Exponents and Scientific Notation



ESSENTIAL QUESTION

How can you use scientific notation to solve real-world problems?





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Real-World Video

The distance from Earth to other planets, moons, and stars is a very great number of kilometers. To make it easier to write very large and very small numbers, we use scientific notation.





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Are **VOU** Ready?

Complete these exercises to review skills you will need for this module.



Exponents

EXAMPLE $10^4 = 10 \times 10 \times 10 \times 10$ = 10,000 Write the exponential expression as a product. Simplify.

Write each exponential expression as a decimal.

	1.	10 ²	2. 10 ³	3. 10 ⁵	4. 10 ⁷	
--	----	-----------------	---------------------------	---------------------------	---------------------------	--

Multiply and Divide by Powers of 10

EXAMPLE	$0.0478 \times 10^5 = 0.0478 \times 100,000$ = 4,780	Identify the number of zeros in the power of 10. When multiplying, move the decimal point to the right the same number of places as the number of zeros.
	$\begin{array}{l} 37.9 \div 10^4 = 37.9 \div 10,000 \\ = 0.00379 \end{array}$	Identify the number of zeros in the power of 10. When dividing, move the decimal point to the <i>left</i> the same number of places as the number of zeros.

Find each product or quotient.

5.	45.3 × 10 ³	6.	$7.08 \div 10^{2}$	7.	0.00235 × 10 ⁶	8.	3,600 ÷ 10 ⁴
9.	0.5 × 10 ²	10.	67.7 ÷ 10 ⁵	11.	0.0057×10^{4}	12.	195 ÷ 10 ⁶

Reading Start-Up

Visualize Vocabulary

Use the ✔ words to complete the Venn diagram. You can put more than one word in each section of the diagram.



Understand Vocabulary

Complete the sentences using the preview words.

- 1. A number produced by raising a base to an exponent
 - is a ______.
- 2. _____ is a method of writing very large or very small numbers by using powers of 10.
- **3.** A ______ is any number that can be expressed as a ratio of two integers.

Active Reading

Two-Panel Flip Chart Create a two-panel flip chart to help you understand the concepts in this module. Label one flap "Positive Powers of 10" and the other flap "Negative Powers of 10." As you study each lesson, write important ideas under the appropriate flap. Include sample problems that will help you remember the concepts later when you look back at your notes.

Vocabulary

Review Words

- ✓ base (base)
- exponent (exponente) integers (enteros)
- positive number (número positivo)

standard notation (notación estándar)

Preview Words

power (potencia) rational number (número racional) real numbers (número real) scientific notation (notación científica) whole number (número entero)



MODULE 2

Unpacking the Standards

Understanding the standards and the vocabulary terms in the standards will help you know exactly what you are expected to learn in this module.

COMMON 8.EE.1

Know and apply the properties of integer exponents to generate equivalent numerical expressions.

Key Vocabulary

integer (entero)

The set of whole numbers and their opposites

exponent (exponente)

The number that indicates how many times the base is used as a factor.

What It Means to You

You will use the properties of integer exponents to find equivalent expressions.

UNPACKING EXAMPLE 8.EE.1

Evaluate two different ways.

 $\frac{8^3}{8^5} \qquad \frac{8^3}{8^5} = \frac{8 \cdot 8 \cdot 8}{8 \cdot 8 \cdot 8 \cdot 8 \cdot 8} = \frac{1}{8 \cdot 8} = \frac{1}{64}$ $\frac{8^3}{8^5} = 8^{(3-5)} = 8^{-2} = \frac{1}{8^2} = \frac{1}{8 \cdot 8} = \frac{1}{64}$ $(3^2)^4 \qquad (3^2)^4 = (3^2)(3^2)(3^2)(3^2) = 3^{2+2+2+2} = 3^8 = 6,561$ $(3^2)^4 = 3^{(2-4)} = 3^8 = 6,561$

COMMON CORE 8.EE.3

Use numbers expressed in the form of a single digit times an integer power of 10 to estimate very large or very small quantities, and to express how many times as much one is than the other.

Key Vocabulary

scientific notation (notación cientifica)

A method of writing very large or very small numbers by using powers of 10.



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What It Means to You

You will convert very large numbers to scientific notation.

