10.1 Lesson

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Key Vocabulary
power, *p. 412*
base, *p. 412*
exponent, *p. 412*

A **power** is a product of repeated factors. The **base** of a power is the common factor. The **exponent** of a power indicates the number of times the base is used as a factor.

base, exponent

$$\left(\frac{1}{2}\right)^5 = \frac{1}{2} \cdot \frac{1}{2} \cdot \frac{1}{2} \cdot \frac{1}{2} \cdot \frac{1}{2}$$

power: $\frac{1}{2}$ is used as a factor 5 times.

EXAMPLE 1 Writing Expressions Using Exponents

Write each product using exponents.

a. $(-7) \cdot (-7) \cdot (-7)$

Because -7 is used as a factor 3 times, its exponent is 3.

∴ So, $(-7) \cdot (-7) \cdot (-7) = (-7)^3$.

b. $\pi \cdot \pi \cdot r \cdot r \cdot r$

Because π is used as a factor 2 times, its exponent is 2. Because r is used as a factor 3 times, its exponent is 3.

∴ So, $\pi \cdot \pi \cdot r \cdot r \cdot r = \pi^2 r^3$.

Study Tip
Use parentheses to write powers with negative bases.

On Your Own

Now You're Ready
Exercises 3–10

Write the product using exponents.

1. $\frac{1}{4} \cdot \frac{1}{4} \cdot \frac{1}{4} \cdot \frac{1}{4} \cdot \frac{1}{4}$
2. $0.3 \cdot 0.3 \cdot 0.3 \cdot 0.3 \cdot x \cdot x$

EXAMPLE 2 Evaluating Expressions

Evaluate each expression.

a. $(-2)^4$

The base is -2.

$(-2)^4 = (-2) \cdot (-2) \cdot (-2) \cdot (-2)$ Write as repeated multiplication.

$= 16$ Simplify.

b. -2^4

The base is 2.

$-2^4 = -(2 \cdot 2 \cdot 2 \cdot 2)$ Write as repeated multiplication.

$= -16$ Simplify.

EXAMPLE 3 Using Order of Operations

Evaluate each expression.

a. $3 + 2 \cdot 3^4 = 3 + 2 \cdot 81$ Evaluate the power.

$= 3 + 162$ Multiply.

$= 165$ Add.

b. $3^3 - 8^2 \div 2 = 27 - 64 \div 2$ Evaluate the powers.

$= 27 - 32$ Divide.

$= -5$ Subtract.

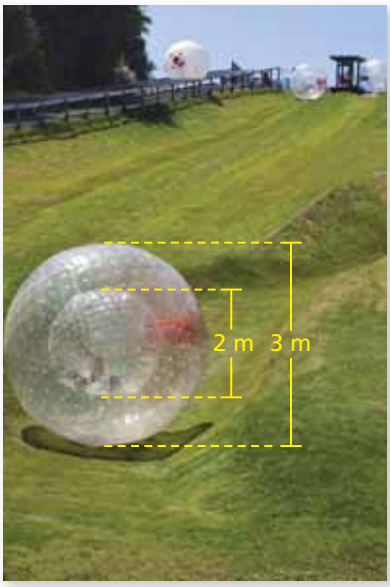
On Your Own

Now You're Ready
Exercises 11–16 and 21–26

Evaluate the expression.

3. -5^4 **4.** $\left(-\frac{1}{6}\right)^3$ **5.** $\left|-3^3 \div 27\right|$ **6.** $9 - 2^5 \cdot 0.5$

EXAMPLE 4 Real-Life Application



In sphering, a person is secured inside a small, hollow sphere that is surrounded by a larger sphere. The space between the spheres is inflated with air. What is the volume of the inflated space?

You can find the radius of each sphere by dividing each diameter given in the diagram by 2.

Outer Sphere		*Inner Sphere*
$V = \frac{4}{3}\pi r^3$	Write formula.	$V = \frac{4}{3}\pi r^3$
$= \frac{4}{3}\pi\left(\frac{3}{2}\right)^3$	Substitute.	$= \frac{4}{3}\pi(1)^3$
$= \frac{4}{3}\pi\left(\frac{27}{8}\right)$	Evaluate the power.	$= \frac{4}{3}\pi(1)$
$= \frac{9}{2}\pi$	Multiply.	$= \frac{4}{3}\pi$

∴ So, the volume of the inflated space is $\frac{9}{2}\pi - \frac{4}{3}\pi = \frac{19}{6}\pi$, or about 10 cubic meters.

On Your Own

7. WHAT IF? The diameter of the inner sphere is 1.8 meters. What is the volume of the inflated space?

Name _____ Date _____

10.1 Puzzle Time

How Does A Bee Part His Hair?

Write the letter of each answer in the box containing the exercise number.

Evaluate the expression.

