Lesson 5 📽 Introduction Operations and Scientific Notation

🕒 Use What You Know

In Lesson 4 you learned to express and compare numbers using scientific notation. Now, take a look at this problem.

Evaluate the following expression. 950,000 + (4.6×10^7)

Use the math you know to answer the question.

- a. What form is 950,000 written in?
- **b.** What form is 4.6×10^7 written in?
- **c.** Write 4.6×10^7 in the same form as 950,000.

 $4.6 \times 10^7 = 4.6 \times$

=

d. Write the original addition expression with all numbers in standard form.

e. Explain how you would simplify your expression. What is the sum?

> Find Out More

When you add very large (or very small) numbers expressed in standard form, it can be difficult to keep track of all the zeros and make sure the numbers are aligned by place value. One way to deal with these problems is to express each number in scientific notation.

Convert to scientific notation: $950,000 = 9.5 \times 100,000$ = 9.5×10^5

Remember that there is a link between place value and powers of 10. Before you can add numbers in standard form, you must align them by place value. Likewise, before you can add numbers in scientific notation, each power of 10 must have the same exponent.

$4.6 imes 10^7 = 4.6 imes (10^2 imes 10^5)$	Apply the product of powers property.
= (4.6 $ imes$ 10 ²) $ imes$ 10 ⁵	Apply the associative property of multiplication.
$=460 \times 10^{5}$	Multiply.

Now that both numbers are expressed with the same exponent, you can find the sum.

$(460 imes10^5)+(9.5 imes10^5)=(460+9.5) imes10^5$	Apply the distributive property.
$=469.5 \times 10^{5}$	Add.
= (4.695 $ imes$ 10 ²) $ imes$ 10 ⁵	Express in scientific notation.
$= 4.695 \times (10^2 \times 10^5)$	Apply the associative property of multiplication.
$= 4.695 \times 10^{7}$	Apply the product of powers property.

Reflect

1 Paul says that $(3.14 \times 10^5) + (2.53 \times 10^4) = 5.67 \times 10^5$. Is Paul correct? Explain.

Learn About Adding and Subtracting Numbers in Scientific Notation

Read the problem below. Then explore how to subtract numbers expressed in scientific notation.

Find the difference: 5.1 \times 10 12 - 6,300,000,000

Solve It Start by converting 6,300,000,000 to scientific notation.

 $6,300,000,000 = 6.3 \times 1,000,000,000$

 $= 6.3 \times 10^{9}$

Picture It Make a table to help you compare powers of 10.

You cannot subtract numbers expressed in scientific notation unless the powers of 10 have the same exponent. Create a table to help you express the numbers in the problem in scientific notation and compare the exponents.

5.1 × 10 ¹²	6.3 $ imes$ 10°
$= 5.1 \times 10^{12}$	$= 0.0063 \times 10^{12}$
$= 51 \times 10^{11}$	$= 0.063 \times 10^{11}$
$= 510 \times 10^{10}$	$= 0.63 \times 10^{10}$
= 5,100 × 10 ⁹	$= 6.3 \times 10^{9}$

Any pair of numbers from the table with powers of 10 that have the same exponents can be used to solve the problem.

_	nnect It Now solve the problem from the previous page. Look at <i>Solve It</i> on the previous page. Write the problem with both numbers expressed in scientific notation.
3	Look at <i>Picture It</i> on the previous page. Use the table to rewrite the expression you wrote for problem 2. Rewrite that expression so that both terms are written with the same exponent.
4	Use the distributive property to simplify the expression you wrote for problem 3.
5	Write your expression as the product of a decimal times a power of 10.
6	Write your solution in scientific notation.
	y It Use what you just learned to solve these problems. Show your work on a parate sheet of paper.
7	Evaluate: (7.4 $ imes$ 10 ¹⁵) – (9.9 $ imes$ 10 ¹³)
	Evaluate: $(8.9 \times 10^5) + (6.5 \times 10^6)$

Lesson 5 🛛 Modeled and Guided Instruction

Learn About Multiplying Numbers in Scientific Notation

Read the problem below. Then explore how to multiply numbers expressed in scientific notation.

Multiply: $(5.78 \times 10^5) \times 0.0804$

Estimate It You can round the factors to estimate the product.

Round 5.78 \times 10⁵ to 6 \times 10⁵. Then round 0.0804 to 0.08. The estimated product is: (6 \times 10⁵) \times (0.08) = 0.48 \times 10⁵ = 4.8 \times 10⁴

You can compare your calculated answer to this estimate to check your solution.

Solve It You can convert both terms to scientific notation.

Write 0.0804 in scientific notation.

$$0.0804 = \frac{8.04}{100}$$

= 8.04 × $\frac{1}{100}$
= 8.04 × $\frac{1}{10^2}$
= 8.04 × 10⁻²

Write the problem with both factors in scientific notation.

 $(5.78 imes 10^5) imes (8.04 imes 10^{-2})$

	Complete the equation by applying the associative property to group the decimals and to group the powers of 10.
	$(5.78 \times 10^5) \times (8.04 \times 10^{-2}) =$
0	Multiply the decimals and multiply the powers of 10.
1	Apply the properties of exponents to write your solution in scientific notation.
2	Look at <i>Estimate It</i> on the previous page. Is your solution reasonable? Explain.
3	Why is it unnecessary to make the exponents the same before multiplying numbers expressed in scientific notation?
	y It Use what you just learned to solve these problems. Show your work on a parate sheet of paper.
4	The world's thinnest computer chip is 7.5 $ imes$ 10 ⁻³ millimeters thick. What would be the height of a stack of 3 $ imes$ 10 ⁹ chips?
5	The speed of a garden snail is about 8.3×10^{-6} miles per second. If a garden snail moves at this speed in a straight line for 3.6×10^3 seconds, how far would the snail travel?