UNPACKING EXAMPLE 8.EE.3

There are about 55,000,000,000 cells in an average-sized adult. Write this number in scientific notation.

Move the decimal point to the left until you have a number that is greater than or equal to 1 and less than 10.

5.5 0 0 0 0 0 0 0 0 0Move the decimal point 10 places to the left.5.5Remove the extra zeros.

You would have to multiply 5.5 by 10^{10} to get 55,000,000,000.

 $55,000,000,000 = 5.5 \times 10^{10}$



EXPLORE ACTIVITY 1

COMMON 8.EE.1

Using Patterns of Integer Exponents

The table below shows powers of 5, 4, and 3.

5 ⁴ = 625	5 ³ = 125	$5^2 = 25$	$5^1 = 5$	5 ⁰ =	5 ⁻¹ =	5 ⁻² =
4 ⁴ = 256	$4^3 = 64$	$4^2 = 16$	$4^1 = 4$	4 ⁰ =	4 ⁻¹ =	4 ⁻² =
3 ⁴ = 81	$3^3 = 27$	$3^2 = 9$	$3^1 = 3$	3 ⁰ =	3 ⁻¹ =	3 ⁻² =

What pattern do you see in the powers of 5?

B What pattern do you see in the powers of 4?

What pattern do you see in the powers of 3?

- **D** Complete the table for the values of 5^0 , 5^{-1} , 5^{-2} .
- **E** Complete the table for the values of 4^0 , 4^{-1} , 4^{-2} .
- **F** Complete the table for the values of 3^0 , 3^{-1} , 3^{-2} .

Reflect

- **1.** Make a Conjecture Write a general rule for the value of a^0 .
- **2.** Make a Conjecture Write a general rule for the value of a^{-n} .

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Use your pattern to complete this equation: $(7^2)^4 = 7^4$

Reflect

Let *m* and *n* be integers.

- **3.** Make a Conjecture Write a general rule for the value of $a^m \cdot a^n$.
- **4.** Make a Conjecture Write a general rule for the value of $\frac{a^m}{a^n}$, $a \neq 0$.
- **5.** Make a Conjecture Write a general rule for the value of $(a^m)^n$.

Applying Properties of Integer Exponents

You can use the general rules you found in the Explore Activities to simplify more complicated expressions.

EXAMPLE 1

Simplify each expression.

A	$(5-2)^5 \cdot 3^{-8} + (5+2)^{-8}$	2) ⁰
	$(3)^5 \cdot 3^{-8} + (7)^0$	Simplify within parentheses.
	$3^{5+(-8)}+1$	Use properties of exponents.
	$3^{-3} + 1$	Simplify.
	$\frac{1}{27} + 1 = 1\frac{1}{27}$	Apply the rule for negative exponents and add

B $\frac{\left[(3+1)^2\right]^3}{(7-3)^2}$	
$\frac{(4^2)^3}{4^2}$	Simplify within parentheses.
$\frac{4^6}{4^2}$	Use properties of exponents.
4 ^{6–2}	Use properties of exponents.
$4^4 = 256$	Simplify.

YOUR TURN

Simplify each expression.

6. $\frac{[(6-1)^2]^2}{(3+2)^3}$

7.
$$(2^2)^3 - (10 - 6)^3 \cdot 4^{-5}$$

COMMON CORE

8.EE.1



Math On the Spot

My Notes

Guided Practice



Class_



37

31. Write equivalent expressions for $x^7 \cdot x^{-2}$ and $\frac{x^7}{x^2}$. What do you notice? Explain how your results relate to the properties of integer exponents.

A toy store is creating a large window display of different colored cubes stacked in a triangle shape. The table shows the number of cubes in each row of the triangle, starting with the top row.

Row	1	2	3	4
Number of cubes in each row	3	3 ²	3 ³	3 ⁴

- **32.** Look for a Pattern Describe any pattern you see in the table.
- **33.** Using exponents, how many cubes will be in Row 6? How many times as many cubes will be in Row 6 than in Row 3?
- **34.** Justify Reasoning If there are 6 rows in the triangle, what is the total number of cubes in the triangle? Explain how you found your answer.