1. 3^3

2. -4^5

3. $(-2)^5$

4. $(-7)^4$

5. $\left(\frac{1}{5}\right)^3$

6. $\left(-\frac{1}{3}\right)^5$

7. $-\left(\frac{1}{4}\right)^3$

8. $\left|-\left(\frac{1}{6}\right)^3\right|$

9. $7^3 - 5^4$

10. $4 \bullet 3^4 + 6$

11. $2\left(11^3 - 10^3\right)$

12. $\frac{1}{8}\left(4^6 - 4^3\right)$

13. $\left|6^3 - 7^3\right|$

14. $\left|9^2 + (-9)^3\right|$

15. You are sending a package in the mail. The box is a cube measuring 14 inches on all sides. How many cubic inches is the package?

16. You sent an email to 8 friends. They each forwarded the email to 8 friends. And those friends each forwarded the email to 8 friends. The chain of emails is represented by the expression $8 + 8^2 + 8^3$. How many people were sent your email?

Answers

S. $-\frac{1}{243}$

T. -282

C. 584

I. -1024

E. 662

O. $\frac{1}{125}$

I. 27

O. 504

H. 330

B. 2744

W. $\frac{1}{216}$

H. 2401

H. 127

Y. 648

M. $-\frac{1}{64}$

N. -32

8	2	9	4		10	1	6		13	5	3	11	14	16	12	7	15

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10.2 Lesson

Check It Out
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Key Ideas

Product of Powers Property

Words To multiply powers with the same base, add their exponents.

Numbers $4^2 \cdot 4^3 = 4^{2+3} = 4^5$ **Algebra** $a^m \cdot a^n = a^{m+n}$

Power of a Power Property

Words To find a power of a power, multiply the exponents.

Numbers $(4^6)^3 = 4^{6 \cdot 3} = 4^{18}$ **Algebra** $(a^m)^n = a^{mn}$

Power of a Product Property

Words To find a power of a product, find the power of each factor and multiply.

Numbers $(3 \cdot 2)^5 = 3^5 \cdot 2^5$ **Algebra** $(ab)^m = a^m b^m$

EXAMPLE 1 Multiplying Powers with the Same Base

a. $2^4 \cdot 2^5 = 2^{4+5}$ Product of Powers Property

$= 2^9$ Simplify.

b. $-5 \cdot (-5)^6 = (-5)^1 \cdot (-5)^6$ Rewrite -5 as $(-5)^1$.

$= (-5)^{1+6}$ Product of Powers Property

$= (-5)^7$ Simplify.

c. $x^3 \cdot x^7 = x^{3+7}$ Product of Powers Property

$= x^{10}$ Simplify.

Study Tip

When a number is written without an exponent, its exponent is 1.

EXAMPLE 2 Finding a Power of a Power

a. $(3^4)^3 = 3^{4 \cdot 3}$ Power of a Power Property

$= 3^{12}$ Simplify.

b. $(w^5)^4 = w^{5 \cdot 4}$ Power of a Power Property

$= w^{20}$ Simplify.

EXAMPLE 3 Finding a Power of a Product

a. $(2x)^3 = 2^3 \cdot x^3$ Power of a Product Property

$= 8x^3$ Simplify.

b. $(3xy)^2 = 3^2 \cdot x^2 \cdot y^2$ Power of a Product Property

$= 9x^2y^2$ Simplify.

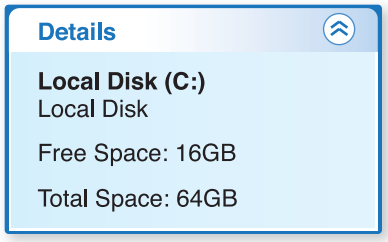
On Your Own

Now You're Ready
Exercises 3–14 and 17–22

Simplify the expression.

1. $6^2 \cdot 6^4$
2. $\left(-\frac{1}{2}\right)^3 \cdot \left(-\frac{1}{2}\right)^6$
3. $z \cdot z^{12}$
4. $(4^4)^3$
5. $(y^2)^4$
6. $((-4)^3)^2$
7. $(5y)^4$
8. $(ab)^5$
9. $(0.5mn)^2$

EXAMPLE 4 Simplifying an Expression



A gigabyte (GB) of computer storage space is 2^{30} bytes. The details of a computer are shown. How many bytes of total storage space does the computer have?

(A) 2^{34} (B) 2^{36} (C) 2^{180} (D) 128^{30}

The computer has 64 gigabytes of total storage space. Notice that you can write 64 as a power, 2^6. Use a model to solve the problem.

Total number of bytes = Number of bytes in a gigabyte · Number of gigabytes

$= 2^{30} \cdot 2^6$ Substitute.

$= 2^{30 + 6}$ Product of Powers Property

$= 2^{36}$ Simplify.

