________
7. ________
8. ________
9. ________
10. ________
11. ________
12. ________
13. ________
14. ________
15. ________
16. ________
17. ________

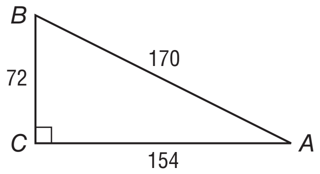
10 Chapter 10 Test, Form 2D *(continued)*

For Questions 18 and 19, find the values of the three trigonometric ratios for angle *A*.

18.



19.



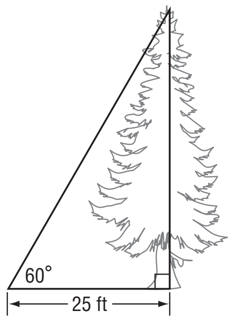
18. ____________

19. ____________

20. The perimeter of a square P with area A can be found using the formula $P = 4\sqrt{A}$. If a square has a perimeter of 36.8 inches, find the area to the nearest tenth of a square foot.

20. ____________

21. Find the height of the tree to the nearest tenth of a foot.



21. ____________

For Questions 22 and 23; round to the nearest hundredth.

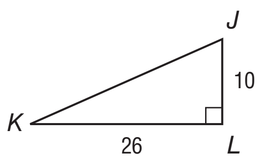
22. Mandy leaves her home for a walk. How far is she from her home after walking 2 miles due east and then 5 miles due south?

22. ____________

23. What is the width of a rectangle if the length is 13 centimeters and the diagonal is 20 centimeters?

23. ____________

24. Solve $m\angle J$ for the right triangle to the nearest degree.



24. ____________

25. At a loading dock, a ramp is 80 feet long. The angle the ramp makes with the ground is 22°. Find the height reached by the ramp.

25. ____________

Bonus Solve $12 + \sqrt{5x^2 + 36} = 12 - 3x$.

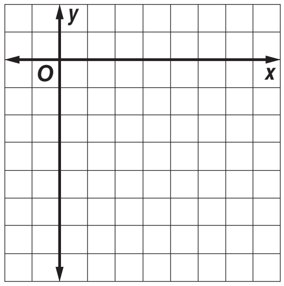
B: ____________

10 Chapter 10 Test, Form 3

SCORE ________

Assessment

1. Graph $y = -2\sqrt{x - 2} - 2$.
State the domain and range.

1. 

2. State the domain and range of $y = -8\sqrt{x + 4} - 12$.

Simplify each expression.

3. $\sqrt{378} \cdot \sqrt{6}$

4. $\sqrt{\frac{5x^4}{4n^5}}$

5. $\frac{\sqrt{8}}{2\sqrt{5} + \sqrt{6}}$

6. $5\sqrt{12} + 6\sqrt{\frac{1}{3}} - 3\sqrt{48}$

7. $(2\sqrt{6} + 7\sqrt{5})(2\sqrt{10} - 5\sqrt{3})$

Solve each equation. If necessary, leave in simplest radical form.

8. $\sqrt{3n - 2} + 6 = 10$

9. $\sqrt{\frac{5n}{3}} + 12 = 7$

10. $2x = 6 + \sqrt{2x^2 - 7x + 1}$

11. Find the length of the hypotenuse of a right triangle if $a = \sqrt{5}$ and $b = 6$.

12. Find the width of a rectangle with a diagonal of 12 centimeters and a length of 10 centimeters.

Determine whether the following side measures form right triangles.

13. 16, 49, 65

14. 5, 9, $\sqrt{106}$

Use a calculator to find the value of each trigonometric ratio to the nearest ten-thousandth.

15. sin 16°

16. cos 31°

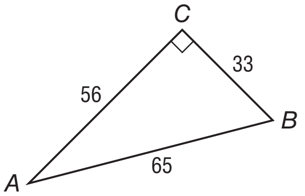
17. tan 88°

2. ____________
3. ____________
4. ____________
5. ____________
6. ____________
7. ____________
8. ____________
9. ____________
10. ____________
11. ____________
12. ____________
13. ____________
14. ____________
15. ____________
16. ____________
17. ____________

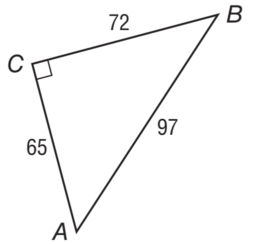
10 Chapter 10 Test, Form 3 *(continued)*

For Questions 18 and 19, find the values of the three trigonometric ratios for angle *A*.

18.



19.



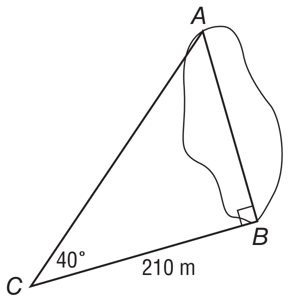
18. ____________

19. ____________

20. The radius r of a cylinder with volume V can be found using the formula $r = \sqrt{\frac{V}{\pi h}}$, where h is the height of the cylinder. If a cylinder has a volume of 120 cubic inches and a radius of 5 inches, find the height of the cylinder to the nearest tenth of an inch.

20. ____________

21. Find the distance across the lake from point A to point B to the nearest tenth of a meter.



21. ____________

For Questions 22 and 23, round to the nearest hundredth.

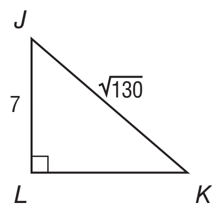
22. A diagonal of a rectangle measures 15 cm. The length of the rectangle is 11 cm. What is the height of the rectangle?

22. ____________

23. Hubert left his home heading due east. He walked that way for 4 miles then headed due north for 7 miles. How far away is Hubert from his home?

23. ____________

24. Solve $m\angle J$ for the right triangle to the nearest degree.



24. ____________

25. A freeway on-ramp is 625 feet long. The angle the ramp makes with the ground is 8°. Find the height reached by the on-ramp.

25. ____________

Bonus Simplify $\frac{2\sqrt{6} - \sqrt{5}}{\sqrt{6} + 3\sqrt{5}}$.

B: ____________

10 Chapter 10 Extended-Response Test

SCORE ________

Demonstrate your knowledge by giving a clear, concise solution to each problem. Be sure to include all relevant drawings and justify your answers. You may show your solution in more than one way or investigate beyond the requirements of the problem.

1. The Product Property of Square Roots and the Quotient Property of Square Roots can be written in symbols as $\sqrt{ab} = \sqrt{a} \cdot \sqrt{b}$ and $\sqrt{\frac{a}{b}} = \frac{\sqrt{a}}{\sqrt{b}}$, respectively.

a. Explain the Product Property of Square Roots and discuss any limitations of a and b for this property.

b. Explain the Quotient Property of Square Roots and discuss any limitations of a and b for this property.

c. Discuss any similarities of the two properties.

2. The formula $L = \sqrt{kP}$ represents the relationship between an airplane's length L in feet and the pounds P its wings can lift, where k is a constant of proportionality calculated for each particular plane.

a. Solve the formula for P.

b. For $k = 0.12$, choose three values for L and calculate the takeoff weight P for each value.

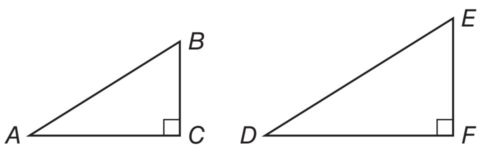
c. For $k = 0.08$, choose three values for L and calculate the takeoff weight P for each value.

d. Determine whether a larger or smaller constant of proportionality allows a plane to carry more weight.

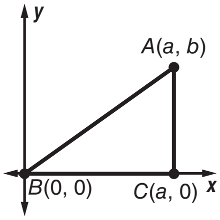
3. Refer to triangles ABC and DEF.

a. Yoki claims that if $\sin A = \sin D$, then $m\angle B = m\angle E$. Do you agree or disagree? Justify your reasoning.

b. Yoki also claims that $\sin A \neq \sin D$, then $m\angle B \neq m\angle E$. Do you agree or disagree? Justify your reasoning.



4. Show that the triangle is a right triangle by using the Pythagorean Theorem.



10 Standardized Test Practice

SCORE ________

(Chapters 1–10)

Part 1: Multiple Choice

Instructions: Fill in the appropriate circle for the best answer.

1. Simplify $(mt^2)(m^3)(m^2t)$. (Lesson 7-1)

A m^6t^3 **B** m^6t^2 **C** m^9t^2 **D** m^3t^2

1. Ⓐ Ⓑ Ⓒ Ⓓ

2. Find $(x + 2y)^2$. (Lesson 8-4)

F $x^2 + 2xy + 2y^2$ **H** $x^2 + 4xy + 4y^2$

G $x^2 + 4y^2$ **J** $2x^2 + 2xy + 4y^2$

2. Ⓕ Ⓖ Ⓗ Ⓙ

3. Solve $6r^2 - 14r - 15 = 0$ by using the Quadratic Formula. Round to the nearest tenth. (Lesson 9-5)

A ∅ **B** {−3.1, 0.8} **C** {−0.8, 3.1} **D** {0.8, 3.1}

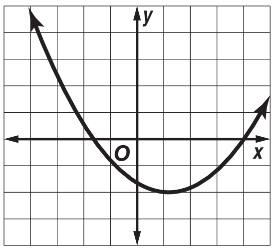
3. Ⓐ Ⓑ Ⓒ Ⓓ

4. Which binomial is a factor of $15t^2 - t - 6$? (Lesson 8-7)

F $3t - 2$ **G** $5t - 3$ **H** $3t + 1$ **J** $5t - 6$

4. Ⓕ Ⓖ Ⓗ Ⓙ

5. Use the graph to identify two consecutive integers between which a root lies. (Lesson 9-2)



A 1, 2 **C** −3, −2

B −4, −3 **D** −2, −1

5. Ⓐ Ⓑ Ⓒ Ⓓ

6. Solve $x^2 - 14x + 49 = 64$. (Lesson 8-9)

F {6, 22} **G** {−1, 15} **H** {−15, 1} **J** {−1, 1}

6. Ⓕ Ⓖ Ⓗ Ⓙ

7. Determine the amount of an investment if \$800 is invested at an interest rate of 6.5% compounded monthly for 5 years. (Lesson 7-6)

A \$15,223.65 **B** \$34,999.87 **C** \$1096 **D** \$1106.25

7. Ⓐ Ⓑ Ⓒ Ⓓ

8. Which expression *cannot* be simplified? (Lesson 10-3)

F $5\sqrt{8} + 2\sqrt{18}$ **H** $2\sqrt{112} + \sqrt{63}$

G $3\sqrt{55} - 4\sqrt{65}$ **J** $2\sqrt{45} + 4\sqrt{20}$

8. Ⓕ Ⓖ Ⓗ Ⓙ

9. Find the length of the hypotenuse of a right triangle if $a = 21$ and $b = 20$. (Lesson 10-5)

A 6.4 **B** 841 **C** 29 **D** 41

9. Ⓐ Ⓑ Ⓒ Ⓓ

10. Solve the system of equations. (Lesson 6-3)

$$4x + 3y = 14$$
$$5x - 4y = 33$$

F (5, −2) **G** (2, 2) **H** (9, 3) **J** (−4, −2)

10. Ⓕ Ⓖ Ⓗ Ⓙ

11. Simplify $\left(\frac{3x^2y}{5zy^4}\right)^3$.

A $\frac{27x^6}{125z^3y^9}$ **B** $\frac{27x^5}{125z^3y^3}$ **C** $\frac{3x^6}{5z^3y^9}$ **D** $\frac{27x^6}{5z^3y^9}$

11. Ⓐ Ⓑ Ⓒ Ⓓ

10 Standardized Test Practice *(continued)*

12. What is the equation of the line that passes through (3, 2) and (0, −5)? (Lesson 4-2)

F $y = \frac{3}{7}x - 5$ **H** $y = -\frac{3}{7}x + 5$

G $y = -\frac{7}{3}x + 5$ **J** $y = \frac{7}{3}x - 5$ **12.** Ⓕ Ⓖ Ⓗ Ⓙ

13. Find the slope of the line that passes through (5, 6) and (2, 1). (Lesson 3-3)

A $-\frac{5}{3}$ **B** $\frac{5}{3}$ **C** $-\frac{3}{5}$ **D** $\frac{3}{5}$ **13.** Ⓐ Ⓑ Ⓒ Ⓓ

14. What is the length of a diagonal of a rectangle with a length of 10 inches and a width of 6 inches? (Lesson 10-5)

F 4 in. **G** 16 in. **H** 11.7 in. **J** 136 in. **14.** Ⓕ Ⓖ Ⓗ Ⓙ

15. Solve the proportion $\frac{b}{12} = \frac{10}{15}$. (Lesson 2-6)

A 6 **B** 8 **C** 4 **D** 120 **15.** Ⓐ Ⓑ Ⓒ Ⓓ

16. Jackson's meal cost \$33.40. How much money should he leave for a 15% tip? (Lesson 2-7)

F about \$2.00 **H** about \$4.00

G about \$3.00 **J** about \$5.00 **16.** Ⓕ Ⓖ Ⓗ Ⓙ

17. What is the length of a diagonal of a square with an area of 36 inches? (Lesson 10-5)

A 9.4 in. **B** 8.5 in. **C** 72 in. **D** 36 in. **17.** Ⓐ Ⓑ Ⓒ Ⓓ

Part 2: Gridded Response

Instructions: Enter your answer by writing each digit of the answer in a column box and then shading in the appropriate circle that corresponds to that entry.

18. Find the discounted price.
cookbook: \$28
discount: 65% (Lesson 2-7)

	⊘	⊘	⊘	
⊙	⊙	⊙	⊙	⊙
⓪	⓪	⓪	⓪	⓪
①	①	①	①	①
②	②	②	②	②
③	③	③	③	③
④	④	④	④	④
⑤	⑤	⑤	⑤	⑤
⑥	⑥	⑥	⑥	⑥
⑦	⑦	⑦	⑦	⑦
⑧	⑧	⑧	⑧	⑧
⑨	⑨	⑨	⑨	⑨

19. The basic breaking strength b in pounds for a natural fiber line is determined by the formula $900c^2 = b$, where c is the circumference of the line in inches. What circumference in inches of natural line would have 22,500 pounds of breaking strength? (Lesson 8-9)

	⊘	⊘	⊘	
⊙	⊙	⊙	⊙	⊙
⓪	⓪	⓪	⓪	⓪
①	①	①	①	①
②	②	②	②	②
③	③	③	③	③
④	④	④	④	④
⑤	⑤	⑤	⑤	⑤
⑥	⑥	⑥	⑥	⑥
⑦	⑦	⑦	⑦	⑦
⑧	⑧	⑧	⑧	⑧
⑨	⑨	⑨	⑨	⑨

10 Standardized Test Practice *(continued)*

(Chapters 1–10)

Part 3: Short Response

Instructions: Write your answers in the space.

20. INVESTMENTS Phyllis invested \$12,000, part at 14% annual interest and the remainder at 10%. Last year she earned \$1632 in interest. How much money did she invest at each rate? (Lesson 2-9)

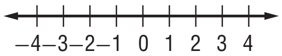
20. ______________

21. Write an equation of a line with a slope of -5 and a y-intercept of 14. (Lesson 4-1)

21. ______________

22. Solve $4 + w \leq 3$ or $5w - 14 > -4$. Then graph the solution set. (Lesson 5-4)

22. ______________

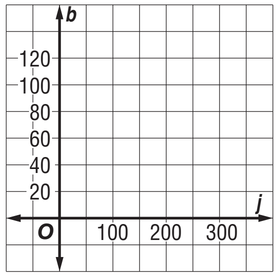


23. Use a graph to determine whether the system has *no* solution, *one* solution, or *infinitely many* solutions. $2y - x = 1$ and $2y - x = -2$ (Lesson 6-1)

23. ______________

24. MANUFACTURING A toy manufacturer makes two type of model airplanes, jets and biplanes. Each month they can make at most 120 planes. Each jet takes 2 hours to build and each biplane takes 5 hours to build. They use 500 hours or less each month to build model airplanes. Make a graph showing the number of jets and biplanes that can be made each month. (Lesson 5-6)

24.