FOCUS ON HIGHER ORDER THINKING

- **35.** Critique Reasoning A student simplified the expression $\frac{6^2}{36^2}$ as $\frac{1}{3}$. Do you agree with this student? Explain why or why not.
- **36.** Draw Conclusions Evaluate $-a^n$ when a = 3 and n = 2, 3, 4, and 5. Now evaluate $(-a)^n$ when a = 3 and n = 2, 3, 4, and 5. Based on this sample, does it appear that $-a^n = (-a)^n$? If not, state the relationships, if any, between $-a^n$ and $(-a)^n$.

37. Persevere in Problem Solving A number to the 12th power divided by the same number to the 9th power equals 125. What is the number?

Work Area

Scientific Notation with Positive Powers of 10

Use numbers expressed in the form of a single digit times an integer power of 10 to estimate very large or very small quantities,

8.EE.3

ESSENTIAL QUESTION

How can you use scientific notation to express very large quantities?

EXPLORE ACTIVITY



Using Scientific Notation

Scientific notation is a method of expressing very large and very small numbers as a product of a number greater than or equal to 1 and less than 10, and a power of 10.

Real

The weights of various sea creatures are shown in the table. Write the weight of the blue whale in scientific notation.

Sea Creature	Blue whale	Gray whale	Whale shark
Weight (lb)	250,000	68,000	41,200

A Move the decimal point in 250,000 to the left as many places as necessary to find a number that is greater than or equal to 1 and less than 10.

What number did you find? _____

B Divide 250,000 by your answer to **A**. Write your answer as a power of 10.

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C Combine your answers to A and B to represent 250,000.



Repeat steps (A) through (C) to write the weight of the whale shark in scientific notation.

41,200 =	×	10	

Reflect

1. How many places to the left did you move the decimal point to write

41,200 in scientific notation? _____

2. What is the exponent on 10 when you write 41,200 in scientific notation?



Writing a Number in Scientific Notation

To translate between standard notation and scientific notation, you can count the number of places the decimal point moves.



Writing a Number in Standard Notation

To translate between scientific notation and standard notation, move the decimal point the number of places indicated by the exponent in the power of 10. When the exponent is positive, move the decimal point to the right and add placeholder zeros as needed.

EXAMPLE 2

STEP 1

STEP 2

Write 3.5 imes 10⁶ in standard notation.

Use the exponent of the power of 10 to see how many places to move the decimal point.

Place the decimal point. Since you are going to write a number greater than 3.5, move the decimal point to the *right*. Add placeholder zeros if necessary.

The number 3.5 imes 10⁶ written in standard notation is 3,500,000.

Reflect

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6. Explain why the exponent in 3.5×10^6 is 6, while there are only 5 zeros in 3,500,000.

7. What is the exponent on 10 when you write 5.3 in scientific notation?

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YOUR TURN

8. 7.034 \times 10⁹

Write each number in standard notation.

10. The mass of one roosting colony of Monarch butterflies in Mexico wa
estimated at 5 $ imes$ 10 6 grams. Write this mass in standard notation.

9. 2.36×10^5





My Notes

COMMON CORE

6 places

3500000.

8.EE.3

Guided Practice

write	e each number in scientific notation. (Exp	lore Activity	and Example 1)
1.	58,927 Hint: Move the decimal left 4 places.	2.	1,304,000,000 Hint: Move the decimal left 9 places.
3.	6,730,000	4.	13,300
5.	An ordinary quarter contains about 97,700,000,000,000,000,000,000 atoms.	6.	The distance from Earth to the Moon is about 384,000 kilometers.
Vrite	e each number in standard notation. (Exa	mple 2)	
7.	4×10^5 Hint: Move the decimal right 5 places.	8.	1.8499×10^9 Hint: Move the decimal right 9 places.
9.	$\overline{6.41\times10^3}$	10.	8.456×10^{7}
1.	8×10^5	12.	9×10^{10}
13.	Diana calculated that she spent about 5.4 $ imes$ homework during October. Write this time i	10 ⁴ second n standard r	s doing her math otation. (Example 2)
14.	The town recycled 7.6 \times 10 ⁶ cans this year. standard notation. (Example 2)	Write the n	umber of cans in
	ESSENTIAL QUESTION CHECK-IN		
15.	Describe how to write 3,482,000,000 in scie	entific notat	on.