Lesson 5 🍰 Guided Practice

Practice Using Operations with Scientific Notation

Study the example below. Then solve problems 16–18.

Example

A hardware factory produces 3.6×10^5 bolts in 2,400 minutes. What is the factory's rate of production in bolts per minute?

Look at how you could solve this problem.

2,400 = 2.4 × 10 ³	Express 2,400 in scientific notation.	
$\frac{\text{total bolts}}{\text{total minutes}} = \text{rate in bolts p}$	ber minute	
$\frac{3.6 \times 10^5}{2.4 \times 10^3} = \frac{3.6}{2.4} \times \frac{10^5}{10^3}$	The quotient of products equals the product of quotients.	Pair/Share
$= 1.5 \times 10^{5-3}$	Subtract the exponents to find the	Would you rather solve this problem with both
$= 1.5 \times 10^2$	quotient of powers.	numbers expressed in standard form or in scientific notation?
Solution The factory produce	es 1.5 $ imes$ 10 2 bolts per minute.	Explain.

16 A company spends a total of \$64,500,000 on salaries for its workers. If the company has 1.5×10^3 workers, what is the average salary per worker?

Show your work.

Which operation will you need to use to solve this problem?

In this problem you will need to divide numbers

expressed in scientific

notation.

🥏 Pair/Share

Do you need to write each number with the same exponent before you can divide? Explain.

Solution

17 Stalactites are cone-shaped formations that hang from the ceilings of underground caverns. Stalactites can grow at the rate of about 0.005 inch per year. At this rate, what is the length of a stalactite that grows for 7.5 \times 10⁴ years?

Show your work.

18 The volume of the planet Venus is about 928,000,000,000 km³. The volume of the planet Mercury is about 6.08 imes 10¹⁰ km³. What is the combined volume of Mercury and Venus?

A 9.888 \times 10¹⁰ km³

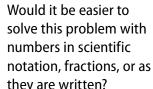
Solution

- **B** $1.536 \times 10^{11} \text{ km}^3$
- **C** 9.888 \times 10¹¹ km³
- **D** $1.536 \times 10^{12} \text{ km}^3$

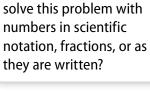
Maya chose **D** as the correct answer. How did she get that answer?









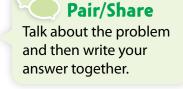


child's rate of growth.

How would you express the volume of Venus in

scientific notation?

Pair/Share Compare the stalactite's rate of growth with a





Practice Using Operations with Scientific Notation

Solve the problems.

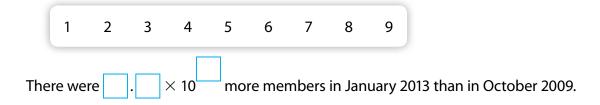
- 1 A rancher uses a water bowl for her dog that holds 8,500 milliliters and a water trough for her horse that holds 2.7×10^5 milliliters. How many milliliters of water will the rancher use to completely fill both the bowl and the trough?
 - **A** $1.12 \times 10^5 \text{ mL}$
 - $\textbf{B} \quad 2.785 \times 10^5 \, \text{mL}$
 - ${f C}$ 5.8 imes 10⁵ mL
 - $\textbf{D} \quad 1.12\times 10^9\,\text{mL}$
- The Moon takes about 28 days to orbit the Earth, going a distance of about 2.413 × 10⁶ kilometers. About how many kilometers does the Moon travel during one day of its orbit around the Earth?
 - $\textbf{A} \quad 8.6\times 10^4\,km$
 - $\textbf{B} \quad 2.8\times 10^6\,km$
 - $\textbf{C} \quad 1.16\times10^7\,km$
 - $\textbf{D}~6.8\times10^7\,km$
- **3** Jackie incorrectly simplified the following expression.

 $(4 \times 10^{-6})(2 \times 10^{3}) + 1,000$

Select each step that shows an error based solely on the previous step.

- **A** Step 1. $(4 \times 10^{-6})(2 \times 10^{3}) + 10^{3}$
- **B** Step 2. $(4 \times 10^{-6})(3 \times 10^{3})$
- **C** Step 3. $(4 \times 3)(10^{-6} \times 10^{3})$
- **D** Step 4. 12×10^{-3}
- **E** Step 5. 1.2×10^{-4}

In October 2009, there were approximately 5 × 10⁷ members of a website. In January 2013, there were approximately 2 × 10⁸ members. How many more members were there in January 2013 than in October 2009? Write your answer in scientific notation. Select from the given digits to complete the sentence.



5 Toshi and Owen need to add 4.9×10^9 and 4.1×10^7 . Toshi says they must use the expression $(490 \times 10^7) + (4.1 \times 10^7)$. Owen says they must use the expression $(4.9 \times 10^9) + (0.041 \times 10^9)$. Are neither, one, or both students correct? Explain.

6 Evaluate $\frac{(7.3 \times 10^6) + (2.4 \times 10^7)}{10^7}$ (4×10^{4})

Show your work.

Answer

Self Check Go back and see what you can check off on the Self Check on page 1.