25. Simplify $\frac{21hk^3j^{-2}}{-14h^{-5}kj^8}$. Assume that the denominator does not equal zero. (Lesson 7-2)

25. ______________

26. Factor $xy - 3x + 4y - 12$. (Lesson 8-5)

26. ______________

27. Find two consecutive odd integers with a product of 255. (Lesson 8-6)

27. ______________

28. Solve $x^2 + 16x + 64 = 13$ by taking the square root of each side. Round to the nearest tenth, if necessary. (Lesson 9-4)

28. ______________

29. A conveyer valued at \$12,000 depreciates at a steady rate of 18% per year. What is the value of the conveyer in 6 years? (Lesson 7-6)

29. ______________

30. Matt leaves his house to visit some friends. He drives 11 miles due west and then 9 miles due north to get to Joe's house. He visits for a while and then drives 6 miles due south and 4 miles due west to get to Mason's house. (Lesson 10-5)

a. When Matt is at Joe's house, how far is he from home?

30a. ______________

b. When Matt is at Mason's house, how far is he from Joe's house?

30b. ______________

NAME ______________________ DATE __________ PERIOD __________

10 Anticipation Guide

Radical Expressions and Triangles

Chapter Resources

Step 1 *Before you begin Chapter 10*

- Read each statement.
- Decide whether you Agree (A) or Disagree (D) with the statement.
- Write A or D in the first column OR if you are not sure whether you agree or disagree, write NS (Not Sure).

STEP 1 A, D, or NS	Statement	STEP 2 A or D
	1. An expression that contains a square root is called a radical expression.	**A**
	2. It is always true that $\sqrt{xy}$ will equal $\sqrt{x} \cdot \sqrt{y}$.	**A**
	3. $\frac{1}{\sqrt{3}}$ is in simplest form because $\sqrt{3}$ is not a whole number.	**D**
	4. The sum of $3\sqrt{3}$ and $2\sqrt{3}$ will equal $5\sqrt{3}$.	**A**
	5. Before multiplying two radical expressions with different radicands the square roots must be evaluated.	**D**
	6. When solving radical equations by squaring each side of the equation, it is possible to obtain solutions that are not solutions to the original equation.	**A**
	7. The longest side of any triangle is called the hypotenuse.	**D**
	8. Because $5^2 = 4^2 + 3^2$, a triangle whose sides have lengths 3, 4, and 5 will be a right triangle.	**A**
	9. On a coordinate plane, the distance between any two points can be found using the Pythagorean Theorem.	**A**
	10. The missing measures of a triangle can be found if the measure of one of its sides is known.	**D**

Step 2 *After you complete Chapter 10*

- Reread each statement and complete the last column by entering an A or a D.
- Did any of your opinions about the statements change from the first column?
- For those statements that you mark with a D, use a piece of paper to write an example of why you disagree.

NAME ______________________ DATE __________ PERIOD __________

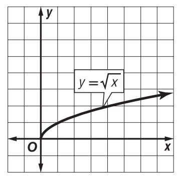
10-1 Study Guide and Intervention

Square Root Functions

Lesson 10-1

Dilations of Radical Functions A **square root function** contains the square root of a variable. Square root functions are a type of **radical function**.

In order for a square root to be a real number, the **radicand**, or the expression under the radical sign, cannot be negative. Values that make the radicand negative are not included in the domain.

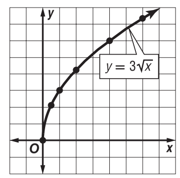
Square Root Function	Parent function: $f(x) = \sqrt{x}$ Type of graph: curve Domain: $\{x \mid x \geq 0\}$ Range: $\{y \mid y \geq 0\}$	

Example **Graph $y = 3\sqrt{x}$. State the domain and range.**

Step 1 Make a table. Choose nonnegative values for x.

x	y
0	0
0.5	≈ 2.12
1	3
2	≈ 4.24
4	6
6	≈ 7.35

Step 2 Plot points and draw a smooth curve.

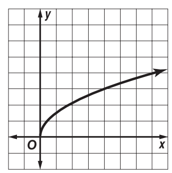


The domain is $\{x \mid x \geq 0\}$ and the range is $\{y \mid y \geq 0\}$.

Exercises

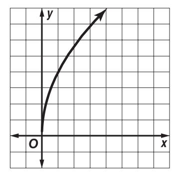
Graph each function, and compare to the parent graph. State the domain and range.

1. $y = \frac{3}{2}\sqrt{x}$



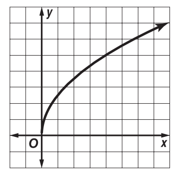
Dilation of $y = \sqrt{x}$; D = $\{x \mid x \geq 0\}$; R = $\{y \mid y \geq 0\}$

2. $y = 4\sqrt{x}$



Dilation of $y = \sqrt{x}$; D = $\{x \mid x \geq 0\}$; R = $\{y \mid y \geq 0\}$

3. $y = \frac{5}{2}\sqrt{x}$



Dilation of $y = \sqrt{x}$; D = $\{x \mid x \geq 0\}$; R = $\{y \mid y \geq 0\}$

Answers

NAME ______________________ DATE ____________ PERIOD ____________

10-1 Study Guide and Intervention *(continued)*

Square Root Functions

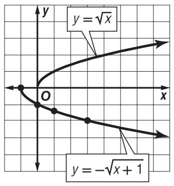
Reflections and Translations of Radical Functions Radical functions, like quadratic functions, can be translated horizontally and vertically, as well as reflected across the x-axis. To draw the graph of $y = a\sqrt{x + h} + k$, follow these steps.

Graphs of Square Root Functions	**Step 1**	Draw the graph of $y = a\sqrt{x}$. The graph starts at the origin and passes through the point at $(1, a)$. If $a > 0$, the graph is in the 1st quadrant. If $a < 0$, the graph is reflected across the x-axis and is in the 4th quadrant.
	Step 2	Translate the graph $\|k\|$ units up if k is positive and down if k is negative.
	Step 3	Translate the graph $\|h\|$ units left if h is positive and right if h is negative.

Example **Graph $y = -\sqrt{x + 1}$ and compare to the parent graph. State the domain and range.**

Step 1 Make a table of values.

x	–1	0	1	3	8
y	0	–1	–1.41	–2	–3

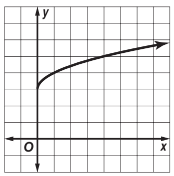


Step 2 This is a horizontal translation 1 unit to the left of the parent function and reflected across the x-axis. The domain is $\{x \mid x \geq -1\}$ and the range is $\{y \mid y \leq 0\}$.

Exercises

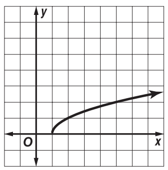
Graph each function, and compare to the parent graph. State the domain and range.

1. $y = \sqrt{x} + 3$



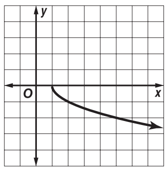
translation of $y = \sqrt{x}$ up 3 units; D = $\{x \mid x \geq 0\}$; R = $\{y \mid y \geq 3\}$

2. $y = \sqrt{x - 1}$



translation of $y = \sqrt{x}$ right 1 unit; D = $\{x \mid x \geq 1\}$; R = $\{y \mid y \geq 0\}$

3. $y = -\sqrt{x - 1}$



translation of $y = \sqrt{x}$ right 1 unit and reflected across the x-axis; D = $\{x \mid x \geq 1\}$; R = $\{y \mid y \leq 0\}$

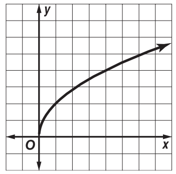
NAME ______________________ DATE ____________ PERIOD ____________

10-1 Skills Practice

Square Root Functions

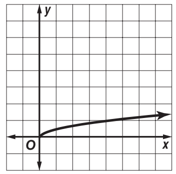
Graph each function, and compare to the parent graph. State the domain and range.

1. $y = 2\sqrt{x}$



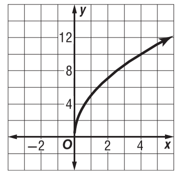
dilation of $y = \sqrt{x}$; D = $\{x \mid x \geq 0\}$, R = $\{y \mid y \geq 0\}$

2. $y = \frac{1}{2}\sqrt{x}$



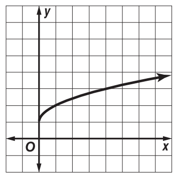
dilation of $y = \sqrt{x}$; D = $\{x \mid x \geq 0\}$, R = $\{y \mid y \geq 0\}$

3. $y = 5\sqrt{x}$



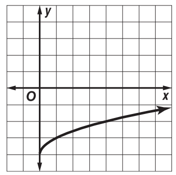
dilation of $y = \sqrt{x}$; D = $\{x \mid x \geq 0\}$, R = $\{y \mid y \geq 0\}$

4. $y = \sqrt{x} + 1$



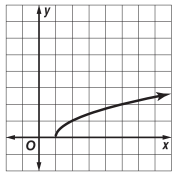
translation of $y = \sqrt{x}$ up 1 unit; D = $\{x \mid x \geq 0\}$, R = $\{y \mid y \geq 1\}$

5. $y = \sqrt{x} - 4$



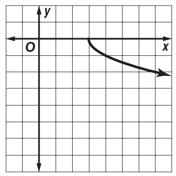
translation of $y = \sqrt{x}$ down 4 units; D = $\{x \mid x \geq 0\}$, R = $\{y \mid y \geq -4\}$

6. $y = \sqrt{x - 1}$



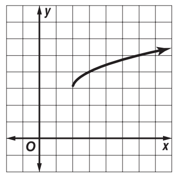
translation of $y = \sqrt{x}$ right 1 unit; D = $\{x \mid x \geq 1\}$, R = $\{y \mid y \geq 0\}$

7. $y = -\sqrt{x - 3}$



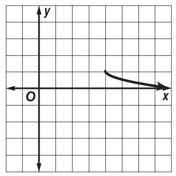
translation of $y = \sqrt{x}$; right 3 units reflected across the x-axis; D = $\{x \mid x \geq 3\}$, R = $\{y \mid y \leq 0\}$

8. $y = \sqrt{x - 2} + 3$



translation of $y = \sqrt{x}$ right 2 units and up 3 units; D = $\{x \mid x \geq 2\}$, R = $\{y \mid y \geq 3\}$

9. $y = -\frac{1}{2}\sqrt{x - 4} + 1$



dialation of $y = \sqrt{x}$ reflected across the x-axis translated right 4 units up 1 units; D = $\{x \mid x \geq 4\}$, R = $\{y \mid y \leq 1\}$

Lesson 10-1

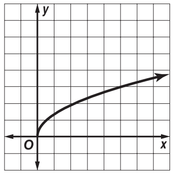
NAME ______________________ DATE __________ PERIOD __________

10-1 Practice

Square Root Functions

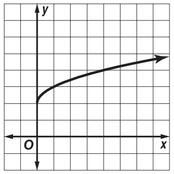
Graph each function, and compare to the parent graph. State the domain and range.

1. $y = \frac{4}{3}\sqrt{x}$



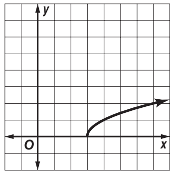
dilation of $y = \sqrt{x}$; D = $\{x \mid x \geq 0\}$, R = $\{y \mid y \geq 0\}$

2. $y = \sqrt{x} + 2$



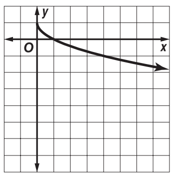
translation of $y = \sqrt{x}$ up 2 units; D = $\{x \mid x \geq 0\}$, R = $\{y \mid y \geq 2\}$

3. $y = \sqrt{x - 3}$



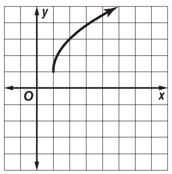
translation of $y = \sqrt{x}$ right 3 units; D = $\{x \mid x \geq 3\}$, R = $\{y \mid y \geq 0\}$

4. $y = -\sqrt{x} + 1$



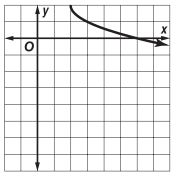
translation of $y = \sqrt{x}$ up 1 unit reflected in the *x*-axis; D = $\{x \mid x \geq 0\}$, R = $\{y \mid y \leq 1\}$

5. $y = 2\sqrt{x - 1} + 1$



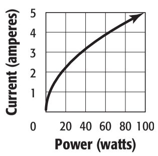
dilation of $y = \sqrt{x}$ translated up 1 unit and right 1 unit; D = $\{x \mid x \geq 1\}$, R = $\{y \mid y \geq 1\}$

6. $y = -\sqrt{x - 2} + 2$



translation of $y = \sqrt{x}$ up 2 units and right 2 units, reflected in the *x*-axis; D = $\{x \mid x \geq 2\}$, R = $\{y \mid y \leq 2\}$

7. OHM'S LAW In electrical engineering, the resistance of a circuit can be found by the equation $I = \sqrt{\frac{P}{R}}$, where I is the current in amperes, P is the power in watts, and R is the resistance of the circuit in ohms. Graph this function for a circuit with a resistance of 4 ohms.



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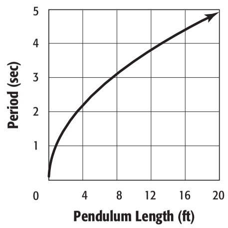
NAME ______________________ DATE __________ PERIOD __________

10-1 Word Problem Practice

Square Root Functions

1. PENDULUM MOTION The period T of a pendulum in seconds, which is the time for the pendulum to return to the point of release, is given by the equation $T = 1.11\sqrt{L}$. The length of the pendulum in feet is given by L. Graph this function.



2. EMPIRE STATE BUILDING The roof of the Empire State Building is 1250 feet above the ground. The velocity of an object dropped from a height of h meters is given by the function $V = \sqrt{2gh}$, where g is the gravitational constant, 32.2 feet per second squared. If an object is dropped from the roof of the building, how fast is it traveling when it hits the street below?

approximately 284 ft/s

3. ERROR ANALYSIS Gregory is drawing the graph of $y = -5\sqrt{x + 1}$. He describes the range and domain as $\{x \mid x \geq -1\}$, $\{y \mid y \geq 0\}$. Explain and correct the mistake that Gregory made.

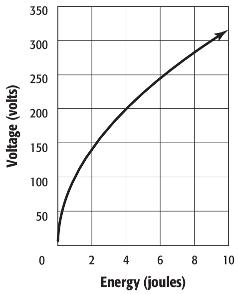
The range is actually $\{y \mid y \leq 0\}$ because the graph has been reflected across the *x*-axis.

4. CAPACITORS A capacitor is a set of plates that can store energy in an electric field. The voltage V required to store E joules of energy in a capacitor with a capacitance of C farads is given by $V = \sqrt{\frac{2E}{C}}$.

a. Rewrite and simplify the equation for the case of a 0.0002 farad capacitor.

$V = 100\sqrt{E}$

b. Graph the equation you found in part **a**.



c. How would the graph differ if you wished to store $E + 1$ joules of energy in the capacitor instead?

translation of $V = 100\sqrt{E}$ one unit to the left

d. How would the graph differ if you applied a voltage of $V + 1$ volts instead?

translation of $V = 100\sqrt{E}$ one unit down

Lesson 10-1

Answers

NAME ______________ DATE ________ PERIOD ________

10-1 Enrichment

Cube Root Functions

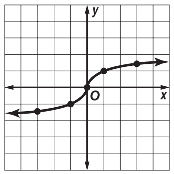
A **cube root function** contains the cube root of a variable. The **cube roots** of a number x are the numbers y that satisfy the equation $y \cdot y \cdot y = x$, or alternatively, $y = \sqrt[3]{x}$. Unlike square root functions, cube root functions return real numbers when the radicand is negative.