2.2 Independent Practice

COMMON 8.EE.3

Paleontology Use the table for problems 16-21. Write the estimated weight of each dinosaur in scientific notation.

Estimated Weight of Dinosaurs				
Name	Pounds			
Argentinosaurus	220,000			
Brachiosaurus	100,000			
Apatosaurus	66,000			
Diplodocus	50,000			
Camarasaurus	40,000			
Cetiosauriscus	19,850			

- **16.** Apatosaurus _____
- **17.** Argentinosaurus _____
- **18.** Brachiosaurus
- **19.** Camarasaurus _____
- **20.** Cetiosauriscus
- **21.** Diplodocus
- **22.** A single little brown bat can eat up to 1,000 mosquitoes in a single hour. Express in scientific notation how many mosquitoes a little brown bat might eat in 10.5 hours.
- **23.** Multistep Samuel can type nearly 40 words per minute. Use this information to find the number of hours it would take him to type 2.6 \times 10⁵ words.



Online

Date.

- 24. Entomology A tropical species of mite named Archegozetes longisetosus is the record holder for the strongest insect in the world. It can lift up to 1.182×10^3 times its own weight.
 - **a.** If you were as strong as this insect, explain how you could find how many pounds you could lift.

- **b.** Complete the calculation to find how much you could lift, in pounds, if you were as strong as an Archegozetes *longisetosus* mite. Express your answer in both scientific notation and standard notation.
- **25.** During a discussion in science class, Sharon learns that at birth an elephant weighs around 230 pounds. In four herds of elephants tracked by conservationists, about 20 calves were born during the summer. In scientific notation, express approximately how much the calves weighed all together.
- 26. Classifying Numbers Which of the following numbers are written in scientific notation?

0.641×10^{3}	9.999×10^{4}
2×10^1	4.38×5^{10}

Class.

- **27.** Explain the Error Polly's parents' car weighs about 3500 pounds. Samantha, Esther, and Polly each wrote the weight of the car in scientific notation. Polly wrote 35.0×10^2 , Samantha wrote 0.35×10^4 , and Esther wrote 3.5×10^4 .
 - a. Which of these girls, if any, is correct?
 - **b.** Explain the mistakes of those who got the question wrong.

28. Justify Reasoning If you were a biologist counting very large numbers of cells as part of your research, give several reasons why you might prefer to record your cell counts in scientific notation instead of standard notation.

Draw Conclusions Which measurement would be least likely to be written in scientific notation: number of stars in a galaxy, number of

FOCUS ON HIGHER ORDER THINKING

- written in scientific notation: number of stars in a galaxy, number of grains of sand on a beach, speed of a car, or population of a country? Explain your reasoning.
- **30.** Analyze Relationships Compare the two numbers to find which is greater. Explain how you can compare them without writing them in standard notation first.

 $4.5\times10^6 \qquad 2.1\times10^8$

31. Communicate Mathematical Ideas To determine whether a number is written in scientific notation, what test can you apply to the first factor, and what test can you apply to the second factor?

Work Area

 H_{01}



2. Explain how the two steps of moving the decimal and multiplying by a power of 10 leave the value of the original number unchanged.



Writing a Number in Scientific Notation

To write a number less than 1 in scientific notation, move the decimal point right and use a negative exponent.

Writing Small Q	uantities in Scient	ific Notation
When the number is between 0 and 1, use a negative exponent.	$0.0783 = 7.83 \times 10^{-2}$	The decimal point moves 2 places to the right.

EXAMPLE 1

COMMON 8.EE.3

The average size of an atom is about 0.0000003 centimeter across. Write the average size of an atom in scientific notation.

Move the decimal point as many places as necessary to find a number that is greater than or equal to 1 and less than 10.

STEP 1 Place the decimal point. 3.0

STEP 2 Count the number of places you moved the decimal point. 8

STEP 3 Multiply 3.0 times a power of 10. 3.0×10^{-8}

Since 0.0000003 is less than 1, you moved the decimal point to the right and the exponent on 10 is negative.

The average size of an atom in scientific notation is 3.0 imes 10⁻⁸.

Reflect

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3. Critical Thinking When you write a number that is less than 1 in scientific notation, how does the power of 10 differ from when you write a number greater than 1 in scientific notation?

Write each number in scientific notation.

