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1. Number and algebra / 1.1 Scientific notation

The big picture

The world around us is full of quantities that are either very large or very small.

There are $602\,214\,085\,700\,000\,000\,000\,000$ water molecules in a few drops of water and the diameter of one of your red blood cells is approximately 0.000005 metres.

Writing very large and very small numbers such as these is very inconvenient and it's hard not to lose some of the zeros when doing calculations with these numbers.

A much easier way to work with these numbers is to write them in scientific notation .

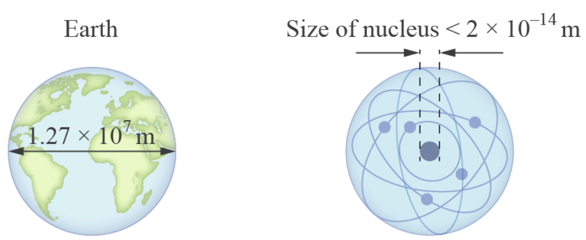
Scientific notation is written in the form

$a \times 10^k$ where $1 \leq |a| < 10$ and k is an integer.

The superscript k is called a power or an exponent.

Another term for scientific notation is standard form.

The diagram shows examples of numbers written in this form.



More information

The diagram compares two scales. On the left, an illustration of the Earth is shown with a horizontal line marking its diameter as (1.27 \times 10^7) meters. On the right, an atomic nucleus is depicted with several orbiting paths to illustrate electron movement. The nucleus is labeled as having a size less than (2 \times 10^{-14}) meters. This comparison aims to highlight the vast difference in sizes between large astronomical bodies and small atomic components.

[Generated by AI]

Concept

Throughout this subtopic you will be asked to convert numbers from the familiar decimal notation to a new, $a \times 10^k$, form of representation of these same numbers.

The purpose of this new form of representation is to facilitate your work with large and small numbers.

As you work through the subtopic, consider where the new form of representation adds to your understanding of numbers and where it would be more appropriate to use the ordinary number format with which you are currently more familiar.

1. Number and algebra / 1.1 Scientific notation

Writing a number in scientific notation

Exploring scientific notation

To better understand scientific notation, we start with an activity that demonstrates the connection between $a \times 10^k$ form and ordinary number format.

Activity

The applet below allows you to move the sliders to change the value of b in $a \times 10^b$ and to observe what this does to the value of $a \times 10^b$. As you move the slider around, what do you observe about the numbers produced when $b > 0$? What about when $b < 0$?

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Interactive 1. Understanding Scientific Notation.

Credit: GeoGebra (https://www.geogebra.org/m/Zb9g4SY3) Tanay Rangel

More information for interactive 1

This interactive enables users to explore the concept of scientific notation by observing the product of $a \times 10^b$. The applet includes sliders that allow users to adjust the exponent *b* in the expression $a \times 10^b$. As the slider moves, users can instantly see how the value of the expression changes.

The variable *a* can be set to increments such as $1, 1.5, 2, 2.5, \ldots, 9, 9.5, 9.9$, and *b* can range from -9 to 10. As users modify these values, the interactive display shows the number in scientific notation and calculates the final product, allowing for a dynamic understanding of how changes in *a* and *b* affect the result.

When $b > 0$, the users notice that the number becomes larger as the exponent increases, shifting the decimal point to the right. When $b < 0$, the number becomes smaller, shifting the decimal point to the left, creating decimal values.

For example, when *a* is set to 2 and *b* is set to 2, the answer displayed is 200, and when *a* is set to 2 and *b* is set to -2, the answer displayed is 0.02. This interactive tool is a powerful way to visualize scientific notation and strengthen conceptual understanding through active engagement.

Writing large and small numbers in scientific notation

Scientists often work with quantities that are either very large or very small. These numbers can be inconvenient to work with as they contain many digits. Scientific notation makes working with such numbers easier.

Watch the video below to see how this works.

Section Student... (0/0) Feedback Print (/study/app/preview-p/sid-122-cid-754029/book/the-big-picture-id-26084/print/) Assign

When converting to scientific notation multiplication and division by 10 moves the decimal point in a number. (Strictly speaking the point does not move, but it is often easier to think of it this way when working.)

