

Solve & Discuss It!

The homecoming committee wants to fly an aerial banner over the football game. The banner is 1,280 inches long and 780 inches tall. How many different ways can the area of the banner be expressed?



Lesson 2-10

Operations with Numbers in Scientific Notation

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I can...
perform operations with numbers in scientific notation.

Focus on math practices

Be Precise Which of the solutions is easiest to manipulate?


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Essential Question How does using scientific notation help when computing with very large or very small numbers?





EXAMPLE 1 Add or Subtract Numbers in Scientific Notation

The mass of Earth and the mass of the Moon are shown. How much greater is the mass of Earth than that of the Moon?



Moon mass
 $= 7.35 \times 10^{22}$ kg



Earth mass
 $= 5.97 \times 10^{24}$ kg

Use Structure What does the exponent tell you about the magnitude of the number?

ONE WAY Write the masses in standard form and then subtract.

$$5.97 \times 10^{24} = 5,970,000,000,000,000,000,000,000$$

$$7.35 \times 10^{22} = 73,500,000,000,000,000,000,000$$

$$\begin{array}{r} 5,970,000,000,000,000,000,000,000 \\ - 73,500,000,000,000,000,000,000 \\ \hline 5,896,500,000,000,000,000,000,000 \end{array}$$

The difference is about 5.8965×10^{24} kilograms.

ANOTHER WAY Write the masses using the same power of 10. Then subtract.

$$5.97 \times 10^{24} = (5.97 \times 10^2) \times 10^{22}$$

$$= 597 \times 10^{22}$$

$$(597 \times 10^{22}) - (7.35 \times 10^{22})$$

$$= (597 - 7.35) \times 10^{22}$$

$$= 589.65 \times 10^{22}$$

$$= 5.8965 \times 10^{24}$$

The difference is about 5.8965×10^{24} kilograms.

Use a property of exponents to write 10^{24} as $10^2 \times 10^{22}$.

Remember, the first factor must be greater than or equal to 1 and less than 10.

Try It!

The planet Venus is on average 2.5×10^7 kilometers from Earth. The planet Mars is on average 2.25×10^8 kilometers from Earth. When Venus, Earth, and Mars are aligned, what is the average distance from Venus to Mars?

$$2.25 \times 10^8 = (2.25 \times \square) \times (\square)$$

$$= \square \times 10^7$$

$$2.5 \times 10^7 + \square \times 10^7 = (2.5 + \square) \times 10^7$$

$$= \square \times 10^7$$

$$= \square \times \square$$

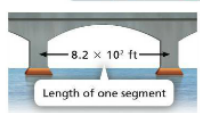
Convince Me! In Example 1 and the Try It, why did you move the decimal point to get the final answer?

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EXAMPLE 2 Multiply Numbers in Scientific Notation

The Confederation Bridge connects New Brunswick to Prince Edward Island. The main part of the bridge rests on piers that form 43 segments. What is the approximate length of the main part of the bridge? Express your answer in scientific notation.



STEP 1 Write an expression to represent the problem situation.

$$(8.2 \times 10^2) \times 43$$

$$= (8.2 \times 10^2) \times (4.3 \times 10^1)$$

Express both numbers in scientific notation.

STEP 2 Multiply.

$$(8.2 \times 10^2) \times (4.3 \times 10^1)$$

$$= (8.2 \times 4.3) \times (10^2 \times 10^1)$$

Remember: The Product of Powers Property states that when multiplying powers with the same base, you add the exponents.

$$= 35.26 \times (10)^{2+1}$$

$$= 35.26 \times 10^3$$

The first factor must be less than 10 and greater than or equal to 1.

$$= 3.526 \times 10^4$$

The length of the main part of the bridge is approximately 3.5×10^4 feet.

EXAMPLE 3 Divide Numbers in Scientific Notation

A queen ant lays 1.83×10^6 eggs over a period of 30 days. Assuming she lays the same number of eggs each day, about how many eggs does she lay in one day? Express your answer in scientific notation.