4. 0.0000829

- **5.** 0.00000302
- **6.** A typical red blood cell in human blood has a diameter of approximately 0.000007 meter. Write this diameter

in scientific notation.



Writing a Number in Standard Notation

To translate between scientific notation and standard notation with very small numbers, you can move the decimal point the number of places indicated by the exponent on the power of 10. When the exponent is negative, move the decimal point to the left.



Math Talk

Mathematical Practices

Describe the two factors

that multiply together to

form a number written in scientific notation.

COMMON CORE 8.EE.3

EXAMPLE 2

Platelets are one component of human blood. A typical platelet has a diameter of approximately 2.33 \times 10⁻⁶ meter. Write 2.33 \times 10⁻⁶ in standard notation.

STEP 1 Use the exponent of the power of 10 to see 6 places how many places to move the decimal point.

STEP 2 Place the decimal point. Since you are going to 0.0000233 write a number less than 2.33, move the decimal point to the *left*. Add placeholder zeros if necessary.

The number 2.33 imes 10⁻⁶ in standard notation is 0.0000233.

Reflect

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7. Justify Reasoning Explain whether 0.9×10^{-5} is written in scientific notation. If not, write the number correctly in scientific notation.

8. Which number is larger, 2×10^{-3} or 3×10^{-2} ? Explain.



Lesson 2.3 47

Math Trainer Online Assessment and Intervention

Guided Practice

1.	0.000487 Hint: Move the decimal right 4 places.	2.	0.000028 Hint: Move the decimal right 5 places.
•	0.000059	4.	0.0417
•	Picoplankton can be as small as 0.00002 centimeter.	6.	The average mass of a grain of sand on a beach is about 0.000015 gram.
it	e each number in standard notation. (Exa	mple 2)	
' .	2×10^{-5} Hint: Move the decimal left 5 places.	8.	3.582×10^{-6} Hint: Move the decimal left 6 places.
•	8.3 × 10 ⁻⁴	10.	2.97 × 10 ⁻²
•	9.06 × 10 ⁻⁵	12.	4×10^{-5}
•	The average length of a dust mite is approx Write this number in scientific notation. (E	ximately 0.0 xample 1)	001 meter.
١.	The mass of a proton is about 1.7×10^{-24} g standard notation. (Example 2)	Jram. Write 1	this number in
	ESSENTIAL QUESTION CHECK-IN		
5.	Describe how to write 0.0000672 in scienti	fic notation.	

2.3 Independent Practice

CORE 8.EE.3

Use the table for problems 16–21. Write the diameter of the fibers in scientific notation.

Average Diameter of Natural Fibers		
Animal	Fiber Diameter (cm)	
Vicuña	0.0008	
Angora rabbit	0.0013	
Alpaca	0.00277	
Angora goat	0.0045	
Llama	0.0035	
Orb web spider	0.015	

16. Alpaca

- **17.** Angora rabbit
- 18. Llama
- **19.** Angora goat
- **20.** Orb web spider
- 21. Vicuña
- 22. Make a Conjecture Which measurement would be least likely to be written in scientific notation: the thickness of a dog hair, the radius of a period on this page, the ounces in a cup of milk? Explain your reasoning.



23. Multiple Representations Convert the length 7 centimeters to meters. Compare the numerical values when both numbers are written in scientific notation.

Class.

- 24. Draw Conclusions A graphing calculator displays 1.89×10^{12} as 1.89E12. How do you think it would display 1.89×10^{-12} ? What does the E stand for?
- **25.** Communicate Mathematical Ideas When a number is written in scientific notation, how can you tell right away whether or not it is greater than or equal to 1?

- **26.** The volume of a drop of a certain liquid is 0.000047 liter. Write the volume of the drop of liquid in scientific notation.
- 27. Justify Reasoning If you were asked to express the weight in ounces of a ladybug in scientific notation, would the exponent of the 10 be positive or negative? Justify your response.