So 250 can be written as 25×10 or $2.5 \times 10 \times 10$. Counting the number of times that you need to multiply by 10 will allow you to convert a large number to scientific notation. Consider **Example 1.**

Example 1

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Convert 276 000 to scientific notation.

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Steps	Explanation
$\begin{aligned} 276\,000 &= 27\,600 \times 10 \\ &= 2760 \times 10 \times 10 \\ &= 276 \times 10 \times 10 \times 10 \\ &= 27.6 \times 10 \times 10 \times 10 \times 10 \\ &= 2.76 \times 10 \times 10 \times 10 \times 10 \times 10 \end{aligned}$	While you could keep going with this pattern, for scientific notation you should stop once $1 \leq a < 10$. In this case, $a = 2.76$.
$276\,000 = 2.76 \times 10^5$	$10 \times 10 \times 10 \times 10 \times 10 = 10^5$

Be aware

When you are converting to scientific notation it is important to remember that $1 \leq a < 10$.
If a does not meet this requirement, the number is not in scientific notation.

You can carry out a similar process with division by 10 for small numbers.

Consider:

$$\begin{aligned} 0.00034 &= 0.0034 \times \frac{1}{10} \\ &= 0.034 \times \frac{1}{10} \times \frac{1}{10} \\ &= 0.34 \times \frac{1}{10} \times \frac{1}{10} \times \frac{1}{10} \\ &= 3.4 \times \frac{1}{10} \times \frac{1}{10} \times \frac{1}{10} \times \frac{1}{10} \\ &= 3.4 \times \frac{1}{10^4} \\ &= 3.4 \times 10^{-4} \end{aligned}$$

Example 2

★★☆

Convert 0.000015 to scientific notation.

Student view

Steps	Explanation
$\begin{aligned} 0.000015 &= 0.00015 \times \frac{1}{10} \\ &= 0.0015 \times \frac{1}{10} \times \frac{1}{10} \\ &= 0.015 \times \frac{1}{10} \times \frac{1}{10} \times \frac{1}{10} \\ &= 0.15 \times \frac{1}{10} \times \frac{1}{10} \times \frac{1}{10} \times \frac{1}{10} \\ &= 1.5 \times \frac{1}{10} \times \frac{1}{10} \times \frac{1}{10} \times \frac{1}{10} \times \frac{1}{10} \\ &= 1.5 \times \frac{1}{10^5} \\ &= 1.5 \times 10^{-5} \end{aligned}$	While you could keep going with this pattern, for scientific notation you should stop once $1 \leq a < 10$. In this case, $a = 1.5$.

At this point it is helpful to note that there is a shortcut for doing this work. This is explained in **Example 3**.

Example 3

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Convert into scientific notation

a) 260 000

b) 0.00043

a) 260 000 can be written as 260 000.0 to clearly show the location of the decimal point.

To write this number in scientific notation you will need to move the decimal point five times to the left to get 2.6×10^{k}. This is shown in the diagram.

The value of k matches the number of moves made by the decimal point. Since the original number was large, k will be positive.

Therefore $260\ 000 = 2.6 \times 10^{5}$

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b) In 0.00043 the decimal point needs to move four spaces to the right to get 4.3×10^{k}. This is shown in the diagram.

The value of k matches the number of moves made by the decimal point. Since the original number was small (between 0 and 1), k will be negative.

Therefore $0.00043 = 4.3 \times 10^{-4}$

Converting numbers from scientific notation to ordinary numbers

Conversion of a number written in scientific notation to ordinary number format can be done by:

1. multiplying by a power of 10, e.g. $4.19 \times 10^{5} = 4.19 \times 100\,000 = 419\,000$
2. dividing by a power of 10, e.g. $2.7 \times 10^{-4} = \frac{2.7}{10^{4}} = \frac{2.7}{10\,000} = 0.00027$.

You can also use a shortcut by moving the decimal point as shown in **Example 4**.

