

Addition and Subtraction in Scientific Notation

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WHAT'S COVERED

In this lesson, you will learn how to add or subtract numbers in scientific notation. Specifically, this lesson will cover:

1. Addition and Subtracting in Scientific Notation

Scientific notation can be used to express very large and very small numbers by multiplying a decimal number by a power of 10. By very large number, we mean a number containing several digits to the left of the decimal, such as 23,000,000 (23 million). By small number, we mean a number with zero in the ones place, with several decimal digits behind it, such as 0.000023 (23 millionths).

Generally, numbers written in scientific notation can be expressed as $a \cdot 10^n$, where a is a decimal number, and 10^n represents a power of ten.

In proper scientific notation, there are a couple of restrictions to what “ a ” is allowed to be. “ a ” can only contain one non-zero digit to the left of the decimal. Here are some examples of numbers that might look like they are in scientific notation, but they violate this rule for what “ a ” can be:

↪ EXAMPLE

0.5×10^4 A zero to the left of the decimal is not allowed

↪ EXAMPLE

12.4×10^{-2} More than 1 digit to the left of the decimal is not allowed

In cases where there is a zero or more than one digit to the left of the decimal, we can move the decimal and adjust the exponent. Let's change our previous examples into proper scientific notation.

↪ EXAMPLE

0.5×10^4 A zero to the left of the decimal is not allowed

5.0×10^3 Decimal moved right 1 place, exponent decreased by 1

↪ EXAMPLE

12.4×10^{-2} More than one digit to the left of the decimal is not allowed

1.24×10^{-1} Decimal moved left 1 place, exponent increased by 1

 BIG IDEA

When moving the decimal in scientific notation, movement to the left increases the power of 10, and movement to the right decreases the power of 10.

 HINT

Be careful when increasing and decreasing negative powers of 10. For example, decreasing -3 by 1 makes the number more negative: -4. Similarly, increasing -3 by 1 makes the number less negative: -2.

2. Adding and Subtracting with Common Powers of 10

How does this help us add and subtract numbers in scientific notation? We can easily add and subtract numbers in scientific notation if they are expressed using the same power of 10.

↪ EXAMPLE

$(3.2 \times 10^4) + (1.3 \times 10^4)$ Add the decimal numbers together, keep the power of 10

$(3.2 + 1.3) \times 10^4$ Simplify

4.5×10^4 Our Solution

We can confirm this is a valid process by showing the addition in standard notation:

↪ EXAMPLE

$(3.2 \times 10^4) + (1.3 \times 10^4)$ Write in standard notation

$32000 + 13000$ Add the numbers

45000 Convert to scientific notation

4.5×10^4 Our Solution

 HINT

Sometimes when you add the decimal numbers, you will get a sum that does not fit the rules for proper scientific notation. Remember to always check that a single non-zero digit is to the left of the decimal. If necessary, move the decimal and adjust the exponent.

 BIG IDEA

When the powers of 10 are the same, we can add and subtract numbers in scientific notation following the rule: $a \times 10^n + b \times 10^n = (a + b) \times 10^n$.

3. Adding and Subtracting with Unlike Powers of 10

What if we wish to add or subtract numbers in scientific notation that have unlike powers of 10? We can use our handy trick of moving the decimal and adjusting the exponent to express the numbers with a common power of 10.

↪ EXAMPLE

$(4.1 \times 10^3) - (2.1 \times 10^4)$ Rewrite one number to have a common power of 10

$(4.1 \times 10^3) - (21 \times 10^3)$ Group the decimal numbers, keep power of 10

$(4.1 - 21) \times 10^3$ Subtract 21 from 4.1

-16.9×10^3 Write in proper scientific notation with only one number in front of the decimal, adjust exponent

-1.69×10^4 Our Solution

Note that it does not matter which number you choose to rewrite. We would get the same result if we chose to rewrite the other number, although we might give ourselves more work to do. Let's go through the same example, but in a different way:

↪ EXAMPLE

$(4.1 \times 10^3) - (2.1 \times 10^4)$ Rewrite one number to have a common power of 10

$(0.41 \times 10^4) - (2.1 \times 10^4)$ Group the decimal numbers, keep power of 10

$(0.41 - 2.1) \times 10^4$ Subtract 2.1 from 0.41

-1.69×10^4 Our Solution

As you can see in the first example, we needed to make a final adjustment to our solution, because -16.9×10^3 is not in proper scientific notation. No matter which number you decide to rewrite, always be sure to make any necessary movements to the decimal, and increase or decrease your exponent accordingly.

HINT

This tip is worth repeating, especially when adding or subtracting numbers in scientific notation. During the process, you will probably work with numbers that are not written in proper scientific notation. This is okay because it is required to create a common power of 10. Just be sure that you make final adjustments to your expression, so that the decimal number contains only a single non-zero digit to the left of the decimal. Remember, decimal movement to the left increases the power of 10, and decimal movement to the right decreases the power of 10.



SUMMARY

When you're **adding and subtracting numbers that are written in scientific notation with common powers of 10**, meaning the powers of 10 are the same, you can just add or subtract your decimal

numbers, and keep the same power of 10.

When **adding or subtracting numbers in scientific notation with unlike powers of 10**, we can rewrite one of the numbers by moving the decimal and increase or decreasing the power of 10. Move the decimal either to the left if you want to increase the exponent or move it to the right if you want to decrease the exponent. This creates two numbers with a common power of 10, which can be added or subtracted by combining the decimal numbers and keeping the common power of 10.

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