Physical Science The table shows the length of the radii of several very small or very large items. Complete the table.

	ltem	Radius in Meters (Standard Notation)	Radius in Meters (Scientific Notation)
28.	The Moon	1,740,000	
29.	Atom of silver		$1.25 imes10^{-10}$
30.	Atlantic wolfish egg	0.0028	
31.	Jupiter		7.149 × 10 ⁷
32.	Atom of aluminum	0.00000000182	
33.	Mars		$3.397 imes10^6$



34. List the items in the table in order from the smallest to the largest.

FOCUS ON HIGHER ORDER THINKING

- **35.** Analyze Relationships Write the following diameters from least to greatest. 1.5×10^{-2} m 1.2×10^{2} m 5.85×10^{-3} m 2.3×10^{-2} m 9.6×10^{-1} m
- **36.** Critique Reasoning Jerod's friend Al had the following homework problem:

Express 5.6 \times 10⁻⁷ in standard form.

Al wrote 56,000,000. How can Jerod explain Al's error and how to correct it?

37. Make a Conjecture Two numbers are written in scientific notation. The number with a positive exponent is divided by the number with a negative exponent. Describe the result. Explain your answer. Work Area

401

2.4 Operations with 2.4 Scientific Notation



Perform operations ... in scientific notation. ... choose units of appropriate size for measurements Interpret scientific notation ... generated by technology.

ESSENTIAL QUESTION

How do you add, subtract, multiply, and divide using scientific notation?

Adding and Subtracting with Scientific Notation

Numbers in scientific notation can be added and subtracted, either directly or by rewriting them in standard form.



Real **EXAMPLE 1**

COMMO CORE 8.EE.4

The table below shows the population of the three largest countries in North America in 2011. Find the total population of these countries.

Country	United States	Canada	Mexico
Population	$3.1 imes 10^8$	$3.38 imes 10^7$	$1.1 imes 10^8$

Method 1:

STEP 1 First, write each population with the same power of 10.

United States: 3.1×10^8

1010

 0.338×10^{8} Canada:

 1.1×10^{8} Mexico:



Add the multipliers for each population.

3.1 + 0.338 + 1.1 = 4.538

Write the final answer in scientific notation: 4.538×10^8 . **STEP 3**

Method 2:		
STEP 1	First, write each	number in standard notation.
	United States:	310,000,000
	Canada:	33,800,000
	Mexico:	110,000,000
STEP 2	Find the sum of	the numbers in standard notation.
×	310,000,000 + 3	33,800,000 + 110,000,000 = 453,800,000
STEP 3	Write the answe	er in scientific notation: 4.538 $ imes$ 10 ⁸ .







1. Using the population table above, how many more people live in Mexico than in Canada? Write your answer in scientific notation.

Multiplying and Dividing with Scientific Notation

Numbers in scientific notation can be multiplied and divided directly by using properties of exponents.



COMMON 8.EE.4

When the Sun makes an orbit around the center of the Milky Way, it travels 2.025×10^{14} kilometers. The orbit takes 225 million years. At what rate does the Sun travel? Write your answer in scientific notation.

Analyze Information

The answer is the number of kilometers per year that the Sun travels around the Milky Way.

Formulate a Plan

Set up a division problem using Rate $=\frac{\text{Distance}}{\text{Time}}$ to represent the situation.

Solve

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Math Talk Mathematical Practices

Could you write 2.025 \times 10¹⁴ in standard notation to do the division? Would this be a good way to solve the problem?

STEP 1	Substitute the values from	the problem into the Rate formula.
	Rate = $\frac{2.025 \times 10^{14} \text{ kilomete}}{225,000,000 \text{ years}}$	<u>ers</u>
STEP 2	Write the expression for range Rate = $\frac{2.025 \times 10^{14} \text{ kilomete}}{2.25 \times 10^{8} \text{ years}}$	ate with years in scientific notation. $225 \text{ million} = 2.25 \times 10^8$
STEP 3	Find the quotient by divid of exponents.	ing the decimals and using the laws
• • •	$2.025 \div 2.25 = 0.9$	Divide the multipliers.
	$\frac{10^{14}}{10^8} = 10^{14-8} = 10^6$	Divide the powers of 10.
STEP 4	Combine the answers to v	vrite the rate in scientific notation.
0	$Rate = 0.9 \times 10^6 = 9.0 \times$	10 ⁵ km per year
Justify a	nd Evaluate	
Check you	r answer using multiplication	on.