Example Graph $y = \sqrt[3]{x}$.

Step 1 Make a table. Round to the nearest hundredth.

x	y
–5	–1.71
–3	–1.44
–1	–1
0	0
1	1
3	1.44
5	1.71

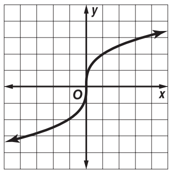
Step 2 Plot points and draw a smooth curve.



Exercises

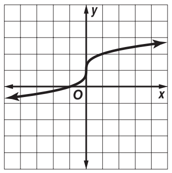
Graph each function, and compare to the parent graph.

1. $y = 2\sqrt[3]{x}$



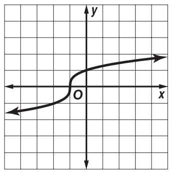
dilation of $y = \sqrt[3]{x}$

2. $y = \sqrt[3]{x} + 1$



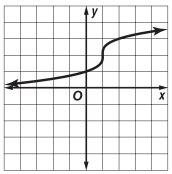
translation of $y = \sqrt[3]{x}$ up 1 unit

3. $y = \sqrt[3]{x + 1}$



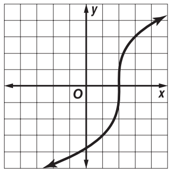
translation of $y = \sqrt[3]{x}$ left 1 unit

4. $y = \sqrt[3]{x - 1} + 2$



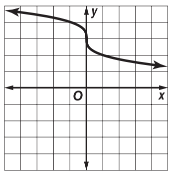
translation of $y = \sqrt[3]{x}$ up 2 units and right 1 unit

5. $y = 3\sqrt[3]{x - 2}$



dilation of $y = \sqrt[3]{x}$ translated right 2 units

6. $y = -\sqrt[3]{x} + 3$



reflection of $y = \sqrt[3]{x}$ across the x-axis translated up 3 units

NAME ______________ DATE ________ PERIOD ________

10-2 Study Guide and Intervention

Simplifying Radical Expressions

Product Property of Square Roots The **Product Property of Square Roots** and prime factorization can be used to simplify expressions involving irrational square roots. When you simplify radical expressions with variables, use absolute value to ensure nonnegative results.

Product Property of Square Roots	For any numbers a and b, where $a \geq 0$ and $b \geq 0$, $\sqrt{ab} = \sqrt{a} \cdot \sqrt{b}$.

Example 1 Simplify $\sqrt{180}$.

$\sqrt{180} = \sqrt{2 \cdot 2 \cdot 3 \cdot 3 \cdot 5}$ Prime factorization of 180

$= \sqrt{2^2} \cdot \sqrt{3^2} \cdot \sqrt{5}$ Product Property of Square Roots

$= 2 \cdot 3 \cdot \sqrt{5}$ Simplify.

$= 6\sqrt{5}$ Simplify.

Example 2 Simplify $\sqrt{120a^2 \cdot b^5 \cdot c^4}$.

$\sqrt{120a^2 \cdot b^5 \cdot c^4}$

$= \sqrt{2^3 \cdot 3 \cdot 5 \cdot a^2 \cdot b^5 \cdot c^4}$

$= \sqrt{2^2} \cdot \sqrt{2} \cdot \sqrt{3} \cdot \sqrt{5} \cdot \sqrt{a^2} \cdot \sqrt{b^4 \cdot b} \cdot \sqrt{c^4}$

$= 2 \cdot \sqrt{2} \cdot \sqrt{3} \cdot \sqrt{5} \cdot |a| \cdot b^2 \cdot \sqrt{b} \cdot c^2$

$= 2|a|b^2c^2\sqrt{30b}$

Exercises

Simplify each expression.

1. $\sqrt{28}$ **$2\sqrt{7}$**

2. $\sqrt{68}$ **$2\sqrt{17}$**

3. $\sqrt{60}$ **$2\sqrt{15}$**

4. $\sqrt{75}$ **$5\sqrt{3}$**

5. $\sqrt{162}$ **$9\sqrt{2}$**

6. $\sqrt{3} \cdot \sqrt{6}$ **$3\sqrt{2}$**

7. $\sqrt{2} \cdot \sqrt{5}$ **$\sqrt{10}$**

8. $\sqrt{5} \cdot \sqrt{10}$ **$5\sqrt{2}$**

9. $\sqrt{4a^2}$ **$2|a|$**

10. $\sqrt{9x^4}$ **$3x^2$**

11. $\sqrt{300a^4}$ **$10a^2\sqrt{3}$**

12. $\sqrt{128c^6}$ **$8|c^3|\sqrt{2}$**

13. $4\sqrt{10} \cdot 3\sqrt{6}$ **$24\sqrt{15}$**

14. $\sqrt{3x^2} \cdot 3\sqrt{3x^4}$ **$9|x^3|$**

15. $\sqrt{20a^2b^4}$ **$2|a|b^2\sqrt{5}$**

16. $\sqrt{100x^3y}$ **$10|x|\sqrt{xy}$**

17. $\sqrt{24a^4b^2}$ **$2a^2|b|\sqrt{6}$**

18. $\sqrt{81x^4y^2}$ **$9x^2|y|$**

19. $\sqrt{150a^2b^2c}$ **$5|ab|\sqrt{6c}$**

20. $\sqrt{72a^6b^3c^2}$ **$6|a^3bc|\sqrt{2b}$**

21. $\sqrt{45x^2y^5z^8}$ **$3|x|y^2z^4\sqrt{5y}$**

22. $\sqrt{98x^4y^6z^2}$ **$7x^2|y^3z|\sqrt{2}$**

NAME ____________________ DATE ________ PERIOD ________

10-2 Study Guide and Intervention *(continued)*

Simplifying Radical Expressions

Quotient Property of Square Roots A fraction containing radicals is in simplest form if no radicals are left in the denominator. The **Quotient Property of Square Roots** and **rationalizing the denominator** can be used to simplify radical expressions that involve division. When you rationalize the denominator, you multiply the numerator and denominator by a radical expression that gives a rational number in the denominator.

Quotient Property of Square Roots	For any numbers a and b, where $a \geq 0$ and $b > 0$, $\sqrt{\frac{a}{b}} = \frac{\sqrt{a}}{\sqrt{b}}$.

Example Simplify $\sqrt{\frac{56}{45}}$.

$\sqrt{\frac{56}{45}} = \sqrt{\frac{4 \cdot 14}{9 \cdot 5}}$ Factor 56 and 45.

$= \frac{2 \cdot \sqrt{14}}{3 \cdot \sqrt{5}}$ Simplify the numerator and denominator.

$= \frac{2\sqrt{14}}{3\sqrt{5}} \cdot \frac{\sqrt{5}}{\sqrt{5}}$ Multiply by $\frac{\sqrt{5}}{\sqrt{5}}$ to rationalize the denominator.

$= \frac{2\sqrt{70}}{15}$ Product Property of Square Roots

Exercises

Simplify each expression.

1. $\frac{\sqrt{9}}{\sqrt{18}}$ $\mathbf{\frac{\sqrt{2}}{2}}$
2. $\frac{\sqrt{8}}{\sqrt{24}}$ $\mathbf{\frac{\sqrt{3}}{3}}$
3. $\frac{\sqrt{100}}{\sqrt{121}}$ $\mathbf{\frac{10}{11}}$
4. $\frac{\sqrt{75}}{\sqrt{3}}$ **5**
5. $\frac{8\sqrt{2}}{2\sqrt{8}}$ **2**
6. $\sqrt{\frac{2}{5}} \cdot \sqrt{\frac{6}{5}}$ $\mathbf{\frac{2\sqrt{3}}{5}}$
7. $\sqrt{\frac{3}{4}} \cdot \sqrt{\frac{5}{2}}$ $\mathbf{\frac{\sqrt{30}}{4}}$
8. $\sqrt{\frac{5}{7}} \cdot \sqrt{\frac{2}{5}}$ $\mathbf{\frac{\sqrt{14}}{7}}$
9. $\sqrt{\frac{3a^2}{10b^6}}$ $\mathbf{\frac{|a|\sqrt{30}}{10|b^3|}}$
10. $\sqrt{\frac{x^6}{y^4}}$ $\mathbf{\frac{|x^3|}{y^2}}$
11. $\sqrt{\frac{100a^4}{144b^8}}$ $\mathbf{\frac{5a^2}{6b^4}}$
12. $\sqrt{\frac{75b^3c^6}{a^2}}$ $\mathbf{\frac{5|bc^3|\sqrt{3b}}{|a|}}$
13. $\frac{\sqrt{4}}{3 - \sqrt{5}}$ $\mathbf{\frac{3 + \sqrt{5}}{2}}$
14. $\frac{\sqrt{8}}{2 + \sqrt{3}}$ $\mathbf{4\sqrt{2} - 2\sqrt{6}}$
15. $\frac{\sqrt{5}}{5 + \sqrt{5}}$ $\mathbf{\frac{\sqrt{5} - 1}{4}}$
16. $\frac{\sqrt{8}}{2\sqrt{7} + 4\sqrt{10}}$ $\mathbf{\frac{4\sqrt{5} - \sqrt{14}}{33}}$

NAME ____________________ DATE ________ PERIOD ________

10-2 Skills Practice

Simplifying Radical Expressions

Simplify each expression.

1. $\sqrt{28}$ $\mathbf{2\sqrt{7}}$
2. $\sqrt{40}$ $\mathbf{2\sqrt{10}}$
3. $\sqrt{72}$ $\mathbf{6\sqrt{2}}$
4. $\sqrt{99}$ $\mathbf{3\sqrt{11}}$
5. $\sqrt{2} \cdot \sqrt{10}$ $\mathbf{2\sqrt{5}}$
6. $\sqrt{5} \cdot \sqrt{60}$ $\mathbf{10\sqrt{3}}$
7. $3\sqrt{5} \cdot \sqrt{5}$ **15**
8. $\sqrt{6} \cdot 4\sqrt{24}$ **48**
9. $2\sqrt{3} \cdot 3\sqrt{15}$ $\mathbf{18\sqrt{5}}$
10. $\sqrt{16b^4}$ $\mathbf{4b^2}$
11. $\sqrt{81a^2d^4}$ $\mathbf{9|a|d^2}$
12. $\sqrt{40x^4y^6}$ $\mathbf{2x^2|y^3|\sqrt{10}}$
13. $\sqrt{75m^5P^2}$ $\mathbf{5m^2|P|\sqrt{3m}}$
14. $\sqrt{\frac{5}{3}}$ $\mathbf{\frac{\sqrt{15}}{3}}$
15. $\sqrt{\frac{1}{6}}$ $\mathbf{\frac{\sqrt{6}}{6}}$
16. $\sqrt{\frac{6}{7}} \cdot \sqrt{\frac{1}{3}}$ $\mathbf{\frac{\sqrt{14}}{7}}$
17. $\sqrt{\frac{q}{12}}$ $\mathbf{\frac{\sqrt{3q}}{6}}$
18. $\sqrt{\frac{4h}{5}}$ $\mathbf{\frac{2\sqrt{5h}}{5}}$
19. $\sqrt{\frac{12}{b^2}}$ $\mathbf{\frac{2\sqrt{3}}{|b|}}$
20. $\sqrt{\frac{45}{4m^4}}$ $\mathbf{\frac{3\sqrt{5}}{2m^2}}$
21. $\frac{2}{4 + \sqrt{5}}$ $\mathbf{\frac{8 - 2\sqrt{5}}{11}}$
22. $\frac{3}{2 - \sqrt{3}}$ $\mathbf{6 + 3\sqrt{3}}$
23. $\frac{5}{7 + \sqrt{7}}$ $\mathbf{\frac{35 - 5\sqrt{7}}{42}}$
24. $\frac{4}{3 - \sqrt{2}}$ $\mathbf{\frac{12 + 4\sqrt{2}}{7}}$

NAME ______________________ DATE __________ PERIOD __________

10-2 Practice

Simplifying Radical Expressions

Simplify.

1. $\sqrt{24}$ **$2\sqrt{6}$**
2. $\sqrt{60}$ **$2\sqrt{15}$**
3. $\sqrt{108}$ **$6\sqrt{3}$**
4. $\sqrt{8} \cdot \sqrt{6}$ **$4\sqrt{3}$**
5. $\sqrt{7} \cdot \sqrt{14}$ **$7\sqrt{2}$**
6. $3\sqrt{12} \cdot 5\sqrt{6}$ **$90\sqrt{2}$**
7. $4\sqrt{3} \cdot 3\sqrt{18}$ **$36\sqrt{6}$**
8. $\sqrt{27tu^3}$ **$3|u|\sqrt{3tu}$**
9. $\sqrt{50p^5}$ **$5p^2\sqrt{2p}$**
10. $\sqrt{108x^6y^4z^5}$ **$6|x^3|y^2z^2\sqrt{3z}$**
11. $\sqrt{56m^2n^4p^5}$ **$2|m|n^2p^2\sqrt{14p}$**
12. $\frac{\sqrt{8}}{\sqrt{6}}$ **$\frac{2\sqrt{3}}{3}$**
13. $\sqrt{\frac{2}{10}}$ **$\frac{\sqrt{5}}{5}$**
14. $\sqrt{\frac{5}{32}}$ **$\frac{\sqrt{10}}{8}$**
15. $\sqrt{\frac{3}{4}} \cdot \sqrt{\frac{4}{5}}$ **$\frac{\sqrt{15}}{5}$**
16. $\sqrt{\frac{1}{7}} \cdot \sqrt{\frac{7}{11}}$ **$\frac{\sqrt{11}}{11}$**
17. $\frac{\sqrt{3k}}{\sqrt{8}}$ **$\frac{\sqrt{6k}}{4}$**
18. $\sqrt{\frac{18}{x^3}}$ **$\frac{3\sqrt{2x}}{x^2}$**
19. $\sqrt{\frac{4y}{3y^2}}$ **$\frac{2\sqrt{3y}}{3|y|}$**
20. $\sqrt{\frac{9ab}{4ab^4}}$ **$\frac{3\sqrt{b}}{2b^2}$**
21. $\frac{3}{5-\sqrt{2}}$ **$\frac{15+3\sqrt{2}}{23}$**
22. $\frac{8}{3+\sqrt{3}}$ **$\frac{12-4\sqrt{3}}{3}$**
23. $\frac{5}{\sqrt{7}+\sqrt{3}}$ **$\frac{5\sqrt{7}-5\sqrt{3}}{4}$**
24. $\frac{3\sqrt{7}}{-1-\sqrt{27}}$ **$\frac{3\sqrt{7}-9\sqrt{21}}{26}$**

25. **SKY DIVING** When a skydiver jumps from an airplane, the time t it takes to free fall a given distance can be estimated by the formula $t = \sqrt{\frac{2s}{9.8}}$, where t is in seconds and s is in meters. If Julie jumps from an airplane, how long will it take her to free fall 750 meters? **about 12.4 s**

26. **METEOROLOGY** To estimate how long a thunderstorm will last, meteorologists can use the formula $t = \sqrt{\frac{d^3}{216}}$, where t is the time in hours and d is the diameter of the storm in miles.

   a. A thunderstorm is 8 miles in diameter. Estimate how long the storm will last. Give your answer in simplified form and as a decimal. **$\frac{8\sqrt{3}}{9}$ h ≈ 1.5 h**

   b. Will a thunderstorm twice this diameter last twice as long? Explain. **No; it will last about 4.4 h, or nearly 3 times as long.**

NAME ______________________ DATE __________ PERIOD __________

10-2 Word Problem Practice

Simplifying Radical Expressions

1. **SPORTS** Jasmine calculated the height of her team's soccer goal to be $\frac{15}{\sqrt{3}}$ feet. Simplify the expression.
   $5\sqrt{3}$

2. **NATURE** In 2010, an earthquake below the ocean floor initiated a devastating tsunami in Sumatra. Scientists can approximate the velocity V in feet per second of a tsunami in water of depth d feet with the formula $V = \sqrt{16d}$. Determine the velocity of a tsunami in 300 feet of water. Write your answer in simplified radical form.
   $40\sqrt{3}$ ft/s

3. **AUTOMOBILES** The following formula can be used to find the "zero to sixty" time for a car, or the time it takes for a car to accelerate from a stop to sixty miles per hour.

$$V = \sqrt{\frac{2PT}{M}}$$

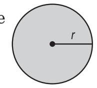
   V is the velocity in meters per second, P is the car's average power in watts, M is the mass of the car in kilograms, and T is the time in seconds.