∴ The computer has 2^{36} bytes of total storage space. The correct answer is (B).

On Your Own

10. How many bytes of free storage space does the computer have?

Name _____ Date _____

10.2 Puzzle Time

Did You Hear About...

A	B	C	D	E	F
G	H	I	J	K	L
M	N				

Complete each exercise. Find the answer in the answer column. Write the word under the answer in the box containing the exercise letter.

$-4c^5$ NOTES
2058 KEYS
$-1024c^5$ BECAUSE
3^{24} HOW
6^{10} PIANO
$8a^3$ DOOR
$\left(\frac{4}{5}\right)^8$ WHO
$\frac{16}{81}m^4$ OF
$6 \cdot 10^7$ STUCK
$(-8)^{30}$ THE

Simplify the expression. Write your answer as a power.

A. $4 \cdot 4^5$

B. $6^3 \cdot 6^7$

C. $(-3)^8 \cdot (-3)^3$

D. $\left(\frac{4}{5}\right)^2 \cdot \left(\frac{4}{5}\right)^6$

E. $\left(7^3\right)^5$

F. $\left((-8)^{10}\right)^3$

Simplify the expression.

G. $(8a)^3$

H. $(-4c)^5$

I. $(1.5r)^2$

J. $\left(\frac{2}{3}m\right)^4$

K. $3^2 \cdot 3^4 - 4^4$

L. $7 \cdot \left(7^3 - 7^2\right)$

M. $\left(\frac{1}{3}\right)^4 \cdot \left(9^3\right)^2$

N. The budget for a remake of a movie is 100 times the budget of the original movie. The original movie's budget was $6 \cdot 10^5$ dollars. What is the budget of the remake? Express your answer as a power.

$2.25r^2$ ONE
$(-3)^{11}$ TEACHER
$1.5r^2$ CLASS
7^{15} CALLED
6561 GOT
$512a^3$ LOCKSMITH
$\frac{2}{3}m^4$ SHE
$\left(\frac{4}{5}\right)^{12}$ ARE
4^6 THE
473 HER

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10.3 Lesson

Check It Out
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Key Idea

Quotient of Powers Property

Words To divide powers with the same base, subtract their exponents.

Numbers $\frac{4^5}{4^2} = 4^{5-2} = 4^3$ **Algebra** $\frac{a^m}{a^n} = a^{m-n}$, where $a \neq 0$

EXAMPLE 1 Dividing Powers with the Same Base

a. $\frac{2^6}{2^4} = 2^{6-4}$ Quotient of Powers Property

$= 2^2$ Simplify.

b. $\frac{(-7)^9}{(-7)^3} = (-7)^{9-3}$ Quotient of Powers Property

$= (-7)^6$ Simplify.

c. $\frac{h^7}{h^6} = h^{7-6}$ Quotient of Powers Property

$= h^1 = h$ Simplify.

Common Error

When dividing powers, do not divide the bases.

$\frac{2^6}{2^4} = 2^2$, not 1^2.

On Your Own

Now You're Ready
Exercises 7–14

Simplify the expression. Write your answer as a power.

1. $\frac{9^7}{9^4}$
2. $\frac{4.2^6}{4.2^5}$
3. $\frac{(-8)^8}{(-8)^4}$
4. $\frac{x^8}{x^3}$

EXAMPLE 2 Simplifying an Expression

Simplify $\frac{3^4 \cdot 3^2}{3^3}$. Write your answer as a power.

The numerator is a product of powers. Add the exponents in the numerator.

$\frac{3^4 \cdot 3^2}{3^3} = \frac{3^{4+2}}{3^3}$ Product of Powers Property

$= \frac{3^6}{3^3}$ Simplify.

$= 3^{6-3}$ Quotient of Powers Property

$= 3^3$ Simplify.

EXAMPLE 3 Simplifying an Expression

Simplify $\frac{a^{10}}{a^6} \cdot \frac{a^7}{a^4}$. Write your answer as a power.

$$\frac{a^{10}}{a^6} \cdot \frac{a^7}{a^4} = a^{10-6} \cdot a^{7-4}$$ Quotient of Powers Property

$$= a^4 \cdot a^3$$ Simplify.

$$= a^{4+3}$$ Product of Powers Property

$$= a^7$$ Simplify.

Study Tip

You can also simplify the expression in Example 3 as follows.

$$\frac{a^{10}}{a^6} \cdot \frac{a^7}{a^4} = \frac{a^{10} \cdot a^7}{a^6 \cdot a^4}$$
$$= \frac{a^{17}}{a^{10}}$$
$$= a^{17-10}$$
$$= a^7$$

On Your Own

Now You're Ready
Exercises 16–21

Simplify the expression. Write your answer as a power.