Example 4

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Convert each of these numbers from scientific notation into ordinary number format.

a) 7.12×10^{4}

b) 2.54×10^{-5}

a) The exponent is 4. This means that you will move the decimal point four spaces. Since $k > 0$ you should expect a big number and so the decimal point moves to the right. This is shown below:

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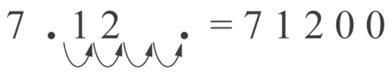
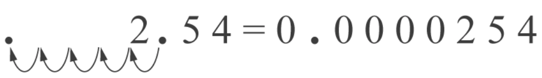


Therefore $7.12 \times 10^4 = 71\ 200$.

b) The exponent is -5. This means that you will move the decimal point five spaces. Since $k < 0$ you should expect a small number and so the decimal point moves to the left. This is shown below:



Therefore $2.54 \times 10^{-5} = 0.0000254$.

Use the applet below to practise some more conversion questions.

Interactive 2. Writing a Number in Scientific Notation.

More information for interactive 2

This interactive is designed to help users practice converting numbers from scientific notation to ordinary decimal form. The applet generates random numbers in the format $a \times 10^b$, where a is a coefficient and b determines the power of ten. Both the variables a and b can be varied by adjusting the sliders.

Users can adjust the value of b, ranging from negative to positive values (from -9 to 10), using a slider at the top right of the applet. The value of a can also be varied from 1 to 9.9, using a slider at the top left of the applet.

As b increases, the numerical value grows exponentially. When b is negative, the value decreases, approaching zero but never reaching it.

The applet dynamically updates the numerical output as the slider is moved. Users can observe how different values of a and b influence the overall number. The scientific notation representation is displayed alongside the standard decimal format, reinforcing the connection between the two.

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Example 1: Set $a = 6.5$ and $b = 5$.

The number written in scientific notation is 6.5×10^{5}

The product is *650000*.

Example 2: Set $a = 5.5$ and $b = -3$.

The number written in scientific notation is 5.5×10^{-3}

The product is 0.0055.

Through this interactive applet, users can easily understand how numbers change when they are expressed in scientific notation.

International Mindedness

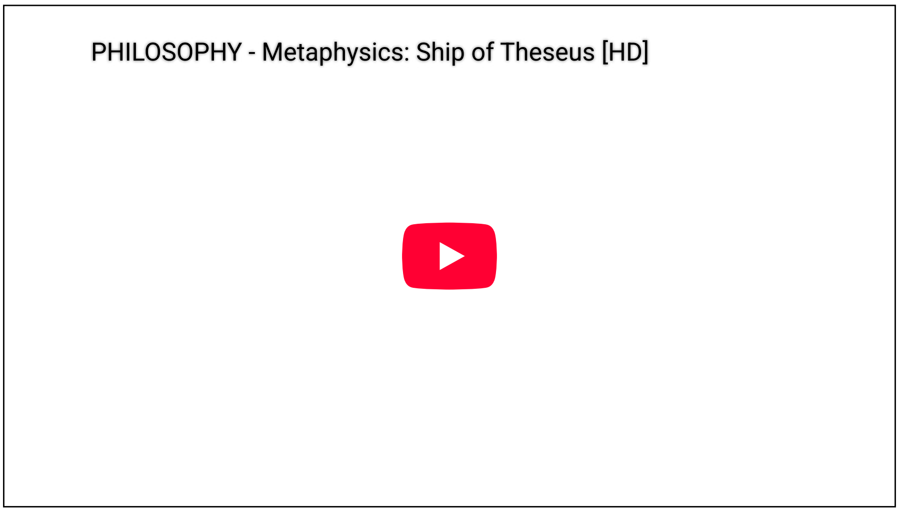
For example, World Bank data (https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?end=2017&locations=CN-AU&start=1960&view=chart) gives that the GDP of China in 2017 was $12\,237\,700\,479\,375$ USD, which is 1.2×10^{13} USD, and the GDP of Australia in 2017 was $1\,323\,421\,072\,479$ USD, which is 1.3×10^{12}. Writing these numbers in scientific notation allows you to quickly see the similarities and differences between the economic factors.

Theory of Knowledge

Scientific notation changes the way a number is represented though not the value it represents. A core principle of mathematics is the interplay between the concepts of representation, modelling and equivalence. All three concepts are relevant in regard to articulating values using scientific notation.