   Find the time it takes for a 900-kilogram car with an average 60,000 watts of power to accelerate from stop to 60 miles per hour, which is 26.82 meters per second. Round your answer to the nearest tenth.
   about 5.4 s

4. **PHYSICAL SCIENCE** When a substance such as water vapor is in its gaseous state, the volume and the velocity of its molecules increase as temperature increases. The average velocity V of a molecule with mass m at temperature T is given by the formula $V = \sqrt{\frac{3kT}{m}}$.

   Solve the equation for k.
   $k = \frac{mV^2}{3T}$

5. **GEOMETRY** Suppose Emeryville Hospital wants to build a new helipad on which medic rescue helicopters can land. The helipad will be circular and made of fire resistant rubber.



   a. If the area of the helipad is A, write an equation for the radius r.
   $r = \sqrt{\frac{A}{\pi}}$

   b. Write an expression in simplified radical form for the radius of a helipad with an area of 288 square meters.
   $r = \frac{12\sqrt{2\pi}}{\pi}$

   c. Using a calculator, find a decimal approximation for the radius. Round your answer to the nearest hundredth.
   9.57 m

NAME ______________________ DATE ________ PERIOD ________

10-2 Enrichment

Squares and Square Roots From a Graph

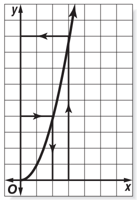
The graph of $y = x^2$ can be used to find the squares and square roots of numbers.

To find the square of 3, locate 3 on the x-axis. Then find its corresponding value on the y-axis.

The arrows show that $3^2 = 9$.

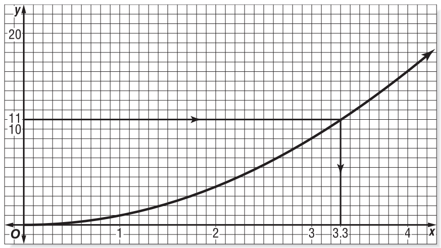
To find the square root of 4, first locate 4 on the y-axis. Then find its corresponding value on the x-axis. Following the arrows on the graph, you can see that $\sqrt{4} = 2$.

A small part of the graph at $y = x^2$ is shown below. A 10:1 ratio for unit length on the y-axis to unit length on the x-axis is used.



Example **Find $\sqrt{11}$.**

The arrows show that $\sqrt{11} = 3.3$ to the nearest tenth.



Exercises

Use the graph above to find each of the following to the nearest whole number.

1. 1.5^2 **2** **2.** 2.7^2 **7** **3.** 0.9^2 **1**

4. 3.6^2 **13** **5.** 4.2^2 **18** **6.** 3.9^2 **15**

Use the graph above to find each of the following to the nearest tenth.

7. $\sqrt{15}$ **3.9** **8.** $\sqrt{8}$ **2.8** **9.** $\sqrt{3}$ **1.7**

10. $\sqrt{5}$ **2.2** **11.** $\sqrt{14}$ **3.7** **12.** $\sqrt{17}$ **4.1**

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NAME ______________________ DATE ________ PERIOD ________

10-3 Study Guide and Intervention

Operations with Radical Expressions

Add or Subtract Radical Expressions When adding or subtracting radical expressions, use the Associative and Distributive Properties to simplify the expressions. If radical expressions are not in simplest form, simplify them.

Example 1 **Simplify $10\sqrt{6} - 5\sqrt{3} + 6\sqrt{3} - 4\sqrt{6}$.**

$10\sqrt{6} - 5\sqrt{3} + 6\sqrt{3} - 4\sqrt{6} = (10 - 4)\sqrt{6} + (-5 + 6)\sqrt{3}$ Associative and Distributive Properties

$= 6\sqrt{6} + \sqrt{3}$ Simplify.

Example 2 **Simplify $3\sqrt{12} + 5\sqrt{75}$.**

$3\sqrt{12} + 5\sqrt{75} = 3\sqrt{2^2 \cdot 3} + 5\sqrt{5^2 \cdot 3}$ Factor 12 and 75.

$= 3 \cdot 2\sqrt{3} + 5 \cdot 5\sqrt{3}$ Simplify.

$= 6\sqrt{3} + 25\sqrt{3}$ Multiply.

$= 31\sqrt{3}$ Distributive Property

Exercises

Simplify each expression.

1. $2\sqrt{5} + 4\sqrt{5}$ $\mathbf{6\sqrt{5}}$ **2.** $\sqrt{6} - 4\sqrt{6}$ $\mathbf{-3\sqrt{6}}$

3. $\sqrt{8} - \sqrt{2}$ $\mathbf{\sqrt{2}}$ **4.** $3\sqrt{75} + 2\sqrt{5}$ $\mathbf{15\sqrt{3} + 2\sqrt{5}}$

5. $\sqrt{20} + 2\sqrt{5} - 3\sqrt{5}$ $\mathbf{\sqrt{5}}$ **6.** $2\sqrt{3} + \sqrt{6} - 5\sqrt{3}$ $\mathbf{-3\sqrt{3} + \sqrt{6}}$

7. $\sqrt{12} + 2\sqrt{3} - 5\sqrt{3}$ $\mathbf{-\sqrt{3}}$ **8.** $3\sqrt{6} + 3\sqrt{2} - \sqrt{50} + \sqrt{24}$ $\mathbf{5\sqrt{6} - 2\sqrt{2}}$

9. $\sqrt{8a} - \sqrt{2a} + 5\sqrt{2a}$ $\mathbf{6\sqrt{2a}}$ **10.** $\sqrt{54} + \sqrt{24}$ $\mathbf{5\sqrt{6}}$

11. $\sqrt{3} + \sqrt{\frac{1}{3}}$ $\mathbf{\frac{4\sqrt{3}}{3}}$ **12.** $\sqrt{12} + \sqrt{\frac{1}{3}}$ $\mathbf{\frac{7\sqrt{3}}{3}}$

13. $\sqrt{54} - \sqrt{\frac{1}{6}}$ $\mathbf{\frac{17\sqrt{6}}{6}}$ **14.** $\sqrt{80} - \sqrt{20} + \sqrt{180}$ $\mathbf{8\sqrt{5}}$

15. $\sqrt{50} + \sqrt{18} - \sqrt{75} + \sqrt{27}$ $\mathbf{8\sqrt{2} - 2\sqrt{3}}$ **16.** $2\sqrt{3} - 4\sqrt{45} + 2\sqrt{\frac{1}{3}}$ $\mathbf{\frac{8\sqrt{3}}{3} - 12\sqrt{5}}$

17. $\sqrt{125} - 2\sqrt{\frac{1}{5}} + \sqrt{\frac{1}{3}}$ $\mathbf{\frac{23\sqrt{5}}{5} + \frac{\sqrt{3}}{3}}$ **18.** $\sqrt{\frac{2}{3}} + 3\sqrt{3} - 4\sqrt{\frac{1}{12}}$ $\mathbf{\frac{\sqrt{6} + 7\sqrt{3}}{3}}$

NAME ______________ DATE ________ PERIOD ________

10-3 Study Guide and Intervention *(continued)*

Operations with Radical Expressions

Multiply Radical Expressions Multiplying two radical expressions with different radicands is similar to multiplying binomials.

Example **Multiply $(3\sqrt{2} - 2\sqrt{5})(4\sqrt{20} + \sqrt{8})$.**

Use the FOIL method.

$(3\sqrt{2}-2\sqrt{5})(4\sqrt{20}+\sqrt{8}) = (3\sqrt{2})(4\sqrt{20}) + (3\sqrt{2})(\sqrt{8}) + (-2\sqrt{5})(4\sqrt{20}) + (-2\sqrt{5})(\sqrt{8})$

$= 12\sqrt{40} + 3\sqrt{16} - 8\sqrt{100} - 2\sqrt{40}$ Multiply.

$= 12\sqrt{2^2 \cdot 10} + 3 \cdot 4 - 8 \cdot 10 - 2\sqrt{2^2 \cdot 10}$ Simplify.

$= 24\sqrt{10} + 12 - 80 - 4\sqrt{10}$ Simplify.

$= 20\sqrt{10} - 68$ Combine like terms.

Exercises

Simplify each expression.

1. $2(\sqrt{3} + 4\sqrt{5})$ $\mathbf{2\sqrt{3} + 8\sqrt{5}}$
2. $\sqrt{6}(\sqrt{3} - 2\sqrt{6})$ $\mathbf{3\sqrt{2} - 12}$
3. $\sqrt{5}(\sqrt{5} - \sqrt{2})$ $\mathbf{5 - \sqrt{10}}$
4. $\sqrt{2}(3\sqrt{7} + 2\sqrt{5})$ $\mathbf{3\sqrt{14} + 2\sqrt{10}}$
5. $(2 - 4\sqrt{2})(2 + 4\sqrt{2})$ $\mathbf{-28}$
6. $(3 + \sqrt{6})^2$ $\mathbf{15 + 6\sqrt{6}}$
7. $(2 - 2\sqrt{5})^2$ $\mathbf{24 - 8\sqrt{5}}$
8. $3\sqrt{2}(\sqrt{8} + \sqrt{24})$ $\mathbf{12 + 12\sqrt{3}}$
9. $\sqrt{8}(\sqrt{2} + 5\sqrt{8})$ $\mathbf{44}$
10. $(\sqrt{5} - 3\sqrt{2})(\sqrt{5} + 3\sqrt{2})$ $\mathbf{-13}$
11. $(\sqrt{3} + \sqrt{6})^2$ $\mathbf{9 + 6\sqrt{2}}$
12. $(\sqrt{2} - 2\sqrt{3})^2$ $\mathbf{14 - 4\sqrt{6}}$
13. $(\sqrt{5} - \sqrt{2})(\sqrt{2} + \sqrt{6})$ $\mathbf{\sqrt{10} - 2 + \sqrt{30} - 2\sqrt{3}}$
14. $(\sqrt{8} - \sqrt{2})(\sqrt{3} + \sqrt{6})$ $\mathbf{\sqrt{6} + 2\sqrt{3}}$
15. $(\sqrt{5} - \sqrt{18})(7\sqrt{5} + \sqrt{3})$ $\mathbf{35 + \sqrt{15} - 21\sqrt{10} - 3\sqrt{6}}$
16. $(2\sqrt{3} - \sqrt{45})(\sqrt{12} + 2\sqrt{6})$ $\mathbf{12 - 6\sqrt{15} + 12\sqrt{2} - 6\sqrt{30}}$
17. $(2\sqrt{5} - 2\sqrt{3})(\sqrt{10} + \sqrt{6})$ $\mathbf{4\sqrt{2}}$
18. $(\sqrt{2} + 3\sqrt{3})(\sqrt{12} - 4\sqrt{8})$ $\mathbf{2 - 22\sqrt{6}}$

NAME ______________ DATE ________ PERIOD ________

10-3 Skills Practice

Operations with Radical Expressions

Simplify each expression.

1. $7\sqrt{7} - 2\sqrt{7}$ $\mathbf{5\sqrt{7}}$
2. $3\sqrt{13} + 7\sqrt{13}$ $\mathbf{10\sqrt{13}}$
3. $6\sqrt{5} - 2\sqrt{5} + 8\sqrt{5}$ $\mathbf{12\sqrt{5}}$
4. $\sqrt{15} + 8\sqrt{15} - 12\sqrt{15}$ $\mathbf{-3\sqrt{15}}$
5. $12\sqrt{r} - 9\sqrt{r}$ $\mathbf{3\sqrt{r}}$
6. $9\sqrt{6a} - 11\sqrt{6a} + 4\sqrt{6a}$ $\mathbf{2\sqrt{6a}}$
7. $\sqrt{44} - \sqrt{11}$ $\mathbf{\sqrt{11}}$
8. $\sqrt{28} + \sqrt{63}$ $\mathbf{5\sqrt{7}}$
9. $4\sqrt{3} + 2\sqrt{12}$ $\mathbf{8\sqrt{3}}$
10. $8\sqrt{54} - 4\sqrt{6}$ $\mathbf{20\sqrt{6}}$
11. $\sqrt{27} + \sqrt{48} + \sqrt{12}$ $\mathbf{9\sqrt{3}}$
12. $\sqrt{72} + \sqrt{50} - \sqrt{8}$ $\mathbf{9\sqrt{2}}$
13. $\sqrt{180} - 5\sqrt{5} + \sqrt{20}$ $\mathbf{3\sqrt{5}}$
14. $2\sqrt{24} + 4\sqrt{54} + 5\sqrt{96}$ $\mathbf{36\sqrt{6}}$
15. $5\sqrt{8} + 2\sqrt{20} - \sqrt{8}$ $\mathbf{8\sqrt{2} + 4\sqrt{5}}$
16. $2\sqrt{13} + 4\sqrt{2} - 5\sqrt{13} + \sqrt{2}$ $\mathbf{-3\sqrt{13} + 5\sqrt{2}}$
17. $\sqrt{2}(\sqrt{8} + \sqrt{6})$ $\mathbf{4 + 2\sqrt{3}}$
18. $\sqrt{5}(\sqrt{10} - \sqrt{3})$ $\mathbf{5\sqrt{2} - \sqrt{15}}$
19. $\sqrt{6}(3\sqrt{2} - 2\sqrt{3})$ $\mathbf{6\sqrt{3} - 6\sqrt{2}}$
20. $3\sqrt{3}(2\sqrt{6} + 4\sqrt{10})$ $\mathbf{18\sqrt{2} + 12\sqrt{30}}$
21. $(4 + \sqrt{3})(4 - \sqrt{3})$ $\mathbf{13}$
22. $(2 - \sqrt{6})^2$ $\mathbf{10 - 4\sqrt{6}}$
23. $(\sqrt{8} + \sqrt{2})(\sqrt{5} + \sqrt{3})$ $\mathbf{3\sqrt{10} + 3\sqrt{6}}$
24. $(\sqrt{6} + 4\sqrt{5})(4\sqrt{3} - \sqrt{10})$ $\mathbf{-8\sqrt{2} + 14\sqrt{15}}$

Lesson 10-3

NAME ______________ DATE ________ PERIOD ________

10-3 Practice

Operations with Radical Expressions

Simplify each expression.

