Operations with Numbers Written in Scientific Notation

When a number is written in **scientific notation** it is written as a product of a number that is at least 1 but less than 10 and a power of 10. Scientific notation makes it easier to read, write, and calculate with very large and very small numbers.

You can add, subtract, multiply, and divide numbers that are written in scientific notation while still keeping the numbers in scientific notation.

Here are the steps for adding or subtracting two numbers written in scientific notation.

- Rewrite the number with the smaller exponent so that it has the same exponent as the number with the larger exponent by moving the decimal point of its decimal number.
- Add/subtract the decimal numbers. The power of 10 will not change.
- Convert your result to scientific notation if necessary.

Here is an example.

Add $(5.7 \times 10^4) + (4.87 \times 10^5)$.

First, notice that the exponents are 4 and 5. You will need to rewrite 5.7×10^4 so that it has an exponent of 5. Because you need to increase the exponent by 1, you will move the decimal point one space to the left.

5.7×10^4 becomes 0.57×10^5

Now, rewrite the problem.

$$(0.57 \times 10^5) + (4.87 \times 10^5)$$

Next, add the decimal numbers using what you have learned about decimal addition. The power of 10 stays the same.

$$(0.57 + 4.87) \times 10^5$$
$$5.44 \times 10^5$$

Last, check to make sure that your answer is in scientific notation. 5.44 is at least 1 but less than 10, so your answer is in scientific notation.

The answer is $(5.7 \times 10^4) + (4.87 \times 10^5) = 5.44 \times 10^5$.

Here are the steps for multiplying or dividing two numbers in scientific notation.

- . Multiply/divide the decimal numbers.
- . Multiply/divide the powers of 10 by adding/subtracting their exponents.
- . Convert your answer to scientific notation if necessary.

Here is an example of multiplying two decimal numbers.

Multiply $(3.4 \times 10^{-2})(6.2 \times 10^6)$.

First, multiply the decimal numbers using what you have learned about decimal multiplication.

$$3.4 \times 6.2 = 21.08$$

Next, multiply the powers of 10 by adding their exponents.

$$10^{-2} \times 10^6 = 10^{-2+6} = 10^4$$

Now, combine the results.

$$\begin{aligned} (3.4 \times 10^{-2})(6.2 \times 10^6) &= (3.4 \times 6.2) \times (10^{-2} \times 10^6) \\ &= 21.08 \times 10^4 \end{aligned}$$

Finally, convert your answer to scientific notation. You will need to rewrite 21.08×10^4 so that the decimal number is at least 1 but less than 10. Move its decimal point one space to the left. Then, to keep the overall value the same, increase the exponent on the 10 by 1.

21.08×10^4 becomes 2.108×10^5

The answer is $(3.4 \times 10^{-2})(6.2 \times 10^6) = 2.108 \times 10^5$.

Here is an example of dividing two decimal numbers.

Divide $(8.4 \times 10^5) \div (1.4 \times 10^{-2})$.

First, divide the decimal numbers using what you have learned about decimal division.

$$8.4 \div 1.4 = 6$$

Next, divide the powers of 10 by subtracting their exponents. Remember that subtracting a negative number is the same as adding the positive version of the number.

$$10^5 \div 10^{-2} = 10^{5-(-2)} = 10^{5+2} = 10^7$$

Now, combine the results.

$$\begin{aligned}(8.4 \times 10^5) \div (1.4 \times 10^{-2}) &= (8.4 \div 1.4) \times (10^5 \div 10^{-2}) \\ &= 6 \times 10^7\end{aligned}$$

Last, check to make sure that your answer is in scientific notation. 6 is at least 1 but less than 10, so your answer is in scientific notation.

The answer is $(8.4 \times 10^5) \div (1.4 \times 10^{-2}) = 6 \times 10^7$.

Examples

Example 1

Earlier, you were given a problem about Diana at the Ocean Institute.

Diana learned that the Atlantic Ocean has an area of 4.108×10^7 square miles while the Indian Ocean has an area of 2.835×10^7 square miles. She wants to know how much bigger the area of the Atlantic Ocean is compared to the area of the Indian Ocean.

In order to figure this out, Diana will need to subtract the two areas.

$$(4.108 \times 10^7) - (2.835 \times 10^7)$$

First, she should notice that the exponents are both 7. Because the exponents are the same, she does not need to rewrite either number.

Now, she can subtract the decimal numbers using what she has learned about decimal subtraction. The power of 10 stays the same.

$$(4.108 - 2.835) \times 10^7$$
$$1.273 \times 10^7$$

The answer is that the Atlantic Ocean is 1.273×10^7 more square miles than the Indian Ocean.