A knowledge question that emerges is, ‘How much can you change a piece of original knowledge before it becomes new knowledge?’ When you change the way you represent a number, is it still the ‘same’ number or a ‘new’ number entirely?

Watch the video below and consider the paradox of Theseus’ Ship. Do you believe his ship is the same? Or does he have a ‘new’ ship? What are the ramifications for representation and change in regard to knowledge construction within the AOK of mathematics?



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Multiplication and divison

Multiplication

When you multiply numbers in $a \times 10^k$ form, there are a few simple rules to follow.

Before the rules are summarised, consider the following two examples.

1. $$\begin{aligned}(2\times 10^7)\times(3\times 10^4) &= 2\times 3\times 10^7\times 10^4\\ &= 2\times 3\times 10\times 10\times 10\times 10\times 10\times 10\times 10\times 10\times 10\times 10\times 10\\ &= 6\times 10^{11}\end{aligned}$$

2. $$\begin{aligned}(4.17\times 10^{-3})\times(6\times 10^5) &= 4.17\times 6\times 10^{-3}\times 10^5\\ &= 4.17\times 6\times \frac{1}{10}\times\frac{1}{10}\times\frac{1}{10}\times 10\times 10\times 10\times 10\times 10\\ &= 25.02\times 10^2\\ &= 2.502\times 10^3\end{aligned}$$

Do you notice any patterns in the examples above?

Why does the second example have an extra step?

The multiplication rules can be summarised as follows.

Important

Given $a \times 10^k$, where $1 \le a < 10$, and k is an integer, and $b\times 10^m$, where $1 \le b < 10$ and m is an integer,

$(a \times 10^k) \times (b\times 10^m) = ab\times 10^{k+m}$

Making connections

$10^k \times 10^m = 10^{k+m}$ uses an exponent rule for multiplication.

You will see this and other exponent rules in more detail in section 1.5.1 (/study/app/preview-p/sid-122-cid-754029/book/laws-of-exponents-id-26155/) .

The second example, $(4.17 \times 10^{-3}) \times (6 \times 10^5) = (4.17 \times 6) \times 10^{-3+5} = 25.02 \times 10^2$, has an extra step because the final result 25.02×10^2 is not in scientific notation since $25.02 > 10$ and the condition for $a \times 10^k$ is that $1 \le a < 10$. You can fix this by moving the decimal one space to the left and adding 1 to the power of 10.

Student view

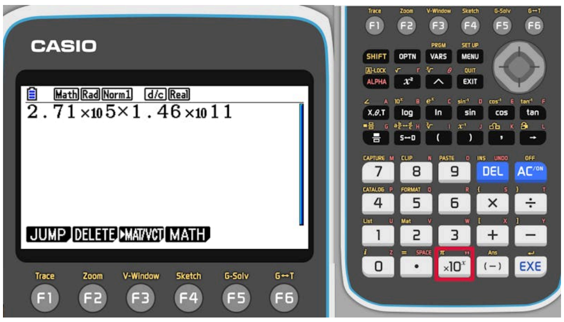
To see more examples of multiplication, watch the video below. For now, you can skip the part of the video that mentions division, which we will tackle a little later in this section.

Scientific Notation - Multiplication and Division

You should be able to carry out multiplication of numbers in scientific notation with and without a calculator.

Simple examples such as $(1\times 10^{-3})\times(4\times 10^{6}) = (1\times 4)\times 10^{-3+6} = 4\times 10^{3}$ can be done without a calculator.

A more complex example such as $(2.71\times 10^{5})\times(1.46\times 10^{11}) = 3.96\times 10^{16}$ can be done on the calculator.

Steps	Explanation
You can enter numbers in scientific notation using the $\times 10^{x}$ option. There is no need to use parentheses, but be careful as the calculator does not display the 5 and the 11 in the exponent.	