First, write 30 in scientific notation: 3.0×10^1

Then, divide.

$$(1.83 \times 10^6) \div (3.0 \times 10^1)$$

$$\frac{1.83 \times 10^6}{3.0 \times 10^1}$$

$$\frac{1.83}{3.0} \times \frac{10^6}{10^1}$$

$$(1.83 \div 3.0) \times (10^{6-1})$$

The Quotient of Powers Property states that when dividing powers with the same base, you subtract the exponents.

$$0.61 \times 10^5$$

$$6.1 \times 10^4$$

The queen ant lays about 6.1×10^4 eggs per day.

Try It!

There are 1×10^{14} good bacteria in the human body. There are 2.6×10^{18} good bacteria among the spectators in a soccer stadium. About how many spectators are in the stadium? Express your answer in scientific notation.

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KEY CONCEPT

Operations with very large or very small numbers can be carried out more efficiently using scientific notation. The properties of exponents apply when carrying out operations.

Addition or Subtraction	Multiplication	Division
$(2.3 \times 10^5) + (1.6 \times 10^5)$ $(2.3 \times 10^5) + (1.6 \times 10^5)$ $(2.3 + 1.6) \times 10^5$ 3.9×10^5 Use the Product of Powers Property.	$(2.3 \times 10^5) \times (1.6 \times 10^5)$ $(2.3 \times 1.6) \times (10^5 \times 10^5)$ 3.68×10^{10} Use the Product of Powers Property.	$(2.3 \times 10^5) \div (1.6 \times 10^5)$ $(2.3 \div 1.6) \times (10^5 \div 10^5)$ 1.4375×10^0 Use the Quotient of Powers Property.

Do You Understand?

- Essential Question** How does using scientific notation help when computing with very small or very large numbers?
- Use Structure** When multiplying and dividing two numbers in scientific notation, why do you sometimes have to rewrite one factor?
- Use Structure** For the sum of (5.2×10^4) and (6.95×10^4) in scientific notation, why will the power of 10 be 10^4 ?

Do You Know How?

- A bacteriologist estimates that there are 5.2×10^4 bacteria growing in each of 20 petri dishes. About how many bacteria in total are growing in the petri dishes? Express your answer in scientific notation.

$(5.2 \times 10^4)(20)$
 $(5.2 \times 2) \times (10^4 \cdot 10^1)$
 $10.40 \times 10^{4+1}$
 $1.040 \times 10^{5+1}$
 1.04×10^6 bacteria
- The distance from Earth to the Moon is approximately 1.2×10^8 feet. The Apollo 11 spacecraft was approximately 360 feet long. About how many spacecraft of that length would fit end to end from Earth to the Moon? Express your answer in scientific notation.
- The mass of Mars is 6.42×10^{23} kilograms. The mass of Mercury is 3.3×10^{23} kilograms.
 - What is the combined mass of Mars and Mercury expressed in scientific notation?
 - What is the difference in the mass of the two planets expressed in scientific notation?

Handwritten work for Question 3:

$$(5.2 \times 10^4) + (6.95 \times 10^4)$$

$$(5.2 + 6.95) \times 10^4$$


$$\begin{array}{r} 5.2 \\ + 6.95 \\ \hline 12.15 \end{array} \times 10^4$$

$$12.15 \times 10^{4+1}$$

$$1.215 \times 10^5$$

Total

5. The distance from Earth to the Moon is approximately 1.2×10^9 feet. The Apollo 11 spacecraft was approximately 360 feet long. About how many spacecraft of that length would fit end to end from Earth to the Moon? Express your answer in scientific notation.



$$(1.2 \times 10^9) \div 360$$

$$(1.2 \times 10^9) \div (3.6 \times 10^2)$$

$$(1.2 \div 3.6) \times (10^9 \div 10^2)$$

$$\frac{12}{36} \times 10^{9-2}$$

$$\frac{12 \div 12}{36 \div 12} \times 10^7$$

$$\frac{1}{3} \times 10^{7-1}$$

$$0.333... \times 10^6$$

$$3.333... \times 10^6$$

$$\approx 3.3 \times 10^6$$

Name: _____

Practice & Problem Solving

Leveled Practice In 7 and 8, perform the operation and express your answer in scientific notation.