Example 2

At its closest, the planet Neptune is 4,300,000,000 kilometers away from Earth. A group of astronauts from Earth want to make it to Neptune in 20,000 days. If they travel the same number of kilometers each day, how many kilometers will they travel each day? Convert both numbers to scientific notation before solving.

First, convert both numbers to scientific notation.

$$\begin{aligned} 4,300,000,000 &= 4.3 \times 10^9 \\ 20,000 &= 2 \times 10^4 \end{aligned}$$

Next, notice that the astronauts want to travel the same distance each day. You will need to divide the total distance by the number of days to find the distance they will need to travel each day.

$$(4.3 \times 10^9) \div (2 \times 10^4)$$

Now, divide the decimal numbers using what you have learned about decimal division.

$$4.3 \div 2 = 2.15$$

Next, divide the powers of 10 by subtracting their exponents.

$$10^9 \div 10^4 = 10^{9-4} = 10^5$$

Now, combine the results.

$$\begin{aligned}(4.3 \times 10^9) \div (2 \times 10^4) &= (4.3 \div 2) \times (10^9 \div 10^4) \\ &= 2.15 \times 10^5\end{aligned}$$

The answer is that the astronauts will need to travel 2.15×10^5 or 215,000 kilometers per day. They will be traveling for almost 55 years!

Example 3

Add $(3.4 \times 10^3) + (5.6 \times 10^4)$.

First, notice that the exponents are 3 and 4. You will need to rewrite 3.4×10^3 so that it has an exponent of 4. Because you need to increase the exponent by 1, you will move the decimal point one space to the left.

3.4×10^3 becomes $0.34 \times \ 10^4$

Now, rewrite the problem.

$$(0.34 \times 10^4) + (5.6 \times 10^4)$$

Next, add the decimal numbers using what you have learned about decimal addition. The power of 10 stays the same.

$$(0.34 + 5.6) \times 10^4$$
$$5.94 \times 10^4$$

Last, check to make sure that your answer is in scientific notation. 5.94 is at least 1 but less than 10, so your answer is in scientific notation.

The answer is $(3.4 \times 10^3) + (5.6 \times 10^4) = 5.94 \times 10^4$.

Example 4

Multiply $(1.2 \times 10^4)(3.4 \times 10^4)$.

First, multiply the decimal numbers using what you have learned about decimal multiplication.

$$1.2 \times 3.4 = 4.08$$

Next, multiply the powers of 10 by adding their exponents.

$$10^4 \times 10^4 = 10^{4+4} = 10^8$$

Now, combine the results.

$$\begin{aligned}(1.2 \times 10^4)(3.4 \times 10^4) &= (1.2 \times 3.4) \times (10^4 \times 10^4) \\ &= 4.08 \times 10^8\end{aligned}$$

Last, check to make sure that your answer is in scientific notation. 4.08 is at least 1 but less than 10, so your answer is in scientific notation.

The answer is $(1.2 \times 10^4)(3.4 \times 10^4) = 4.08 \times 10^8$.

Example 5

Subtract $(5.6 \times 10^4) - (3.2 \times 10^4)$.

First, notice that the exponents are both 4. Because the exponents are the same, you do not need to rewrite either number.

Now, subtract the decimal numbers using what you have learned about decimal subtraction. The power of 10 stays the same.

$$\begin{aligned}&(5.6 - 3.2) \times 10^4 \\ &2.4 \times 10^4\end{aligned}$$

Last, check to make sure that your answer is in scientific notation. 2.4 is at least 1 but less than 10, so your answer is in scientific notation.

The answer is $(5.6 \times 10^4) - (3.2 \times 10^4) = 2.4 \times 10^4$.

Review

Add, subtract, multiply or divide.

- $(3.4 \times 10^3) + (5.4 \times 10^3)$
- $(5.4 \times 10^4) - (1.3 \times 10^4)$
- $(6.7 \times 10^5) + (5.4 \times 10^5)$
- $(13.4 \times 10^3) - (5.4 \times 10^3)$
- $(12.5 \times 10^5) \div (2 \times 10^3)$
- $(5.4 \times 10^5) + (4.4 \times 10^5)$
- $(12.2 \times 10^3) - (10.1 \times 10^3)$
- $(5.6 \times 10^3) + (4.5 \times 10^3)$
- $(3.3 \times 10^4)(1.2 \times 10^2)$
- $(24.6 \times 10^5) \div (6 \times 10^3)$
- $(266 \times 10^{-6}) + (8.6 \times 10^{-6})$
- $(7.14 \times 10^4) - (5.5 \times 10^4)$
- $(2.56 \times 10^{-3}) \times (3.8 \times 10^6)$
- $(4.97 \times 10^8) \div (7 \times 10^5)$