1. $8\sqrt{30} - 4\sqrt{30}$ **$4\sqrt{30}$**
2. $2\sqrt{5} - 7\sqrt{5} - 5\sqrt{5}$ **$-10\sqrt{5}$**
3. $7\sqrt{13x} - 14\sqrt{13x} + 2\sqrt{13x}$ **$-5\sqrt{13x}$**
4. $2\sqrt{45} + 4\sqrt{20}$ **$14\sqrt{5}$**
5. $\sqrt{40} - \sqrt{10} + \sqrt{90}$ **$4\sqrt{10}$**
6. $2\sqrt{32} + 3\sqrt{50} - 3\sqrt{18}$ **$14\sqrt{2}$**
7. $\sqrt{27} + \sqrt{18} + \sqrt{300}$ **$3\sqrt{2} + 13\sqrt{3}$**
8. $5\sqrt{8} + 3\sqrt{20} - \sqrt{32}$ **$6\sqrt{2} + 6\sqrt{5}$**
9. $\sqrt{14} - \sqrt{\frac{2}{7}}$ **$\frac{6\sqrt{14}}{7}$**
10. $\sqrt{50} + \sqrt{32} - \sqrt{\frac{1}{2}}$ **$\frac{17\sqrt{2}}{2}$**
11. $5\sqrt{19} + 4\sqrt{28} - 8\sqrt{19} + \sqrt{63}$ **$-3\sqrt{19} + 11\sqrt{7}$**
12. $3\sqrt{10} + \sqrt{75} - 2\sqrt{40} - 4\sqrt{12}$ **$-\sqrt{10} - 3\sqrt{3}$**
13. $\sqrt{6}(\sqrt{10} + \sqrt{15})$ **$2\sqrt{15} + 3\sqrt{10}$**
14. $\sqrt{5}(5\sqrt{2} - 4\sqrt{8})$ **$-3\sqrt{10}$**
15. $2\sqrt{7}(3\sqrt{12} + 5\sqrt{8})$ **$12\sqrt{21} + 20\sqrt{14}$**
16. $(5 - \sqrt{15})^2$ **$40 - 10\sqrt{15}$**
17. $(\sqrt{10} + \sqrt{6})(\sqrt{30} - \sqrt{18})$ **$4\sqrt{3}$**
18. $(\sqrt{8} + \sqrt{12})(\sqrt{48} + \sqrt{18})$ **$36 + 14\sqrt{6}$**
19. $(\sqrt{2} + 2\sqrt{8})(3\sqrt{6} - \sqrt{5})$ **$30\sqrt{3} - 5\sqrt{10}$**
20. $(4\sqrt{3} - 2\sqrt{5})(3\sqrt{10} + 5\sqrt{6})$ **$2\sqrt{30} + 30\sqrt{2}$**

21. **SOUND** The speed of sound V in meters per second near Earth's surface is given by $V = 20\sqrt{t + 273}$, where t is the surface temperature in degrees Celsius.

a. What is the speed of sound near Earth's surface at 15°C and at 2°C in simplest form? **$240\sqrt{2}$ m/s, $100\sqrt{11}$ m/s**

b. How much faster is the speed of sound at 15°C than at 2°C? **$240\sqrt{2} - 100\sqrt{11} \approx 7.75$ m/s**

22. **GEOMETRY** A rectangle is $5\sqrt{7} + 2\sqrt{3}$ meters long and $6\sqrt{7} - 3\sqrt{3}$ meters wide.

a. Find the perimeter of the rectangle in simplest form. **$(22\sqrt{7} - 2\sqrt{3})$ m**

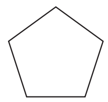
b. Find the area of the rectangle in simplest form. **$(192 - 3\sqrt{21})$ m²**

NAME ______________ DATE ________ PERIOD ________

10-3 Word Problem Practice

Operations with Radical Expressions

1. **ARCHITECTURE** The Pentagon is the building that houses the U.S. Department of Defense. Find the approximate perimeter of the building, which is a regular pentagon. Leave your answer as a radical expression.



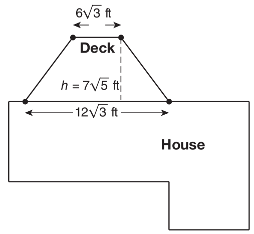
$115\sqrt{149}$ m

2. **EARTH** The surface area S of a sphere with radius r is given by the formula $S = 4\pi r^2$. Assuming that Earth is close to spherical in shape and has a surface area of about 5.1×10^8 square kilometers, what is the radius of Earth to the nearest ten kilometers?

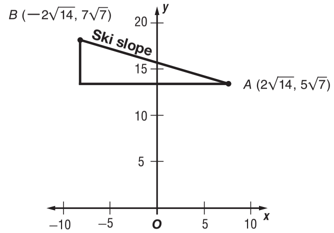
6370 km

3. **GEOMETRY** The area of a trapezoid is found by multiplying its height by the average length of its bases. Find the area of deck attached to Mr. Wilson's house. Give your answer as a simplified radical expression.

$63\sqrt{15}$ ft²



4. **RECREATION** Carmen surveyed a ski slope using a digital device connected to a computer. The computer model assigned coordinates to the top and bottom points of the hill as shown in the diagram. Write a simplified radical expression that represents the slope of the hill. **$-\frac{\sqrt{2}}{4}$**



5. **FREE FALL** A ball is dropped from a building window 800 feet above the ground. A heavier ball is dropped from a lower window 288 feet high. Both balls are released at the same time. Assume air resistance is not a factor and use the following formula to find how many seconds t it will take a ball to fall h feet.

$$t = \frac{1}{4}\sqrt{h}$$

a. How much time will pass between when the first ball hits the ground and when the second ball hits the ground? Give your answer as a simplified radical expression. **$2\sqrt{2}$ s**

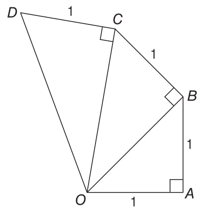
b. Which ball lands first? **The ball dropped from 288 feet lands first.**

c. Find a decimal approximation of the answer for part **a**. Round your answer to the nearest tenth. **about 2.8 s**

NAME ______________ DATE ________ PERIOD ________

10-3 Enrichment

The Wheel of Theodorus



The Greek mathematicians were intrigued by problems of representing different numbers and expressions using geometric constructions.

Theodorus, a Greek philosopher who lived about 425 B.C., is said to have discovered a way to construct the sequence $\sqrt{1}, \sqrt{2}, \sqrt{3}, \sqrt{4}, \ldots$.

The beginning of his construction is shown. You start with an isosceles right triangle with sides 1 unit long.

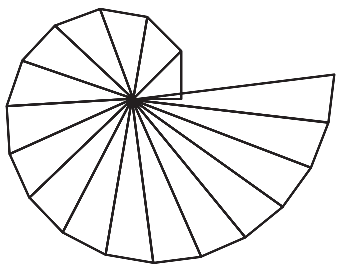
Use the figure above. Write each length as a radical expression in simplest form.

1. line segment AO **$\sqrt{1}$**
2. line segment BO **$\sqrt{2}$**
3. line segment CO **$\sqrt{3}$**
4. line segment DO **$\sqrt{4}$**
5. Describe how each new triangle is added to the figure. **Draw a new side of length 1 at right angles to the last hypotenuse. Then draw the new hypotenuse.**
6. The length of the hypotenuse of the first triangle is $\sqrt{2}$. For the second triangle, the length is $\sqrt{3}$. Write an expression for the length of the hypotenuse of the nth triangle.

   $\sqrt{n+1}$
7. Show that the method of construction will always produce the next number in the sequence. (*Hint:* Find an expression for the hypotenuse of the $(n + 1)$th triangle.)

   $\sqrt{(\sqrt{n})^2 + (1)^2}$ or $\sqrt{n+1}$
8. In the space below, construct a Wheel of Theodorus. Start with a line segment 1 centimeter long. When does the Wheel start to overlap?

   after length $\sqrt{18}$



NAME ______________ DATE ________ PERIOD ________

10-4 Study Guide and Intervention

Radical Equations

Radical Equations Equations containing radicals with variables in the radicand are called **radical equations**. These can be solved by first using the following steps.

Step 1	Isolate the radical on one side of the equation.
Step 2	Square each side of the equation to eliminate the radical.

Example 1 **Solve $16 = \frac{\sqrt{x}}{2}$ for x.**

$16 = \frac{\sqrt{x}}{2}$	Original equation
$2(16) = 2\left(\frac{\sqrt{x}}{2}\right)$	Multiply each side by 2.
$32 = \sqrt{x}$	Simplify.
$(32)^2 = (\sqrt{x})^2$	Square each side.
$1024 = x$	Simplify.

The solution is 1024, which checks in the original equation.

Example 2 **Solve $\sqrt{4x-7} + 2 = 7$.**

$\sqrt{4x-7} + 2 = 7$	Original equation
$\sqrt{4x-7} + 2 - 2 = 7 - 2$	Subtract 2 from each side.
$\sqrt{4x-7} = 5$	Simplify.
$\left(\sqrt{4x-7}\right)^2 = 5^2$	Square each side.
$4x - 7 = 25$	Simplify.
$4x - 7 + 7 = 25 + 7$	Add 7 to each side.
$4x = 32$	Simplify.
$x = 8$	Divide each side by 4.

The solution is 8, which checks in the original equation.

Exercises

Solve each equation. Check your solution.

1. $\sqrt{a} = 8$ **64**
2. $\sqrt{a} + 6 = 32$ **676**
3. $2\sqrt{x} = 8$ **16**
4. $7 = \sqrt{26 - n}$ **−23**
5. $\sqrt{-a} = 6$ **−36**
6. $\sqrt{3r^2} = 3$ **$\pm\sqrt{3}$**
7. $2\sqrt{3} = \sqrt{y}$ **12**
8. $2\sqrt{3a} - 2 = 7$ **$6\frac{3}{4}$**
9. $\sqrt{x - 4} = 6$ **40**
10. $\sqrt{2m + 3} = 5$ **11**
11. $\sqrt{3b - 2} + 19 = 24$ **9**
12. $\sqrt{4x - 1} = 3$ **$\frac{5}{2}$**
13. $\sqrt{3r + 2} = 2\sqrt{3}$ **$\frac{10}{3}$**
14. $\sqrt{\frac{x}{2}} = \frac{1}{2}$ **$\frac{1}{2}$**
15. $\sqrt{\frac{x}{8}} = 4$ **128**
16. $\sqrt{6x^2 + 5x} = 2$ **$\frac{1}{2}, -\frac{4}{3}$**
17. $\sqrt{\frac{x}{3}} + 6 = 8$ **12**
18. $2\sqrt{\frac{3x}{5}} + 3 = 11$ **$26\frac{2}{3}$**

Lesson 10-4

NAME ______________ DATE ________ PERIOD ________

10-4 Study Guide and Intervention *(continued)*

Radical Equations

Extraneous Solutions To solve a radical equation with a variable on both sides, you need to square each side of the equation. Squaring each side of an equation sometimes produces **extraneous solutions**, or solutions that are not solutions of the original equation. Therefore, it is very important that you check each solution.

Example 1 Solve $\sqrt{x+3} = x - 3$.

$\sqrt{x+3} = x - 3$	Original equation
$\left(\sqrt{x+3}\right)^2 = (x-3)^2$	Square each side.
$x + 3 = x^2 - 6x + 9$	Simplify.
$0 = x^2 - 7x + 6$	Subtract x and 3 from each side.
$0 = (x-1)(x-6)$	Factor.
$x - 1 = 0$ or $x - 6 = 0$	Zero Product Property
$x = 1$ $\quad$ $x = 6$	Solve.

CHECK

$\sqrt{x+3} = x - 3$	$\sqrt{x+3} = x - 3$
$\sqrt{1+3} \stackrel{?}{=} 1 - 3$	$\sqrt{6+3} \stackrel{?}{=} 6 - 3$
$\sqrt{4} \stackrel{?}{=} -2$	$\sqrt{9} \stackrel{?}{=} 3$
$2 \neq -2$	$3 = 3$ ✓

Since $x = 1$ does not satisfy the original equation, $x = 6$ is the only solution.

Exercises

Solve each equation. Check your solution.

1. $\sqrt{a} = a$ **0, 1**
2. $\sqrt{a+6} = a$ **3**
3. $2\sqrt{x} = x$ **0, 4**
4. $n = \sqrt{2-n}$ **1**
5. $\sqrt{-a} = a$ **0**
6. $\sqrt{10-6k} + 3 = k$ **∅**
7. $\sqrt{y-1} = y - 1$ **1, 2**
8. $\sqrt{3a-2} = a$ **1, 2**
9. $\sqrt{x+2} = x$ **2**
10. $\sqrt{2b+5} = b - 5$ **10**
11. $\sqrt{3b+6} = b + 2$ **−2, 1**
12. $\sqrt{4x-4} = x$ **2**
13. $r + \sqrt{2-r} = 2$ **1, 2**
14. $\sqrt{x^2+10x} = x + 4$ **8**
15. $-2\sqrt{\frac{x}{8}} = 15$ **∅**
16. $\sqrt{6x^2-4x} = x + 2$ **$-\frac{2}{5}$, 2**
17. $\sqrt{2y^2-64} = y$ **8**
18. $\sqrt{3x^2+12x+1} = x + 5$ **−4, 3**

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NAME ______________ DATE ________ PERIOD ________

10-4 Skills Practice

Radical Equations

Solve each equation. Check your solution.

1. $\sqrt{f} = 7$ **49**
2. $\sqrt{-x} = 5$ **−25**
3. $\sqrt{5p} = 10$ **20**
4. $\sqrt{4y} = 6$ **9**
5. $2\sqrt{2} = \sqrt{u}$ **8**
6. $3\sqrt{5} = \sqrt{-n}$ **−45**
7. $\sqrt{g} - 6 = 3$ **81**
8. $\sqrt{5a} + 2 = 0$ **∅**
9. $\sqrt{2t-1} = 5$ **13**
10. $\sqrt{3k-2} = 4$ **6**
11. $\sqrt{x+4} - 2 = 1$ **5**
12. $\sqrt{4x-4} - 4 = 0$ **5**
13. $\frac{\sqrt{d}}{3} = 4$ **144**
14. $\sqrt{\frac{m}{3}} = 3$ **27**
15. $x = \sqrt{x+2}$ **2**
16. $d = \sqrt{12-d}$ **3**
17. $\sqrt{6x-9} = x$ **3**
18. $\sqrt{6p-8} = p$ **2, 4**
19. $\sqrt{x+5} = x - 1$ **4**
20. $\sqrt{8-d} = d - 8$ **8**
21. $\sqrt{r-3} + 5 = r$ **7**
22. $\sqrt{y-1} + 3 = y$ **5**
23. $\sqrt{5n+4} = n + 2$ **1, 0**
24. $\sqrt{3z-6} = z - 2$ **5, 2**

NAME ______________________ DATE __________ PERIOD __________

10-4 Practice

Radical Equations

Solve each equation. Check your solution.

1. $\sqrt{-b} = 8$ **−64**
2. $4\sqrt{3} = \sqrt{x}$ **48**
3. $2\sqrt{4r} + 3 = 11$ **4**
4. $6 - \sqrt{2y} = -2$ **32**
5. $\sqrt{k+2} - 3 = 7$ **98**
6. $\sqrt{m-5} = 4\sqrt{3}$ **53**
7. $\sqrt{6t+12} = 8\sqrt{6}$ **62**
8. $\sqrt{3j-11} + 2 = 9$ **20**
9. $\sqrt{2x+15} + 5 = 18$ **77**
10. $\sqrt{\frac{3d}{5}} - 4 = 2$ **60**
11. $6\sqrt{\frac{3x}{3}} - 3 = 0$ **$\frac{1}{4}$**
12. $6 + \sqrt{\frac{5r}{6}} = -2$ **∅**
13. $y = \sqrt{y+6}$ **3**
14. $\sqrt{15-2x} = x$ **3**
15. $\sqrt{w+4} = w + 4$ **−4, −3**
16. $\sqrt{17-k} = k - 5$ **8**
17. $\sqrt{5m-16} = m - 2$ **4, 5**
18. $\sqrt{24+8q} = q + 3$ **−3, 5**
19. $\sqrt{4t+17} - t - 3 = 0$ **2**
20. $4 - \sqrt{3m+28} = m$ **−1**
21. $\sqrt{10p+61} - 7 = p$ **−6, 2**
22. $\sqrt{2x^2-9} = x$ **3**

23. **ELECTRICITY** The voltage V in a circuit is given by $V = \sqrt{PR}$, where P is the power in watts and R is the resistance in ohms.

a. If the voltage in a circuit is 120 volts and the circuit produces 1500 watts of power, what is the resistance in the circuit? **9.6 ohms**

b. Suppose an electrician designs a circuit with 110 volts and a resistance of 10 ohms. How much power will the circuit produce? **1210 watts**

24. **FREE FALL** Assuming no air resistance, the time t in seconds that it takes an object to fall h feet can be determined by the equation $t = \frac{\sqrt{h}}{4}$.

a. If a skydiver jumps from an airplane and free falls for 10 seconds before opening the parachute, how many feet does the skydiver fall? **1600 ft**

b. Suppose a second skydiver jumps and free falls for 6 seconds. How many feet does the second skydiver fall? **576 ft**

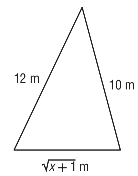
NAME ______________________ DATE __________ PERIOD __________

10-4 Word Problem Practice

Radical Equations

1. **SUBMARINES** The distance in miles that the lookout of a submarine can see is approximately $d = 1.22\sqrt{h}$, where h is the height in feet above the surface of the water. How far would a submarine periscope have to be above the water to locate a ship 6 miles away? Round your answer to the nearest tenth. **24.2 ft**

2. **PETS** Find the value of x if the perimeter of a triangular dog pen is 25 meters. **x = 8**



3. **LOGGING** Doyle's log rule estimates the amount of usable lumber in board feet that can be milled from a shipment of logs. It is represented by the equation $B = L\left(\frac{d-4}{4}\right)^2$, where d is the log diameter in inches and L is the log length in feet. Suppose the truck carries 20 logs, each 25 feet long, and that the shipment yields a total of 6000 board feet of lumber. Estimate the diameter of the logs to the nearest inch. Assume that all the logs have uniform length and diameter.
18 in.