7. $(7 \times 10^{-6})(7 \times 10^{-6})$

$$\left(\frac{\square}{\square} \cdot \frac{\square}{\square} \right) \times (10^{\square} \cdot 10^{\square})$$

$$\frac{\square}{\square} \times 10^{\square}$$

$$4.9 \times 10^{\square}$$

8. $(3.76 \times 10^5) + (7.44 \times 10^5)$

$$\left(\frac{\square}{\square} + \frac{\square}{\square} \right) \times (10^{\square})$$

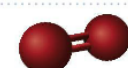
$$\frac{\square}{\square} \times 10^{\square}$$

$$1.12 \times 10^{\square}$$

9. What is the value of n in the equation $1.9 \times 10^7 = (1 \times 10^3)(1.9 \times 10^n)$?

10. Find $(5.3 \times 10^3) - (8 \times 10^2)$. Express your answer in scientific notation.

11. What is the mass of 30,000 molecules? Express your answer in scientific notation.



Mass of one molecule of oxygen = 5.3×10^{-23} gram

12. **Critique Reasoning** Your friend says that the product of 4.8×10^5 and 2×10^{-3} is 9.6×10^{-5} . Is this answer correct? Explain.

13. Find $\frac{7.2 \times 10^{-3}}{3 \times 10^{-2}}$. Write your answer in scientific notation.

14. A certain star is 4.3×10^2 light years from Earth. One light year is about 5.9×10^{12} miles. How far from Earth (in miles) is the star? Express your answer in scientific notation.

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10. Find $(5.3 \times 10^3) - (8 \times 10^2)$.
Express your answer in scientific notation.

$$(5.3 \times 10^3) - (0.8 \times 10^3) \leftarrow +1$$

$$8 \times 10^2 = 800$$

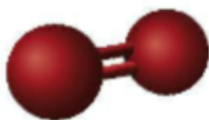
$$0.8 \times 10^3 = 800$$

$$(5.3 - 0.8) \times 10^3$$

$$\begin{array}{r} 5.3 \\ - 0.8 \\ \hline 4.5 \end{array} \times 10^3$$

$$\boxed{4.5 \times 10^3}$$

11. What is the mass of 30,000 molecules?
Express your answer in scientific notation.



Mass of one molecule of oxygen = 5.3×10^{-23} gram

$$30,000 \times 5.3 \times 10^{-23}$$

$$(3.0 \times 10^4) \times (5.3 \times 10^{-23})$$

$$(3.0 \times 5.3) \times (10^4 \times 10^{-23})$$

$$\begin{array}{r} 5.3 \\ \times 3 \\ \hline 15.9 \end{array}$$

$$10^{4 + -23}$$

$$10^{-19}$$

$$15.9 \times 10^{-19+1}$$

$$1.59 \times 10^{-18} \text{ grams}$$

17. What was the approximate number of pounds of garbage produced per person in the country in one year? Express your answer in scientific notation.



Garbage generated in country:
 6.958×10^{10} pounds
 Population of country:
 4.57×10^6 people

$$(6.958 \times 10^{10}) \div (4.57 \times 10^6)$$

$$(6.958 \div 4.57) \times (10^{10} \div 10^6)$$

$$\approx 1.52$$

$$\times 10^{10-6}$$

$$\approx 1.52$$

$$\times 10^4 \text{ pounds}$$

$$\frac{6.958 \times 10^{10}}{4.57 \times 10^6}$$

$$\frac{6.958}{4.57} \times \frac{10^{10}}{10^6}$$

$$\approx 1.52 \times 10^{10-6}$$

$$\approx 1.52 \times 10^4 \text{ lb.}$$