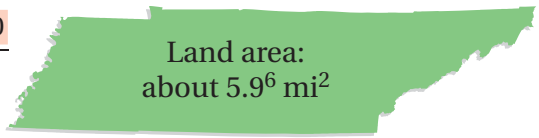
5. $\frac{2^{15}}{2^3 \cdot 2^5}$ **6.** $\frac{d^5}{d} \cdot \frac{d^9}{d^8}$ **7.** $\frac{5^9}{5^4} \cdot \frac{5^5}{5^2}$

EXAMPLE 4 Real-Life Application

The projected population of Tennessee in 2030 is about $5 \cdot 5.9^8$. Predict the average number of people per square mile in 2030.

Use a model to solve the problem.

$$\text{People per square mile} = \frac{\text{Population in 2030}}{\text{Land area}}$$



$$= \frac{5 \cdot 5.9^8}{5.9^6}$$ Substitute.

$$= 5 \cdot \frac{5.9^8}{5.9^6}$$ Rewrite.

$$= 5 \cdot 5.9^2$$ Quotient of Powers Property

$$= 174.05$$ Evaluate.

∴ So, there will be about 174 people per square mile in Tennessee in 2030.

On Your Own

Now You're Ready
Exercises 23–28

8. The projected population of Alabama in 2030 is about $2.25 \cdot 2^{21}$. The land area of Alabama is about 2^{17} square kilometers. Predict the average number of people per square kilometer in 2030.

Name _____ Date _____

10.3 Puzzle Time

What Do You Give A Dog That Loves Computers?

Write the letter of each answer in the box containing the exercise number.

Simplify the expression. Write the answer as a power.

1. $\frac{8^{12}}{8^6}$

2. $\frac{3^{24}}{3^{15}}$

3. $\frac{(-7)^{14}}{(-7)^4}$

4. $\frac{2.8^7}{2.8^4}$

5. $\frac{\pi^{12}}{\pi^5}$

6. $\frac{x^8}{x^3}$

7. $\frac{3^4 \bullet 3^5}{3^2 \bullet 3^2}$

8. $\frac{8^{15}}{8^7 \bullet 8}$

9. $\frac{\pi^5 \bullet \pi^9}{\pi^3 \bullet \pi^3}$

10. $\frac{x^{14} \bullet x^5}{x^7}$

11. $\frac{(-7)^3 \bullet (-7)^9}{(-7)^2 \bullet (-7)}$

12. $\frac{2.8^{15} \bullet 2.8^8}{2.8^9 \bullet 2.8^6}$

13. There are about $4 \bullet 10^5$ known species of beetles. The number of known species of caddis flies is about 10^4. How many times more species of beetles are there than caddis flies?

14. The area of the Pacific Ocean is approximately $6.4 \bullet 10^7$ square miles. The area of the Gulf of Mexico is approximately 10^5 square miles. How many times greater is the area of the Pacific Ocean than the area of the Gulf of Mexico?

Answers

Y. 2.8^3

D. x^{12}

I. π^7

D. $(-7)^9$

E. x^5

E. 3^9

T. 40

G. 8^7

O. $(-7)^{10}$

S. π^8

S. 8^6

K. 640

T. 3^5

G. 2.8^8

11	3	8	12	4		10	5	9	14	6	7	13	2	1

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10.4 Lesson

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Key Ideas

Zero Exponents

Words For any nonzero number a, $a^0 = 1$. The power 0^0 is *undefined*.

Numbers $4^0 = 1$ **Algebra** $a^0 = 1$, where $a \neq 0$

Negative Exponents

Words For any integer n and any nonzero number a, a^{-n} is the reciprocal of a^n.

Numbers $4^{-2} = \frac{1}{4^2}$ **Algebra** $a^{-n} = \frac{1}{a^n}$, where $a \neq 0$

EXAMPLE 1 Evaluating Expressions

a. $3^{-4} = \frac{1}{3^4}$ Definition of negative exponent

$= \frac{1}{81}$ Evaluate power.

b. $(-8.5)^{-4} \cdot (-8.5)^4 = (-8.5)^{-4+4}$ Product of Powers Property

$= (-8.5)^0$ Simplify.

$= 1$ Definition of zero exponent

c. $\frac{2^6}{2^8} = 2^{6-8}$ Quotient of Powers Property

$= 2^{-2}$ Simplify.

$= \frac{1}{2^2}$ Definition of negative exponent

$= \frac{1}{4}$ Evaluate power.

On Your Own

Now You're Ready
Exercises 5–16

Evaluate the expression.

1. 4^{-2}
2. $(-2)^{-5}$
3. $6^{-8} \cdot 6^8$
4. $\frac{(-3)^5}{(-3)^6}$
5. $\frac{1}{5^7} \cdot \frac{1}{5^{-4}}$
6. $\frac{4^5 \cdot 4^{-3}}{4^2}$

EXAMPLE 2 Simplifying Expressions

a. $-5x^0 = -5(1)$ Definition of zero exponent

$= -5$ Multiply.

b. $\frac{9y^{-3}}{y^5} = 9y^{-3-5}$ Quotient of Powers Property

$= 9y^{-8}$ Simplify.