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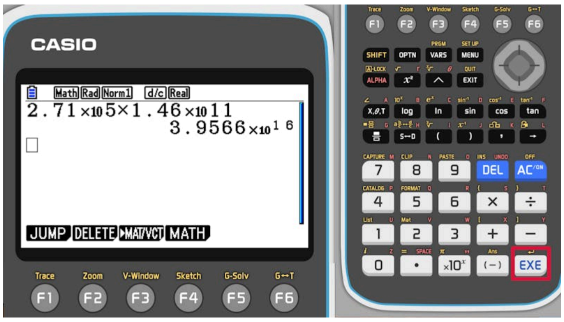
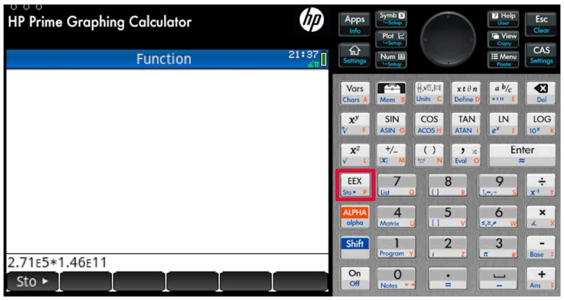
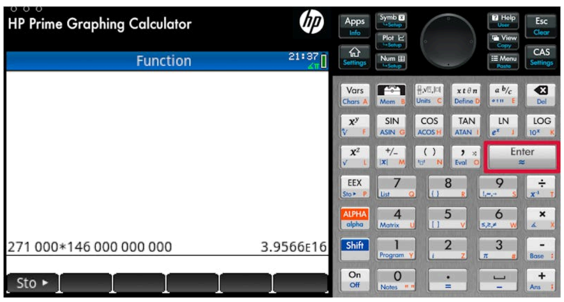
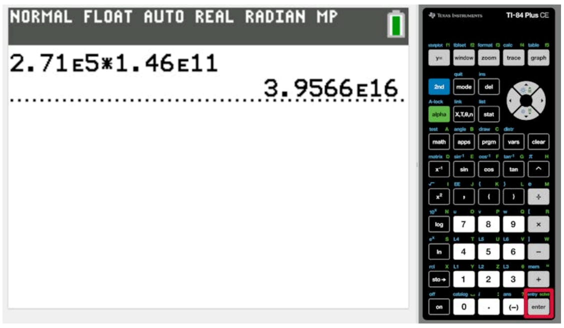
Steps	Explanation
After pressing EXE, the calculator shows the result using scientific notation. Unlike when you entered the expressions, this time the 16 is in the exponent. Notice also that the 10 is displayed in a smaller font, which is an indication that scientific notation is used here.	

Steps	Explanation
You can enter numbers in scientific notation using the EEX option. There is no need to use parentheses as the calculator treats $2.71\text{E}5$ as a single number.	
After pressing enter, the calculator shows the result using scientific notation. The 16 after the letter E is the exponent of 10. You should know that this result is the calculator notation for the number 3.9566×10^{16}.	

Student view

Steps	Explanation
You can enter numbers in scientific notation using the EE option. There is no need to use parentheses as the calculator treats $2.71\text{E}5$ as a single number.	
After pressing enter, the calculator shows the result using scientific notation. The 16 after the letter E is the exponent of 10. You should know that this result is the calculator notation for the number 3.9566×10^{16}.	

Steps	Explanation
You can enter numbers in scientific notation using the EE option. There is no need to use parentheses as the calculator treats $2.71\text{E}5$ as a single number.	

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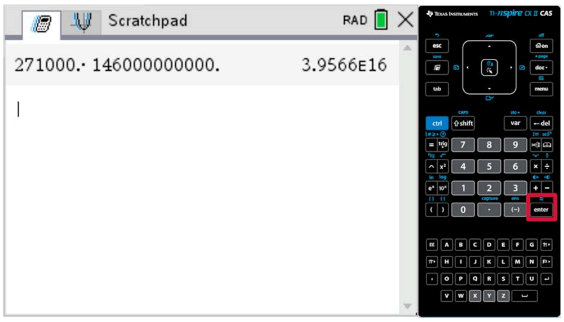
Steps	Explanation
After pressing enter, the calculator shows the result using scientific notation. The 16 after the letter E is the exponent of 10. You should know that this result is the calculator notation for the number 3.9566×10^{16}.	