Lesson 2.4 53

Guided Practice

	or subtract. Write your answe	r in scientific nota	tion. (Example 1)	
1.	$4.2 \times 10^6 + 2.25 \times 10^5 + 2.8 >$	< 10 ⁶ 2.	$8.5\times10^3-5.3\times$	$10^3 - 1.0 \times 10^2$
	$4.2 \times 10^6 + \times 10^6$	$+2.8 \times 10^{6}$	$8.5 \times 10^3 - 5.3 \times$	$10^3 - \bigcirc \times 10^{\circ}$
	$+.2 + 10^{+} \times 10^{-10}$			
3.	$1.25 \times 10^2 + 0.50 \times 10^2 + 3.22$	5×10^2 4	$6.2\times10^5-2.6\times$	$10^4 - 1.9 imes 10^2$
Mult	iply or divide. Write your ans	wer in scientific no	tation. (Example 2)	
5.	$(1.8 \times 10^9)(6.7 \times 10^{12})$	6	$\frac{3.46 \times 10^{17}}{2 \times 10^9}$	
7.	$(5 \times 10^{12})(3.38 \times 10^{6})$	8.	$\frac{8.4 \times 10^{21}}{4.2 \times 10^{14}}$	
Write	e each number using calculate	or notation. (Exam	ole 3)	
٥	3.6 × 10 ¹¹	10. 7.25×10^{-5}	11.	8×10^{-1}
Э.				
y. Write	e each number using scientifi	c notation. (Examp	e 3)	
y. Write 12.	e each number using scientific 7.6E—4	c notation. (Examp 13. 1.2E16	e 3) 14.	9E1
y. Write 12.	e each number using scientific 7.6E—4	c notation. (Examp 13. 1.2E16	e 3) 14.	9E1
9. Write 12.	e each number using scientifie 7.6E—4 	c notation. (Examp 13. 1.2E16 HECK-IN	e 3) 14.	9E1
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2.4 Independent Practice

COMMON 8.EE.4

- **16.** An adult blue whale can eat 4.0×10^7 krill in a day. At that rate, how many krill can an adult blue whale eat in 3.65 \times 10² days?
- **17.** A newborn baby has about 26,000,000,000 cells. An adult has about 4.94×10^{13} cells. How many times as many cells does an adult have than a newborn? Write your answer in scientific notation.

Represent Real-World Problems The table shows the number of tons of waste generated and recovered (recycled) in 2010.



	Paper	Glass	Plastics
Tons generated	$7.131 imes 10^7$	$1.153 imes 10^7$	$\textbf{3.104}\times\textbf{10}^{7}$
Tons recovered	$\textbf{4.457}\times\textbf{10}^{7}$	$0.313 imes 10^7$	$0.255 imes 10^7$

- **18.** What is the total amount of paper, glass, and plastic waste generated?
- **19.** What is the total amount of paper, glass, and plastic waste recovered?



Date

20. What is the total amount of paper, glass, and plastic waste not recovered?

Class

21. Which type of waste has the lowest recovery ratio?

Social Studies The table shows the approximate populations of three countries.

Country	China	France	Australia
Population	$1.3 imes10^9$	$6.48 imes 10^7$	$\textbf{2.15}\times\textbf{10}^{7}$

- **22.** How many more people live in France than in Australia?
- **23.** The area of Australia is 2.95×10^6 square miles. What is the approximate average number of people per square mile in Australia?
- **24.** How many times greater is the population of China than the population of France? Write your answer in standard notation.
- **25.** Mia is 7.01568 \times 10⁶ minutes old. Convert her age to more appropriate units using years, months, and days. Assume each month to have 30.5 days.

Personal

Math Trainer Online Assessment and

- **26.** Courtney takes 2.4×10^4 steps during her a long-distance run. Each step covers an average of 810 mm. What total distance (in mm) did Courtney cover during her run? Write your answer in scientific notation. Then convert the distance to the more appropriate unit kilometers. Write that answer in standard form.
- **27.** Social Studies The U.S. public debt as of October 2010 was $\$9.06 \times 10^{12}$. What was the average U.S. public debt per American if the population in 2010 was 3.08×10^8 people?



28. Communicate Mathematical Ideas How is multiplying and dividing numbers in scientific notation different from adding and subtracting numbers in scientific notation?