$= \frac{9}{y^8}$ Definition of negative exponent

On Your Own

Now You're Ready
Exercises 20–27

Simplify. Write the expression using only positive exponents.

7. $8x^{-2}$ **8.** $b^0 \cdot b^{-10}$ **9.** $\frac{z^6}{15z^9}$

EXAMPLE 3 Real-Life Application

A drop of water leaks from a faucet every second. How many liters of water leak from the faucet in 1 hour?

Drop of water: 50^{-2} liter

Convert 1 hour to seconds.

$$1 \text{ h} \times \frac{60 \text{ min}}{1 \text{ h}} \times \frac{60 \text{ sec}}{1 \text{ min}} = 3600 \text{ sec}$$

Water leaks from the faucet at a rate of 50^{-2} liter per second. Multiply the time by the rate.

$3600 \text{ sec} \cdot 50^{-2} \frac{\text{L}}{\text{sec}} = 3600 \cdot \frac{1}{50^2}$ Definition of negative exponent

$= 3600 \cdot \frac{1}{2500}$ Evaluate power.

$= \frac{3600}{2500}$ Multiply.

$= 1\frac{11}{25} = 1.44 \text{ L}$ Simplify.

∴ So, 1.44 liters of water leak from the faucet in 1 hour.

On Your Own

10. WHAT IF? The faucet leaks water at a rate of 5^{-5} liter per second. How many liters of water leak from the faucet in 1 hour?

Name _____ Date _____

10.4 Puzzle Time

What Happened When The Tree Saw The Ghost?

Circle the letter of each correct answer in the boxes below. The circled letters will spell out the answer to the riddle.

Evaluate the expression.

1. $7^{-5} \bullet 7^{3}$

2. $5^{2} \bullet 5^{-6}$

3. $\dfrac{2^{7}}{2^{10}}$

4. $\dfrac{6^{0}}{6^{3}}$

5. $\dfrac{(-8)^{3}}{(-8)^{5}}$

6. $\dfrac{(2.2)^{7}}{(2.2)^{9}}$

7. $\dfrac{4^{5}}{4^{4}} \bullet \dfrac{4^{8}}{4^{13}}$

8. $\dfrac{(-9)^{3}}{(-9)^{7} \bullet (-9)^{-2}}$

Simplify the expression using only positive exponents.

9. $3^{-2}a^{4}$

10. $12^{-1}t^{-3}$

11. $\dfrac{b^{4}}{5^{-2}b^{8}}$

12. $\dfrac{14r^{8}}{2r^{15}}$

13. $\dfrac{x^{5} \bullet y^{6}}{2^{-2} \bullet x^{0} \bullet y^{9}}$

14. $\dfrac{6 \bullet f^{-4} \bullet g^{2}}{2 \bullet f^{-4} \bullet g^{-1}}$

H	A	I	S	T	R	M	E	W	L	A	N	S	U	V	D	Y
8	$\dfrac{4x^{4}}{y^{2}}$	$\dfrac{1}{12t^{3}}$	$\dfrac{1}{16}$	$\dfrac{1}{49}$	$\dfrac{1}{9a^{4}}$	$\dfrac{1}{36}$	$7r^{7}$	$\dfrac{1}{4.84}$	$3fg^{3}$	$\dfrac{1}{216}$	81	$\dfrac{1}{625}$	$\dfrac{x^{5}}{4y^{3}}$	$\dfrac{25}{b^{2}}$	49	$-\dfrac{1}{64}$

I	P	T	E	G	T	R	O	I	S	F	Q	I	K	E	B	D
$\dfrac{12}{t^{3}}$	$3g^{3}$	$\dfrac{1}{125}$	$\dfrac{1}{8}$	4.84	$\dfrac{25}{b^{4}}$	$\dfrac{1}{81}$	-8	$\dfrac{a^{4}}{9}$	64	$\dfrac{4x^{5}}{y^{3}}$	$\dfrac{3}{fg}$	$\dfrac{1}{64}$	-16	$\dfrac{1}{256}$	$\dfrac{t^{3}}{12}$	$\dfrac{7}{r^{7}}$

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7.1 Lesson

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Key Vocabulary
square root, *p. 290*
perfect square, *p. 290*
radical sign, *p. 290*
radicand, *p. 290*

A **square root** of a number is a number that, when multiplied by itself, equals the given number. Every positive number has a positive *and* a negative square root. A **perfect square** is a number with integers as its square roots.

EXAMPLE 1 Finding Square Roots of a Perfect Square

Find the two square roots of 49.