4. **FIREFIGHTING** Fire fighters calculate the flow rate of water out of a particular hydrant by using the following formula.

$$F = 26.9d^2\sqrt{p}$$

F is the flow rate in gallons per minute, p is the nozzle pressure in pounds per square inch, and d is the diameter of the hose in inches. In order to effectively fight a fire, the combined flow rate of two hoses needs to be about 2430 gallons per minute. The diameter of each of the hoses is 3 inches, but the nozzle pressure of one hose is 4 times that of the second hose. What are the nozzle pressures for each hose? Round your answers to the nearest tenth.

11.2 psi and 44.8 psi

5. **GEOMETRY** The lateral surface area L of a right circular cone is the surface area not including the area of the base. The lateral surface area is represented by $L = \pi r\sqrt{r^2 + h^2}$, where r is the radius of the base and h is the height.

a. If the lateral surface area of a funnel is 127.54 square centimeters and its radius is 3.5 centimeters, find its height to the nearest tenth of a centimeter.
11.1 cm

b. What is the area of the opening of the funnel, that is, the base of the cone?
38.5 cm²

Lesson 10-4

NAME ______________ DATE ________ PERIOD ________

10-4 Enrichment

More Than One Square Root

You have learned that to remove the square root in an equation, you first need to isolate the square root, then square both sides of the equation, and finally, solve the resulting equation. However, there are equations that contain more that one square root and simply squaring once is not enough to remove all of the radicals.

Example **Solve $\sqrt{x+7} = \sqrt{x} + 1$.**

$\sqrt{x+7} = \sqrt{x} + 1$	One of the square roots is already isolated.
$(\sqrt{x+7})^2 = (\sqrt{x} + 1)^2$	Square each side to remove the square root.
$x + 7 = x + 2\sqrt{x} + 1$	Simplify. Use the FOIL method to square the right side.
$x + 7 - x - 1 = 2\sqrt{x}$	Isolate the square root term again.
$6 = 2\sqrt{x}$	Simplify.
$3 = \sqrt{x}$	Divide each side by 2.
$9 = x$	Square each side to remove the square root.

Check: Substitute into the *original* equation to make sure your solution is valid.

$\sqrt{9+7} \stackrel{?}{=} \sqrt{9} + 1$	Replace x with 9.
$\sqrt{16} \stackrel{?}{=} 3 + 1$	Simplify.
$4 = 4$ ✓	The equation is true, so $x = 9$ is the solution.

Exercises

Solve each equation.

1. $\sqrt{x+13} - 2 = \sqrt{x+1}$ **3**

2. $\sqrt{x+11} = \sqrt{x+3} + 2$ **−2**

3. $\sqrt{x+9} - 3 = \sqrt{x-6}$ **7**

4. $\sqrt{x+21} = \sqrt{x} + 3$ **4**

5. $\sqrt{x+9} + 3 = \sqrt{x+20} + 2$ **16**

6. $\sqrt{x-6} + 6 = \sqrt{x+1} + 5$ **15**

NAME ______________ DATE ________ PERIOD ________

10-4 Graphing Calculator Activity

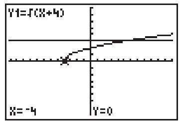
Radical Inequalities

The graphs of radical equations can be used to determine the solutions of radical inequalities through the **CALC** menu.

Example **Solve each inequality.**

a. $\sqrt{x+4} \le 3$

Enter $\sqrt{x+4}$ in **Y1** and 3 in **Y2** and graph. Examine the graphs. Use TRACE to find the endpoint of the graph of the radical equation. Use **CALC** to determine the intersection of the graphs. This interval, −4 to 5, where the graph of $y = \sqrt{x+4}$ is below the graph of $y = 3$, represents the solution to the inequality. Thus, the solution is $-4 \le x \le 5$.



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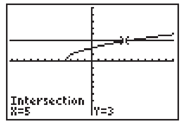
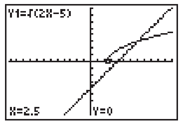


[−10, 10] scl:1 by [−10, 10] scl:1

b. $\sqrt{2x-5} > x - 4$

Graph each side of the inequality. Find the intersection and trace to the endpoint of the radical graph.

The graph of $y = \sqrt{2x-5}$ is above the graph of $y = x - 4$ from 2.5 up to 7. Thus, the solution is $2.5 < x < 7$.



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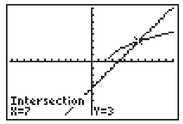

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Exercises

Solve each inequality.

1. $6 - \sqrt{2x+1} < 3$ **$x > 4$**

2. $\sqrt{4x-5} \le 7$ **$\frac{5}{4} \le x \le \frac{27}{2}$**

3. $\sqrt{5x-4} \ge 4$ **$x \ge 4$**

4. $-4 > \sqrt{3x-2}$ **no solution**

5. $\sqrt{3x-6} + 5 \ge -3$ **$x \ge 2$**

6. $\sqrt{6-3x} < x + 16$ **$-10 < x < 2$**

Lesson 10-4

Answers

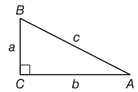
NAME ______________________ DATE ________ PERIOD ________

10-5 Study Guide and Intervention

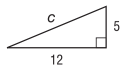
The Pythagorean Theorem

The Pythagorean Theorem The side opposite the right angle in a right triangle is called the **hypotenuse**. This side is always the longest side of a right triangle. The other two sides are called the **legs** of the triangle. To find the length of any side of a right triangle, given the lengths of the other two sides, you can use the **Pythagorean Theorem**.

Pythagorean Theorem	If a and b are the measures of the legs of a right triangle and c is the measure of the hypotenuse, then $c^2 = a^2 + b^2$.



Example **Find the missing length.**

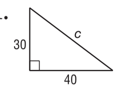


$c^2 = a^2 + b^2$ Pythagorean Theorem
$c^2 = 5^2 + 12^2$ $a = 5$ and $b = 12$
$c^2 = 169$ Simplify.
$c = \sqrt{169}$ Take the square root of each side.
$c = 13$ Simplify.

The length of the hypotenuse is 13.

Exercises

Find the length of each missing side. If necessary, round to the nearest hundredth.

1.


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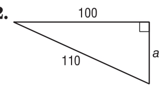
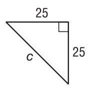
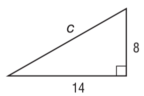
2.


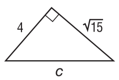
45.83

3.


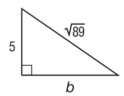
35.36

4.


16.12

5.


5.57

6.


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NAME ______________________ DATE ________ PERIOD ________

10-5 Study Guide and Intervention *(continued)*

The Pythagorean Theorem

Right Triangles If a and b are the measures of the shorter sides of a triangle, c is the measure of the longest side, and $c^2 = a^2 + b^2$, then the triangle is a right triangle.

Example **Determine whether each set of measures can be sides of a right triangle.**

a. 10, 12, 14

Since the greatest measure is 14, let $c = 14$, $a = 10$, and $b = 12$.

$c^2 = a^2 + b^2$ Pythagorean Theorem
$14^2 \stackrel{?}{=} 10^2 + 12^2$ $a = 10$, $b = 12$, $c = 14$
$196 \stackrel{?}{=} 100 + 144$ Multiply.
$196 \neq 244$ Add.

Since $c^2 \neq a^2 + b^2$, segments with these measures cannot form a right triangle.

b. 7, 24, 25

Since the greatest measure is 25, let $c = 25$, $a = 7$, and $b = 24$.

$c^2 = a^2 + b^2$ Pythagorean Theorem
$25^2 \stackrel{?}{=} 7^2 + 24^2$ $a = 7$, $b = 24$, $c = 25$
$625 \stackrel{?}{=} 49 + 576$ Multiply.
$625 = 625$ Add.

Since $c^2 = a^2 + b^2$, segments with these measures can form a right triangle.

Exercises

Determine whether each set of measures can be sides of a right triangle. Then determine whether they form a Pythagorean triple.

1. 14, 48, 50 **yes; yes**

2. 6, 8, 10 **yes; yes**

3. 8, 8, 10 **no; no**

4. 90, 120, 150 **yes; yes**

5. 15, 20, 25 **yes; yes**

6. 4, 8, $4\sqrt{5}$ **yes; no**

7. 2, 2, $\sqrt{8}$ **yes; no**

8. 4, 4, $\sqrt{20}$ **no; no**

9. 25, 30, 35 **no; no**

10. 24, 36, 48 **no; no**

11. 18, 80, 82 **yes; yes**

12. 150, 200, 250 **yes; yes**

13. 100, 200, 300 **no; no**

14. 500, 1200, 1300 **yes; yes**

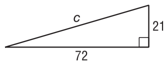
15. 700, 1000, 1300 **no; no**

NAME ______________________ DATE __________ PERIOD ________

10-5 Skills Practice

The Pythagorean Theorem

Find each missing length. If necessary, round to the nearest hundredth.

1.


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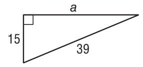
2.


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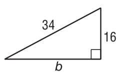
3.


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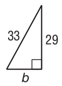
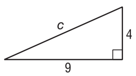
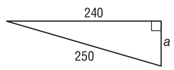
4.


15.75

5.


9.85

6.


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Determine whether each set of measures can be sides of a right triangle. Then determine whether they form a Pythagorean triple.

7. 7, 24, 25 **yes; yes**

8. 15, 30, 34 **no; no**

9. 16, 28, 32 **no; no**

10. 18, 24, 30 **yes; yes**

11. 15, 36, 39 **yes; yes**

12. 5, 7, $\sqrt{74}$ **yes; no**

13. 4, 5, 6 **no; no**

14. 10, 11, $\sqrt{221}$ **yes; no**

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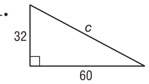
NAME ______________________ DATE __________ PERIOD ________

10-5 Practice

The Pythagorean Theorem

Find each missing length. If necessary, round to the nearest hundredth.

1.


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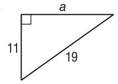
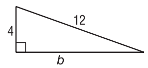
2.


15.49

3.


11.31

Determine whether each set of measures can be sides of a right triangle. Then determine whether they form a Pythagorean triple.

4. 11, 18, 21
no; no

5. 21, 72, 75
yes; yes

6. 7, 8, 11
no; no

7. 9, 10, $\sqrt{161}$
no; no

8. 9, $2\sqrt{10}$, 11
yes; no

9. $\sqrt{7}$, $2\sqrt{2}$, $\sqrt{15}$
yes; no

10. STORAGE The shed in Stephan's back yard has a door that measures 6 feet high and 3 feet wide. Stephan would like to store a square theater prop that is 7 feet on a side. Will it fit through the door diagonally? Explain. **No; the greatest length that will fit through the door is $\sqrt{45} \approx 6.71$ ft.**

11. SCREEN SIZES The size of a television is measured by the length of the screen's diagonal.

a. If a television screen measures 24 inches high and 18 inches wide, what size television is it? **30-in. television**

b. Darla told Tri that she has a 35-inch television. The height of the screen is 21 inches. What is its width? **28 in.**

c. Tri told Darla that he has a 5-inch handheld television and that the screen measures 2 inches by 3 inches. Is this a reasonable measure for the screen size? Explain. **No; if the screen measures 2 in. by 3 in., then its diagonal is only about 3.61 in.**

Lesson 10-5

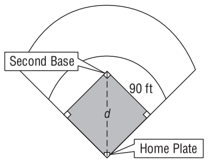
Answers

NAME ________________ DATE ________ PERIOD ________

10-5 Word Problem Practice

Pythagorean Theorem

1. **BASEBALL** A baseball diamond is a square. Each base path is 90 feet long. After a pitch, the catcher quickly throws the ball from home plate to a teammate standing by second base. Find the distance the ball travels. Round your answer to the nearest tenth.
127.3 ft

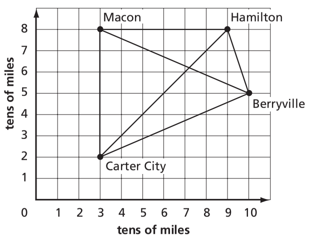


2. **TRIANGLES** Each student in Mrs. Kelly's geometry class constructed a unique right triangle from drinking straws. Mrs. Kelly made a chart with the dimensions of each triangle. However, Mrs. Kelly made a mistake when recording their results. Which result was recorded incorrectly? **Fran's**

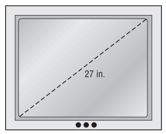
Side Lengths

Student	a	b	c	Student	a	b	c
Amy	3	4	5	Fran	8	14	16
Belinda	7	24	25	Gus	5	12	13
Emory	9	12	15				

3. **MAPS** Find the distance between Macon and Berryville. Round your answer to the nearest tenth. **76.2 mi**



4. **TELEVISION** Televisions are identified by the diagonal measurement of the viewing screen. For example, a 27-inch television has a diagonal screen measurement of 27 inches.

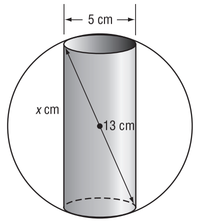


Complete the chart to find the screen height of each television given its size and screen width. Round your answers to the nearest whole number.

TV size	width (in.)	height (in.)
19-inch	15	**12**
25-inch	21	**14**
32-inch	25	**20**
50-inch	40	**30**

Source: Best Buy

5. **MANUFACTURING** Karl works for a company that manufactures car parts. His job is to drill a hole in spherical steel balls. The balls and the holes have the dimensions shown on the diagram.



a. How deep is the hole? **12 cm**

b. What would be the radius of a ball with a similar hole 7 centimeters wide and 24 centimeters deep? **12.5 cm**

Chapter 10 34 Glencoe Algebra 1

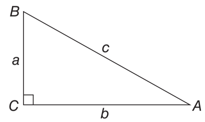
NAME ________________ DATE ________ PERIOD ________

10-5 Enrichment

Pythagorean Triples

Recall the Pythagorean Theorem:

In a right triangle, the square of the length of the hypotenuse is equal to the sum of the squares of the lengths of the legs.



$a^2 + b^2 = c^2$

Note that c is the length of the hypotenuse.

The integers 3, 4, and 5 satisfy the Pythagorean Theorem and can be the lengths of the sides of a right triangle.

$3^2 + 4^2 \stackrel{?}{=} 5^2$
$9 + 16 \stackrel{?}{=} 25$
$25 = 25$ ✓

Furthermore, for any positive integer n, the numbers $3n$, $4n$, and $5n$ satisfy the Pythagorean Theorem.