Work Area

- **29.** Explain the Error A student found the product of 8×10^6 and 5×10^9 to be 4×10^{15} . What is the error? What is the correct product?
- **30.** Communicate Mathematical Ideas Describe a procedure that can be used to simplify $\frac{(4.87 \times 10^{12}) (7 \times 10^{10})}{(3 \times 10^7) + (6.1 \times 10^8)}$. Write the expression in scientific notation in simplified form.

1 2-4	a 2 <i>E</i> 0	3 44
I. J	c to write an equival	J. 4
4. $8^3 \cdot 8^7$	5. $\frac{12^6}{12^2}$	6. (10 ³) ⁵
2.2 Scientific Notation v	with Positive Po	wers of 10
onvert each number to scienti 7. 2.000	TIC NOTATION OF STANC	91.007.500
9. 1.0395 × 10 ⁹	10.	4 × 10 ²
13. 8.9×10^{-5} 2.4 Operations with Scie erform the operation. Write yo 15. $7 \times 10^6 - 5.3 \times 10^6$	14. entific Notation our answer in scienti 16.	4.41 × 10 ⁻² fic notation. $3.4 \times 10^4 + 7.1 \times 10^5$
17. $(2 \times 10^4)(5.4 \times 10^6)$	18.	$\frac{7.86 \times 10^9}{3 \times 10^4}$
19. Neptune's average dista distance from the Sun i the Sun is Neptune that	ance from the Sun is 4 s 5.791 $ imes$ 10 ⁷ km. Abc n Mercury? Write your	4.503×10^9 km. Mercury's average but how many times farther from r answer in scientific notation.
ESSENTIAL QUESTION		
~		



MODULE 2 MIXED REVIEW Assessment Readiness



Selected Response

1. Which of the following is equivalent to 6^{-3} ?

(A) 216 (C) $-\frac{1}{216}$ (B) $\frac{1}{216}$ (D) -216

- **2.** About 786,700,000 passengers traveled by plane in the United States in 2010. What is this number written in scientific notation?
 - (A) 7,867 \times 10⁵ passengers
 - (B) 7.867 \times 10² passengers
 - \bigcirc 7.867 \times 10⁸ passengers
 - (D) 7.867 \times 10⁹ passengers
- **3.** In 2011, the population of Mali was about 1.584×10^7 people. What is this number written in standard notation?
 - (A) 1.584 people
 - (B) 1,584 people
 - C 15,840,000 people
 - D 158,400,000 people
- **4.** The square root of a number is between 7 and 8. Which could be the number?
 - (A) 72 (C) 51
 - **B** 83 **D** 66
- **5.** Each entry-level account executive in a large company makes an annual salary of $$3.48 \times 10^4$. If there are 5.2×10^2 account executives in the company, how much do they make in all?
 - (A) \$6.69 × 10¹
 - **B** \$3.428 × 10⁴
 - € \$3.532 × 10⁴
 - **D** \$1.8096 × 10⁷

6. Place the numbers in order from least to greatest.

 $0.24, 4 imes 10^{-2}, 0.042, 2 imes 10^{-4}, 0.004$

(a) 2×10^{-4} , 4×10^{-2} , 0.004, 0.042, 0.24

- (B) 0.004, 2×10^{-4} , 0.042, 4×10^{-2} , 0.24
- \bigcirc 0.004, 2 × 10⁻⁴, 4 × 10⁻², 0.042, 0.24
- (D) 2×10^{-4} , 0.004, 4×10^{-2} , 0.042, 0.24
- 7. Guillermo is $5\frac{5}{6}$ feet tall. What is this number of feet written as a decimal?
 - (A) 5.7 feet (C) 5.83 feet
 - (B) 5.7 feet (D) 5.83 feet
- 8. A human hair has a width of about 6.5×10^{-5} meter. What is this width written in standard notation?
 - (A) 0.00000065 meter
 - (B) 0.0000065 meter
 - © 0.000065 meter
 - (D) 0.00065 meter

Mini-Task

- **9.** Consider the following numbers: 7000, 700, 70, 0.7, 0.07, 0.007
 - **a.** Write the numbers in scientific notation.
 - **b.** Look for a pattern in the given list and the list in scientific notation. Which numbers are missing from the lists?
 - **c.** Make a conjecture about the missing numbers.