$7 \cdot 7 = 49$ and $(-7) \cdot (-7) = 49$

∴ So, the square roots of 49 are 7 and -7.

Study Tip
Zero has one square root, which is 0.

The symbol $\sqrt{\ }$ is called a **radical sign**. It is used to represent a square root. The number under the radical sign is called the **radicand**.

Positive Square Root, $\sqrt{\ }$	Negative Square Root, $-\sqrt{\ }$	Both Square Roots, $\pm\sqrt{\ }$
$\sqrt{16} = 4$	$-\sqrt{16} = -4$	$\pm\sqrt{16} = \pm 4$

EXAMPLE 2 Finding Square Roots

Find the square root(s).

a. $\sqrt{25}$

∴ Because $5^2 = 25$, $\sqrt{25} = \sqrt{5^2} = 5$.

$\sqrt{25}$ represents the *positive* square root.

b. $-\sqrt{\frac{9}{16}}$

∴ Because $\left(\frac{3}{4}\right)^2 = \frac{9}{16}$, $-\sqrt{\frac{9}{16}} = -\sqrt{\left(\frac{3}{4}\right)^2} = -\frac{3}{4}$.

$-\sqrt{\frac{9}{16}}$ represents the *negative* square root.

c. $\pm\sqrt{2.25}$

∴ Because $1.5^2 = 2.25$, $\pm\sqrt{2.25} = \pm\sqrt{1.5^2} = 1.5$ and -1.5.

$\pm\sqrt{2.25}$ represents both the *positive* and the *negative* square roots.

On Your Own

Now You're Ready
Exercises 7–18

Find the two square roots of the number.

1. 36 **2.** 100 **3.** 121

Find the square root(s).

4. $-\sqrt{1}$ **5.** $\pm\sqrt{\frac{4}{25}}$ **6.** $\sqrt{12.25}$

7.2 Lesson

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Key Vocabulary
cube root, *p. 296*
perfect cube, *p. 296*

A **cube root** of a number is a number that, when multiplied by itself, and then multiplied by itself again, equals the given number. A **perfect cube** is a number that can be written as the cube of an integer. The symbol $\sqrt[3]{\ }$ is used to represent a cube root.

EXAMPLE 1 Finding Cube Roots

Find each cube root.

a. $\sqrt[3]{8}$

∴ Because $2^3 = 8$, $\sqrt[3]{8} = \sqrt[3]{2^3} = 2$.

b. $\sqrt[3]{-27}$

∴ Because $(-3)^3 = -27$, $\sqrt[3]{-27} = \sqrt[3]{(-3)^3} = -3$.

c. $\sqrt[3]{\frac{1}{64}}$

∴ Because $\left(\frac{1}{4}\right)^3 = \frac{1}{64}$, $\sqrt[3]{\frac{1}{64}} = \sqrt[3]{\left(\frac{1}{4}\right)^3} = \frac{1}{4}$.

Cubing a number and finding a cube root are inverse operations. You can use this relationship to evaluate expressions and solve equations involving cubes.

EXAMPLE 2 Evaluating Expressions Involving Cube Roots

Evaluate each expression.

a. $2\sqrt[3]{-216} - 3 = 2(-6) - 3$ Evaluate the cube root.

$= -12 - 3$ Multiply.

$= -15$ Subtract.

b. $\left(\sqrt[3]{125}\right)^3 + 21 = 125 + 21$ Evaluate the power using inverse operations.

$= 146$ Add.

On Your Own

Now You're Ready
Exercises 6–17

Find the cube root.

1. $\sqrt[3]{1}$
2. $\sqrt[3]{-343}$
3. $\sqrt[3]{-\frac{27}{1000}}$

Evaluate the expression.

4. $18 - 4\sqrt[3]{8}$
5. $\left(\sqrt[3]{-64}\right)^3 + 43$
6. $5\sqrt[3]{512} - 19$

Solve each problem.