For $n = 2$: $6^2 + 8^2 \stackrel{?}{=} 10^2$
$36 + 64 \stackrel{?}{=} 100$
$100 = 100$ ✓

If three positive integers satisfy the Pythagorean Theorem, they are called a **Pythagorean triple**. Here is an easy way to find other Pythagorean triples.

The numbers a, b, and c are a Pythagorean triple if $a = m^2 - n^2$, $b = 2mn$, and $c = m^2 + n^2$, where m and n are relatively prime positive integers and $m > n$.

Example **Choose $m = 5$ and $n = 2$.**

$a = m^2 - n^2 = 5^2 - 2^2 = 25 - 4 = 21$

$b = 2mn = 2(5)(2) = 20$

$c = m^2 + n^2 = 5^2 + 2^2 = 25 + 4 = 29$

Check $20^2 + 21^2 \stackrel{?}{=} 29^2$
$400 + 441 \stackrel{?}{=} 841$
$841 = 841$ ✓

Exercises

Use the following values of m and n to find Pythagorean triples.

1. $m = 3$ and $n = 2$ **5, 12, 13**
2. $m = 4$ and $n = 1$ **8, 15, 17**
3. $m = 5$ and $n = 3$ **16, 30, 34**
4. $m = 6$ and $n = 5$ **11, 60, 61**
5. $m = 10$ and $n = 7$ **51, 140, 149**
6. $m = 8$ and $n = 5$ **39, 80, 89**

Chapter 10 35 Glencoe Algebra 1

Lesson 10-5

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NAME ____________________ DATE ________ PERIOD ________

10-5 Spreadsheet Activity

Pythagorean Triples

A **Pythagorean triple** is a set of three whole numbers that satisfies the equation $a^2 + b^2 = c^2$, where c is the greatest number. You can use a spreadsheet to investigate the patterns in Pythagorean triples. A **primitive Pythagorean triple** is a Pythagorean triple in which the numbers have no common factors other than 1. A **family of Pythagorean triples** is a primitive Pythagorean triple and its whole number multiples.

The spreadsheet at the right produces a family of Pythagorean triples.

Step 1 Enter a primitive Pythagorean triple into cells A1, B1, and C1.

Step 2 Use rows 2 through 10 to find 9 additional Pythagorean triples that are multiples of the primitive triple. Format the rows so that row 2 multiplies the numbers in row 1 by 2, row 3 multiplies the numbers in row 1 by 3, and so on.

Triples.xls

◇	A	B	C
1	3	4	5
2	6	8	10
3	9	12	15
4	12	16	20
5	15	20	25
6	18	24	30
7	21	28	35
8	24	32	40
9	27	36	45
10	30	40	50

Sheet 1 | Sheet 2 | Sh

The formula in cell A10 is A1 * 10.

Exercises

Use the spreadsheet of families of Pythagorean triples.

1. Choose one of the triples other than (3, 4, 5) from the spreadsheet. Verify that it is a Pythagorean triple. **Sample answer: For (6, 8, 10), $6^2 + 8^2 = 36 + 64$ or $100 = 10^2$.**

2. Two polygons are **similar** if they are the same shape, but not necessarily the same size. For triangles, if two triangles have angles with the same measures then they are similar. Use a centimeter ruler to draw triangles with measures from the spreadsheet. Do the triangles appear to be similar? **See students' work.; yes**

Each of the following is a primitive Pythagorean triple. Use the spreadsheet to find two Pythagorean triples in their families.

3. (5, 12, 13) **Sample answer: (10, 24, 26), (15, 36, 39)**

4. (9, 40, 41) **Sample answer: (18, 80, 82), (27, 120, 123)**

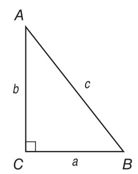
5. (20, 21, 29) **Sample answer: (40, 42, 58), (60, 63, 87)**

NAME ____________________ DATE ________ PERIOD ________

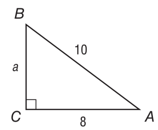
10-6 Study Guide and Intervention

Trigonometric Ratios

Trigonometric Ratios Trigonometry is the study of relationships of the angles and the sides of a right triangle. The three most common trigonometric ratios are the **sine**, **cosine**, and **tangent**.

sine of $\angle A = \frac{\text{leg opposite } \angle A}{\text{hypotenuse}}$ sine of $\angle B = \frac{\text{leg opposite } \angle B}{\text{hypotenuse}}$	$\sin A = \frac{a}{c}$ $\sin B = \frac{b}{c}$	
cosine of $\angle A = \frac{\text{leg adjacent to } \angle A}{\text{hypotenuse}}$ cosine of $\angle B = \frac{\text{leg adjacent to } \angle B}{\text{hypotenuse}}$	$\cos A = \frac{b}{c}$ $\cos B = \frac{a}{c}$	
tangent of $\angle A = \frac{\text{leg opposite } \angle A}{\text{leg adjacent to } \angle A}$ tangent of $\angle B = \frac{\text{leg opposite } \angle B}{\text{leg adjacent to } \angle B}$	$\tan A = \frac{a}{b}$ $\tan B = \frac{b}{a}$	

Example **Find the values of the three trigonometric ratios for angle A.**



Step 1 Use the Pythagorean Theorem to find BC.

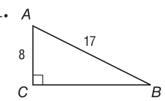
$a^2 + b^2 = c^2$ — Pythagorean Theorem
$a^2 + 8^2 = 10^2$ — $b = 8$ and $c = 10$
$a^2 + 64 = 100$ — Simplify.
$a^2 = 36$ — Subtract 64 from each side.
$a = 6$ — Take the positive square root of each side.

Step 2 Use the side lengths to write the trigonometric ratios.

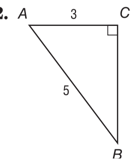
$\sin A = \frac{\text{opp}}{\text{hyp}} = \frac{6}{10} = \frac{3}{5}$ $\quad\cos A = \frac{\text{adj}}{\text{hyp}} = \frac{8}{10} = \frac{4}{5}$ $\quad\tan A = \frac{\text{opp}}{\text{adj}} = \frac{6}{8} = \frac{3}{4}$

Exercises

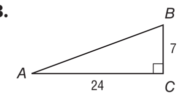
Find the values of the three trigonometric ratios for angle A.

1. 

$\sin A = \frac{15}{17}$, $\cos A = \frac{8}{17}$, $\tan A = \frac{15}{8}$

2. 

$\sin A = \frac{4}{5}$, $\cos A = \frac{3}{5}$, $\tan A = \frac{4}{3}$

3. 

$\sin A = \frac{7}{25}$, $\cos A = \frac{24}{25}$, $\tan A = \frac{7}{24}$

Use a calculator to find the value of each trigonometric ratio to the nearest ten-thousandth.

4. sin 40° **0.6428** **5.** cos 25° **0.9063** **6.** tan 85° **11.4301**

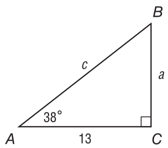
NAME ______________ DATE ________ PERIOD ________

10-6 Study Guide and Intervention *(continued)*

Trigonometric Ratios

Use Trigonometric Ratios When you find all of the unknown measures of the sides and angles of a right triangle, you are **solving the triangle**. You can find the missing measures of a right triangle if you know the measure of two sides of the triangle, or the measure of one side and the measure of one acute angle.

Example **Solve the right triangle. Round each side length to the nearest tenth.**



Step 1 Find the measure of $\angle B$. The sum of the measures of the angles in a triangle is 180.
$180° - (90° + 38°) = 52°$
The measure of $\angle B$ is 52°.

Step 2 Find the measure of $\overline{AB}$. Because you are given the measure of the side adjacent to $\angle A$ and are finding the measure of the hypotenuse, use the cosine ratio.

$\cos 38° = \frac{13}{c}$ Definition of cosine

$c \cos 38° = 13$ Multiply each side by *c*.

$c = \frac{13}{\cos 38°}$ Divide each side by cos 38°.

So the measure of $\overline{AB}$ is about 16.5.

Step 3 Find the measure of $\overline{BC}$. Because you are given the measure of the side adjacent to $\angle A$ and are finding the measure of the side opposite $\angle A$, use the tangent ratio.

$\tan 38° = \frac{a}{13}$ Definition of tangent

$13 \tan 38° = a$ Multiply each side by 13.

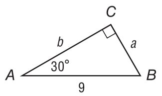
$10.2 \approx a$ Use a calculator.

So the measure of $\overline{BC}$ is about 10.2.

Exercises

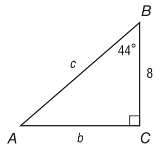
Solve each right triangle. Round each side length to the nearest tenth.

1.



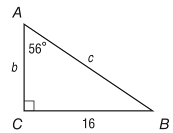
$\angle B = 60°$, $AC \approx 7.8$, $BC = 4.5$

2.



$\angle A = 46°$, $AC \approx 7.7$, $AB \approx 11.1$

3.



$\angle B = 34°$, $AC \approx 19.3$, $AB \approx 10.8$

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NAME ______________ DATE ________ PERIOD ________

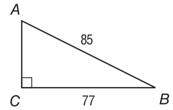
10-6 Skills Practice

Trigonometric Ratios

Lesson 10-6

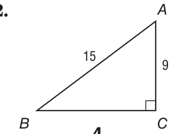
Find the values of the three trigonometric ratios for angle *A*.

1.



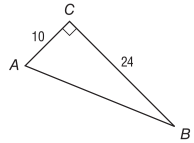
$\sin A = \frac{77}{85}$, $\cos A = \frac{36}{85}$, $\tan A = \frac{77}{36}$

2.



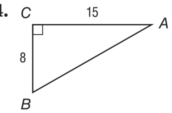
$\sin A = \frac{4}{5}$, $\cos A = \frac{3}{5}$, $\tan A = \frac{4}{3}$

3.



$\sin A = \frac{12}{13}$, $\cos A = \frac{5}{13}$, $\tan A = \frac{12}{5}$

4.



$\sin A = \frac{8}{17}$, $\cos A = \frac{15}{17}$, $\tan A = \frac{8}{15}$

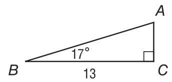
Use a calculator to find the value of each trigonometric ratio to the nearest ten-thousandth.

5. sin 18° **0.3090** **6.** cos 68° **0.3746** **7.** tan 27° **0.5095**

8. cos 60° **0.5000** **9.** tan 75° **3.7321** **10.** sin 9° **0.1564**

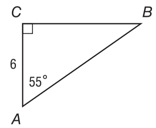
Solve each right triangle. Round each side length to the nearest tenth.

11.



$\angle A = 73°$, $AB = 13.6$, $AC = 4.0$

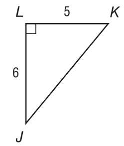
12.



$\angle B = 35°$, $AB = 10.5$, $BC = 8.6$

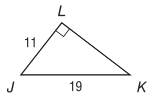
Find $m\angle J$ for each right triangle to the nearest degree.

13.



40°

14.



55°

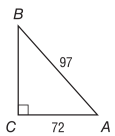
NAME ______________ DATE ________ PERIOD ________

10-6 Practice

Trigonometric Ratios

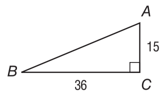
Find the values of the three trigonometric ratios for angle *A*.

1.



$\sin A = \frac{65}{97}$, $\cos A = \frac{72}{97}$, $\tan A = \frac{65}{72}$

2.



$\sin A = \frac{36}{39}$, $\cos A = \frac{15}{39}$, $\tan A = \frac{36}{15}$

Use a calculator to find the value of each trigonometric ratio to the nearest ten-thousandth.

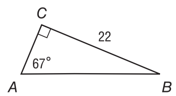
3. tan 26° **0.4877**

4. sin 53° **0.7986**

5. cos 81° **0.1564**

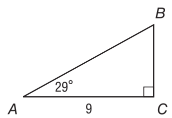
Solve each right triangle. Round each side length to the nearest tenth.

6.



$\angle B = 23°$, $AB = 23.9$, $AC = 9.3$

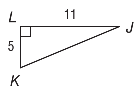
7.



$\angle A = 61°$, $AB = 10.3$, $BC = 5.0$

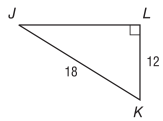
Find $m\angle J$ for each right triangle to the nearest degree.

8.



24°

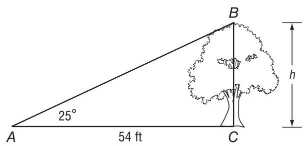
9.



42°

10. **SURVEYING** If point *A* is 54 feet from the tree, and the angle between the ground at point *A* and the top of the tree is 25°, find the height *h* of the tree.

25.2 ft

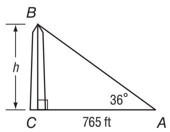


NAME ______________ DATE ________ PERIOD ________

10-6 Word Problem Practice

Trigonometric Ratios

1. **WASHINGTON MONUMENT** Jeannie is trying to determine the height of the Washington Monument. If point *A* is 765 feet from the monument, and the angle between the ground and the top of the monument at point *A* is 36°, find the height *h* of the monument to the nearest foot. **556 ft**

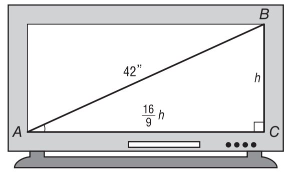


2. **AIRPLANES** A pilot takes off from a runway at an angle of 20° and maintains that angle until it is at its cruising altitude of 2500 feet. What horizontal distance has the plane traveled when it reaches its cruising altitude? **6869 ft**

3. **TRUCK RAMPS** A moving company uses an 11-foot-long ramp to unload furniture from a truck. If the truck bed is 3 feet above the ground, what is the angle of incline of the ramp to the nearest degree? **16°**

4. **SPECIAL TRIANGLES** While investigating right triangle *KLM*, Mercedes finds that $\cos M = \sin M$. What is the measure of angle *M*? **45°**

5. **TELEVISIONS** Televisions are commonly sized by measuring their diagonal. A common size for widescreen plasma TVs is 42 inches.



a. A widescreen television has a 16:9 aspect ratio, that is, the screen width is $\frac{16}{9}$ times the screen height. Use the Pythagorean Theorem to write an equation and solve for the height *h* of the television in inches.

$\left(\frac{16}{9}h\right)^2 + h^2 = 42^2$; **$h = 20.6$ in.**

b. Use the information from part **a** to solve the right triangle.

width = 36.6 in., $m\angle A = 29°$, $m\angle B = 61°$

c. To the nearest degree what would the measure of angle *BAC* be on a standard television with a 4:3 aspect ratio? **37°**

Lesson 10-6

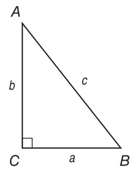
Answers

NAME ______________________ DATE ____________ PERIOD ____________

10-6 Enrichment

More Trigonometric Ratios

In addition to the sine, cosine, and tangent, there are three other common trigonometric ratios. They are the **secant**, **cosecant**, and **cotangent**.

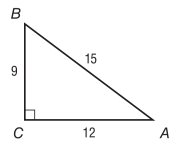
secant of $\angle A = \frac{\text{hypotenuse}}{\text{leg adjacent } \angle A}$ secant of $\angle B = \frac{\text{hypotenuse}}{\text{leg adjacent } \angle B}$	$\sec A = \frac{c}{b}$ $\sec B = \frac{c}{a}$	
cosecant of $\angle A = \frac{\text{hypotenuse}}{\text{leg opposite } \angle A}$ cosecant of $\angle B = \frac{\text{hypotenuse}}{\text{leg opposite } \angle B}$	$\csc A = \frac{c}{a}$ $\csc B = \frac{c}{b}$	
cotangent of $\angle A = \frac{\text{leg adjacent to } \angle A}{\text{leg opposite } \angle A}$ cotangent of $\angle B = \frac{\text{leg adjacent to } \angle B}{\text{leg opposite } \angle B}$	$\cot A = \frac{b}{a}$ $\cot B = \frac{a}{b}$	

Example **Find the secant, cosecant, and cotangent of angle *A*.**

Use the side lengths to write the trigonometric ratios.