1) $\sqrt{49}$

2) $\sqrt[3]{729}$

3) $\sqrt{100}$

4) $\sqrt[3]{1{,}000}$

5) $\sqrt{25}$

6) $\sqrt[3]{512}$

7) $\sqrt{64}$

8) $\sqrt[3]{8}$

9) $\sqrt{4}$

10) $\sqrt{9}$

11) $\sqrt[3]{216}$

12) $\sqrt{1}$

13) $\sqrt[3]{1}$

14) $\sqrt{36}$

15) $\sqrt{16}$

16) $\sqrt[3]{125}$

17) $\sqrt{81}$

18) $\sqrt[3]{343}$

19) $\sqrt[3]{64}$

20) $\sqrt[3]{27}$

Answers

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

1-10	95	90	85	80	75	70	65	60	55	50
11-20	45	40	35	30	25	20	15	10	5	0

7.3 Lesson

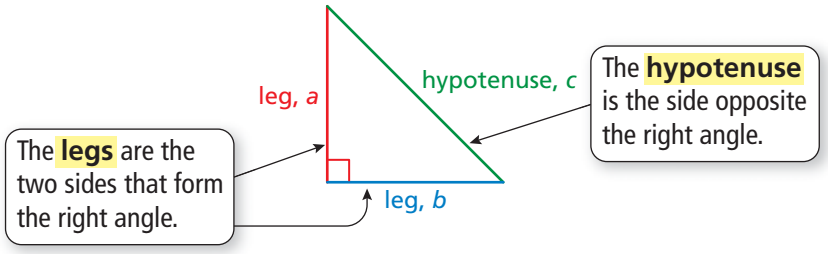
Check It Out
Lesson Tutorials
BigIdeasMath.com

Key Vocabulary
theorem, *p. 300*
legs, *p. 302*
hypotenuse, *p. 302*
Pythagorean Theorem, *p. 302*

Key Ideas

Sides of a Right Triangle

The sides of a right triangle have special names.



The Pythagorean Theorem

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

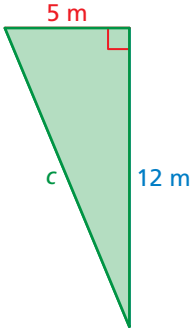
Algebra $a^2 + b^2 = c^2$

Study Tip

In a right triangle, the legs are the shorter sides and the hypotenuse is always the longest side.

EXAMPLE 1 Finding the Length of a Hypotenuse

Find the length of the hypotenuse of the triangle.



$a^2 + b^2 = c^2$ Write the Pythagorean Theorem.

$5^2 + 12^2 = c^2$ Substitute 5 for a and 12 for b.

$25 + 144 = c^2$ Evaluate powers.

$169 = c^2$ Add.

$\sqrt{169} = \sqrt{c^2}$ Take positive square root of each side.

$13 = c$ Simplify.

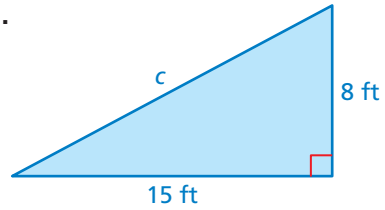
∴ The length of the hypotenuse is 13 meters.

On Your Own

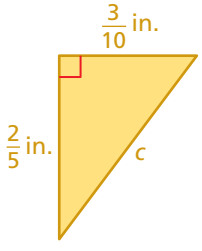
Now You're Ready
Exercises 3 and 4

Find the length of the hypotenuse of the triangle.

1.

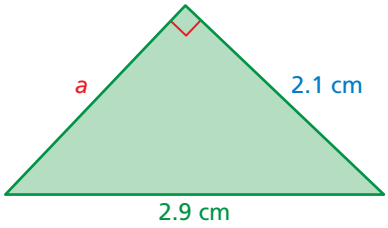


2.



EXAMPLE 2 Finding the Length of a Leg

Find the missing length of the triangle.



$a^2 + b^2 = c^2$ Write the Pythagorean Theorem.

$a^2 + 2.1^2 = 2.9^2$ Substitute 2.1 for b and 2.9 for c.

$a^2 + 4.41 = 8.41$ Evaluate powers.

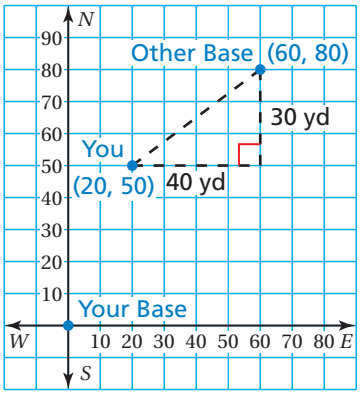
$a^2 = 4$ Subtract 4.41 from each side.

$a = 2$ Take positive square root of each side.

∴ The missing length is 2 centimeters.

EXAMPLE 3 Real-Life Application

You are playing capture the flag. You are 50 yards north and 20 yards east of your team's base. The other team's base is 80 yards north and 60 yards east of your base. How far are you from the other team's base?



Step 1: Draw the situation in a coordinate plane. Let the origin represent your team's base. From the descriptions, you are at (20, 50) and the other team's base is at (60, 80).

Step 2: Draw a right triangle with a hypotenuse that represents the distance between you and the other team's base. The lengths of the legs are 30 yards and 40 yards.

Step 3: Use the Pythagorean Theorem to find the length of the hypotenuse.

$a^2 + b^2 = c^2$ Write the Pythagorean Theorem.

$30^2 + 40^2 = c^2$ Substitute 30 for a and 40 for b.

$900 + 1600 = c^2$ Evaluate powers.

$2500 = c^2$ Add.

$50 = c$ Take positive square root of each side.

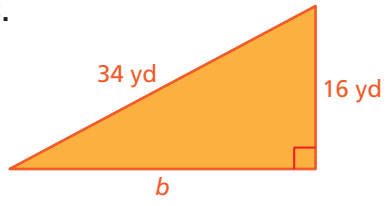
∴ So, you are 50 yards from the other team's base.

On Your Own

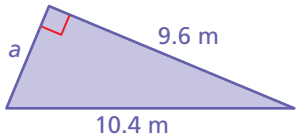
Now You're Ready
Exercises 5–8

Find the missing length of the triangle.

3.



4.



5. In Example 3, what is the distance between the bases?

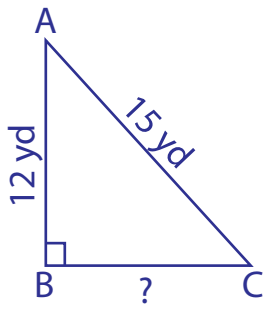
Name : _____ Score : _____

Pythagorean Theorem

Sheet 1

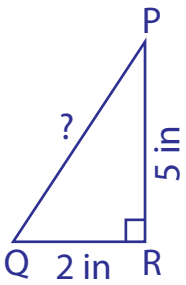
Determine the missing length in each right triangle using the Pythagorean theorem. Round the answer to the nearest tenth.

1)



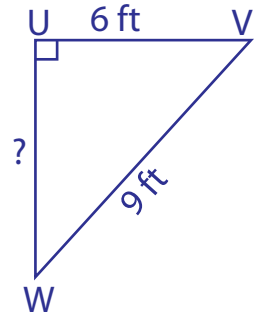
BC = _____

2)



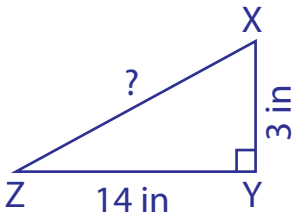
PQ = _____

3)



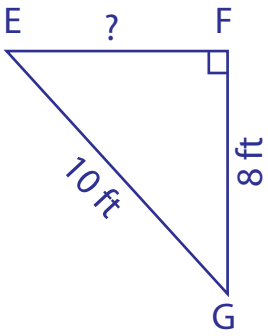
UW = _____

4)



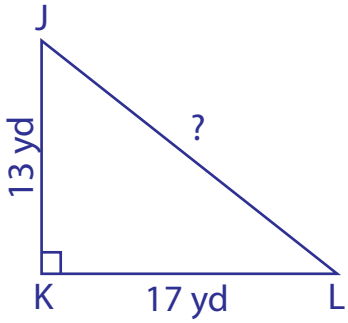
XZ = _____

5)



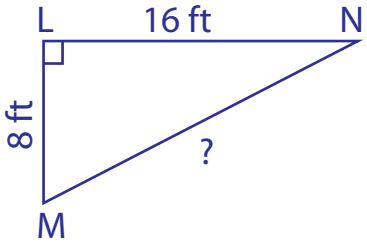
EF = _____

6)



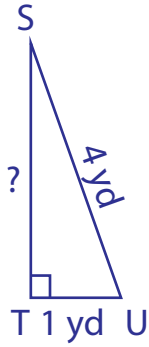
JL = _____

7)



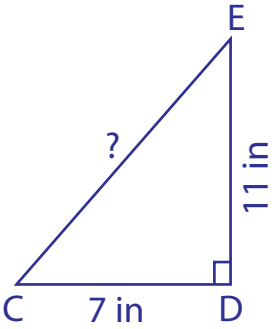
MN = _____

8)



ST = _____

9)



CE = _____

Pythagorean Theorem Word Problems

Draw a picture and then use the pythagorean theorem to solve for the missing side.

1. The bottom of a ladder must be placed 3 feet from a wall. The ladder is 10 feet long. How far above the ground does the ladder touch the wall?

2. A soccer field is a rectangle 100 meters wide and 130 meters long. The coach asks players to run from one corner to the other corner diagonally across. What is that distance?

3. How far from the base of the house do you need to place a 15-foot ladder so that it exactly reaches the top of a 12- foot tall wall?

4. What is the length of the diagonal of a 10 cm by 15 cm rectangle?

5. The diagonal of a rectangle is 25 in. The width is 15 inches. What is the length?

6. Two sides of a right triangle are 8 and 12. Find the hypotenuse.

7. A baseball diamond is a square that is 90 feet on each side. What is the distance a catcher has to throw the ball from home to second base?

8. David leaves the house to go to school. He walks 200m west and 125m north. How far away is he from his starting point? (the diagonal)

9. A park is in the shape of a rectangle 8 miles long and 6 miles wide. How much shorter is your walk if you walk diagonally across the park than along the two sides of it?