$\sec A = \frac{\text{hyp}}{\text{adj}} = \frac{15}{12} = \frac{5}{4}$ $\qquad \csc A = \frac{\text{hyp}}{\text{opp}} = \frac{15}{9} = \frac{5}{3}$

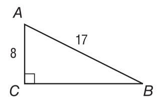
$\cot A = \frac{\text{adj}}{\text{opp}} = \frac{12}{9} = \frac{4}{3}$



Exercises

Find the secant, cosecant, and cotangent of angle *A*.

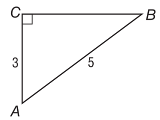
1.



sec $A = \frac{17}{8}$, csc $A = \frac{17}{15}$

cot $A = \frac{8}{15}$

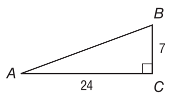
2.



sec $A = \frac{5}{3}$, csc $A = \frac{5}{4}$,

cot $A = \frac{3}{4}$

3.



sec $A = \frac{25}{24}$, csc $A = \frac{25}{7}$,

cot $A = \frac{24}{7}$

4. How does the sine of an angle relate to the angle's cosecant? How does the cosine of an angle relate to the angle's secant? How does the cotangent of an angle relate to the angle's tangent?

csc $A = \frac{1}{\sin A}$, sec $A = \frac{1}{\cos A}$, and cot $A = \frac{1}{\tan A}$

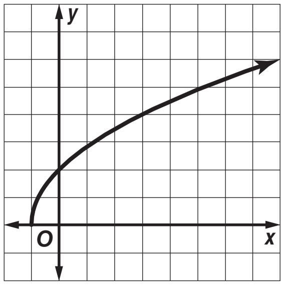
Use the relations that you found in Exercise 4 and a calculator to find the value of each trigonometric ratio to the nearest ten-thousandth.

5. sec 17° **1.0457** **6.** csc 49° **1.3250** **7.** cot 81° **0.1584**

Chapter 10 42 Glencoe Algebra 1

Chapter 10 Assessment Answer Key

Quiz 1 (Lessons 10-1 and 10-2)
Page 45

1. 

$D = \{x|x \geq -1\}$; $R = \{y|y \geq 0\}$;

2. A
3. $6\sqrt{2}$
4. $2|x|\sqrt{2y}$
5. $\frac{12 - 3\sqrt{2}}{14}$

Quiz 2 (Lessons 10-3 and 10-4)
Page 45

1. $26\sqrt{5}$
2. $4\sqrt{6} + 8\sqrt{10}$
3. $5\sqrt{2} + 6\sqrt{5}$
4. $\sqrt{15} - 2\sqrt{2}$
5. D
6. 5
7. 7
8. 3, 8
9. 2
10. 2

Quiz 3 (Lesson 10-5)
Page 46

1. 14.70
2. no
3. C
4. no
5. no

Quiz 4 (Lessons 10-6)
Page 46

1. 8
2. $\sin B = \frac{4}{5}$, $\cos B = \frac{3}{5}$, $\tan B = \frac{4}{3}$
3. $\sin A = \frac{3}{5}$, $\cos A = \frac{4}{5}$, $\tan A = \frac{3}{4}$
4. A
5. $RP = 27.5$, $PQ = 29.2$, $m\angle Q = 70^\circ$

Mid-Chapter Test
Page 47 (Lessons 10-1 through 10-4)

1. D
2. F
3 D
4. G
5. D
6. F
7. D
8. $6\sqrt{5} - 20\sqrt{3}$
9. 23
10. $39\sqrt{2}$
11. $7\sqrt{5} - 2\sqrt{10}$
12. $3\sqrt{2} + 2\sqrt{6}$
13. 5
14 29
15. 9.49 ft

Chapter 10 Assessment Answer Key

Vocabulary Test
Page 48

1. converse
2. cosine
3. Pythagorean Theorem
4. radical equation
5. conjugates
6. hypotenuse
7. radicand
8. legs
9. solving the triangle
10. Sample answer: the study of relationships among the angles and sides of the triangle
11. Sample answer: the trigonometric ratio equivalent to the leg opposite to an angle divided by the leg adjacent to the angle.

Form 1
Page 49

1. A
2. F
3. C
4. F
5. D
6. H
7. D
8. G
9. B
10. F
11. B
12. J

Page 50

13. D
14. H
15. C
16. F
17. D
18. H
19. A
20. J

B: $|2x + 1|$

Answers

Chapter 10 Assessment Answer Key

Form 2A

Page 51

1. D
2. J
3. D
4. G
5. C
6. F
7. B
8. G
9. B
10. H
11. D
12. H

Page 52

13. B
14. G
15. A
16. G
17. C
18. F
19. A
20. H

B: 12 m

Form 2B

Page 53

1. D
2. F
3. B
4. F
5. C
6. J
7. C
8. J
9. C
10. F
11. B
12. G

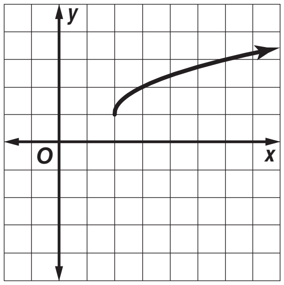
Page 54

13. D
14. J
15. A
16. G
17. A
18. J
19. A
20. H

B: 14 ft

Form 2C

Page 55

1. 

$D = \{x \mid x \geq 2\}$; $R = \{y \mid y \geq 1\}$

2. $D = \{x \mid x \geq 1\}$; $R = \{y \mid y \leq 5\}$

3. $6\sqrt{2}$

4. $5y^2|w|\sqrt{3w}$

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

6. $20\sqrt{5}$

7. $2\sqrt{14} + 5\sqrt{3}$

8. 12

9. 11

10. 12

11. 11.66

12. 7

13. yes

14. no

15. 0.7431

16. 0.9925

17. 2.9040

Page 56

18. $\sin A = \frac{21}{29}$; $\cos A = \frac{20}{29}$; $\tan A = \frac{21}{20}$

19. $\sin A = \frac{48}{73}$; $\cos A = \frac{55}{73}$; $\tan A = \frac{48}{55}$

20. 53.7 ft^2

21. 10.4 ft

22. $\sqrt{149}$ mi or 12.2 mi

23. ≈ 12.5 cm

24. 67°

25. ≈ 23.2 ft

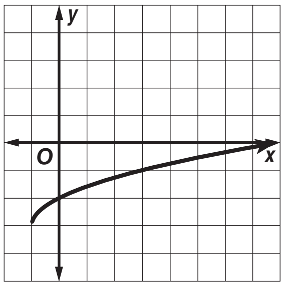
B: –2

Answers

Chapter 10 Assessment Answer Key

Form 2D

Page 57

1. 

2. $D = \{x \mid x \geq -1\}$; $R = \{y \mid y \geq -3\}$; $D = \{x \mid x \geq -2\}$; $R = \{y \mid y \leq -1\}$

3. $10\sqrt{2}$

4. $5|xy|\sqrt{2x}$

5. $10\sqrt{5} + 15\sqrt{2}$

6. $22\sqrt{6}$

7. $9\sqrt{3} - 2\sqrt{22}$

8. 4

9. 3

10. 4

11. 8.06

12. 8

13. yes

14. no

15. 0.7431

16. 0.4695

17. 0.2126

Page 58

18. $\sin A = \frac{4}{5}$; $\cos A = \frac{3}{5}$; $\tan A = \frac{4}{3}$

19. $\sin A = \frac{36}{85}$; $\cos A = \frac{77}{85}$; $\tan A = \frac{36}{77}$

20. 84.6 ft^2

21. 43.3 ft

22. 5.39 mi

23. 15.20 cm

24. 69°

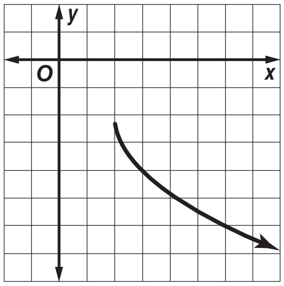
25. ≈ 30.0 ft

B: –3

Chapter 10 Assessment Answer Key

Form 3

Page 59

1. 

$D = \{x \mid x \geq 2\}$;
$R = \{y \mid y \leq -2\}$

2. $D = \{x \mid x \geq -4\}$; $R = \{y \mid y \leq -12\}$

3. $18\sqrt{7}$

4. $\frac{x^2\sqrt{5n}}{2|n^3|}$

5. $\frac{2(\sqrt{10}-\sqrt{3})}{7}$

6. 0

7. $40\sqrt{2} - 27\sqrt{15}$

8. 6

9. no solution

10. $\frac{7}{2}$, 5

11. $\sqrt{41}$

12. $2\sqrt{11}$ cm

13. no

14. yes

15. 0.2756

16. 0.8572

17. 28.6363

Page 60

18. $\sin A = \frac{33}{65}$; $\cos A = \frac{56}{65}$; $\tan A = \frac{33}{56}$

19. $\sin A = \frac{72}{97}$; $\cos A = \frac{65}{97}$; $\tan A = \frac{72}{65}$

20. 1.5 in.

21. 176.2 m

22. 10.20 cm

23. 8.06 miles

24. 52°

25. 87.0 ft

B: $\frac{7\sqrt{30} - 27}{39}$

Answers

Chapter 10 Assessment Answer Key

Page 61, Extended-Response Test
Scoring Rubric

Score	General Description	Specific Criteria
4	**Superior** A correct solution that is supported by well-developed, accurate explanations	• Shows thorough understanding of the concepts of *simplifying radical expressions, solving radical equations, the Pythagorean Theorem, right triangles, similar triangles, and the distance formula.* • Uses appropriate strategies to solve problems. • Computations are correct. • Written explanations are exemplary. • Graphs are accurate and appropriate. • Goes beyond requirements of some or all problems.
3	**Satisfactory** A generally correct solution, but may contain minor flaws in reasoning or computation	• Shows an understanding of the concepts of *simplifying radical expressions, solving radical equations, the Pythagorean Theorem, right triangles, similar triangles, and the distance formula.* • Uses appropriate strategies to solve problems. • Computations are mostly correct. • Written explanations are effective. • Graphs are mostly accurate and appropriate. • Satisfies all requirements of problems.
2	**Nearly Satisfactory** A partially correct interpretation and/or solution to the problem	• Shows an understanding of most of the concepts of *simplifying radical expressions, solving radical equations, the Pythagorean Theorem, right triangles, similar triangles, and the distance formula.* • May not use appropriate strategies to solve problems. • Computations are mostly correct. • Written explanations are satisfactory. • Graphs are mostly accurate. • Satisfies the requirements of most of the problems.
1	**Nearly Unsatisfactory** A correct solution with no supporting evidence or explanation	• Final computation is correct. • No written explanations or work is shown to substantiate the final computation. • Graphs may be accurate but lack detail or explanation. • Satisfies minimal requirements of some of the problems.
0	**Unsatisfactory** An incorrect solution indicating no mathematical understanding of the concept or task, or no solution is given	• Shows little or no understanding of most of the concepts of *simplifying radical expressions, solving radical equations, the Pythagorean Theorem, right triangles, similar triangles, and the distance formula.* • Does not use appropriate strategies to solve problems. • Computations are incorrect. • Written explanations are unsatisfactory. • Graphs are inaccurate or inappropriate. • Does not satisfy requirements of problems. • No answer may be given.

Chapter 10 Assessment Answer Key

Page 61, Extended-Response Test
Sample Answers

In addition to the scoring rubric found on page A28, the following sample answers may be used as guidance in evaluating extended-response assessment items.

1a. The Product Property of Square Roots states that the square root of a product is equal to the product of the square roots of the factors. For this property, $a \geq 0$ and $b \geq 0$.

1b. The Quotient Property of Square Roots states that the square root of a quotient is equal to the quotient of the square roots of the numerator and denominator. For this property, $a \geq 0$ and $b > 0$.

1c. The student should recognize that both properties state that finding a square root can be done before or after certain other operations.

2a. $P = \frac{L^2}{k}$

2b. Sample answer:

L	25	50	75
P	5208	20,833	46,875

2c. Sample answer:

L	25	50	75
P	7813	31,250	70,313

2d. A smaller constant of proportionality allows a plane to carry more weight.

3a. Agree; Sample answer: When $\sin A = \sin D$, $m\angle A = m\angle D$. The triangles are right triangles, so $m\angle C = m\angle F$ and, thus, $m\angle B = m\angle E$.

3b. Agree; Sample answer: When $\sin A \neq \sin D$, $m\angle A \neq m\angle D$. The triangles are right triangles, so $m\angle C = m\angle F$ and, thus, $m\angle B \neq m\angle E$.

4. Sample answer: $a = 9$, $b = 8$.

$$\left(\sqrt{145}\right)^2 \stackrel{?}{=} 9^2 + 8^2$$
$$145 = 81 + 64$$

Chapter 10 Assessment Answer Key

Standardized Test Practice

Page 62

1. ● Ⓑ Ⓒ Ⓓ

2. Ⓕ Ⓖ ● Ⓙ

3. Ⓐ Ⓑ ● Ⓓ

4. ● Ⓖ Ⓗ Ⓙ

5. Ⓐ Ⓑ Ⓒ ●

6. Ⓕ ● Ⓗ Ⓙ

7. Ⓐ Ⓑ Ⓒ ●

8. Ⓕ ● Ⓗ Ⓙ

9. Ⓐ Ⓑ ● Ⓓ

10. ● Ⓖ Ⓗ Ⓙ

11. ● Ⓑ Ⓒ Ⓓ

Page 63

12. Ⓕ Ⓖ Ⓗ ●

13. Ⓐ ● Ⓒ Ⓓ

14. Ⓕ Ⓖ ● Ⓙ

15. Ⓐ ● Ⓒ Ⓓ

16. Ⓕ Ⓖ Ⓗ ●

17. Ⓐ ● Ⓒ Ⓓ

18.

	9	.	8	0
	⊘	⊘	⊘	
⊙	⊙	●	⊙	⊙
⓪	⓪	⓪	⓪	●
①	①	①	①	①
②	②	②	②	②
③	③	③	③	③
④	④	④	④	④
⑤	⑤	⑤	⑤	⑤
⑥	⑥	⑥	⑥	⑥
⑦	⑦	⑦	⑦	⑦
⑧	⑧	⑧	●	⑧
⑨	●	⑨	⑨	⑨

19.

				5
	⊘	⊘	⊘	
⊙	⊙	⊙	⊙	⊙
⓪	⓪	⓪	⓪	⓪
①	①	①	①	①
②	②	②	②	②
③	③	③	③	③
④	④	④	④	④
⑤	⑤	⑤	⑤	●
⑥	⑥	⑥	⑥	⑥
⑦	⑦	⑦	⑦	⑦
⑧	⑧	⑧	⑧	⑧
⑨	⑨	⑨	⑨	⑨

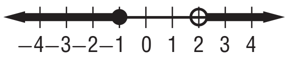
Chapter 10 Assessment Answer Key

Standardized Test Practice
Page 64

20. $10,800 at 14%, $1200 at 10%

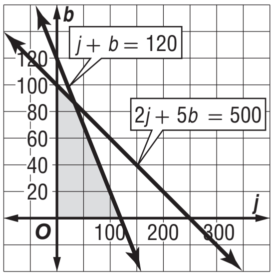
21. $y = -5x + 14$

22. $\{w \mid w \leq -1 \text{ or } w > 2\}$;



23. no solution

24.



25. $\frac{3h^6k^2}{-2j^{10}}$

26. $(x + 4)(y - 3)$

27. −15 and −17 or 15 and 17

28. $\{-4.4, -11.6\}$

29. $3648.08

30a. 14.2 mi

30b. 7.2 mi

Answers