Exam tip

Answers obtained on the calculator should be rounded to 3 significant figures unless the question tells you otherwise.

Hence, $(2.71\times 10^{5})\times (1.46\times 10^{11}) = 3.96\times 10^{16}$.

Be aware

When using your GDC to answer questions involving scientific notation, it is important that you recognise and interpret calculator notation for these numbers, which is $a\text{E}k$, but that in your written tests you use $a\times 10^{k}$ notation.

Example 1

★★☆

The sides of a rectangular microchip measure 3.2×10^{-6} and 4.7×10^{-6} metres. Calculate the area of this microchip, giving your answer in the form $a\times 10^{k}$, where $1\leq a< 10$ and k is an integer.

Method 1

Using a GDC (most appropriate method for this question).

Steps	Explanation
$\text{Area} = (3.2\times 10^{-6})\times (4.7\times 10^{-6})$	Area of a rectangle is length × width.

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Steps	Explanation
Area = 1.504×10^{-11}	Use the GDC to multiply these numbers. The GDC output is $1.504\text{E}-11$ which must be written in correct scientific notation.
Area = $1.50\times 10^{-11}\ \text{m}^2$	Round to 3 significant figures and include units.

Method 2

No calculator.

Steps	Explanation
Area = $(3.2\times 10^{-6})\times(4.7\times 10^{-6})$	Area of a rectangle is length × width.
Area = $(3.2\times 4.7)\times 10^{-6+(-6)}$	Multiply 3.2×4.7.
Area = 15.04×10^{-12}	This answer is not in scientific notation since $15.04 > 10$.
Area = $1.504\times 10^{-12+1} = 1.504\times 10^{-11}$	Convert to scientific notation by moving the decimal point one place to the left and adding one to the power of 10.
Area = $1.50\times 10^{-11}\ \text{m}^2$	Round to 3 significant figures and include units.

Example 2

★☆☆

Find the value of $(3\times 10^7)\times(4\times 10^5)$. Give your answer in the form $a\times 10^k$, where $1\leq a < 10$ and k is an integer.

Method 1

No calculator (most appropriate method for this question).

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Steps	Explanation
$(3\times 10^7)\times(4\times 10^5) = (3\times 4)\times 10^{7+5}$ $= 12\times 10^{12}$ $(3\times 10^7)\times(4\times 10^5) = 1.2\times 10^{13}$	Using the pattern for multiplying numbers in scientific notation, multiply the coefficients and add the exponents. This number is not in scientific notation since $12 > 10$. Convert to scientific notation by moving the decimal point one place to the left and adding one to the power of 10. 1.2 is an exact value of 3×4; it does not need to be given correct to 3 significant figures.

Method 2

Using a GDC.

Steps	Explanation
$(3\times 10^7)\times(4\times 10^5) = 1.2\times 10^{13}$	GDC output is 1.2E13. 1.2 is an exact value of 3×4; it does not need to be given correct to 3 significant figures.

Division

Division of numbers in scientific notation follows a similar pattern to multiplication.

✓ **Important**

Given $a\times 10^k$, where $1 \le a < 10$, and k is an integer, and $b\times 10^m$, where $1 \le b < 10$ and m is an integer, $(a\times 10^k)\div(b\times 10^m) = \frac{a}{b}\times 10^{k-m}$.

As for multiplication, if you are carrying out division without a calculator, you need to check that the result of $\frac{a}{b}$ is between 1 and 10 and move the decimal point if it isn't. For example:

$$\frac{2\times 10^{-2}}{8\times 10^5} = \frac{2}{8}\times 10^{-2-5} = 0.25\times 10^{-7} = 2.5\times 10^{-7-1} = 2.5\times 10^{-8}.$$

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Note that moving the decimal point to the right means that you need to subtract 1 from the power of 10.

3 section questions

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1. Number and algebra / 1.1 Scientific notation

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Addition and subtraction

Addition and subtraction

Numbers in scientific notation that have the same exponent can be easily added or subtracted from each other.

Here are two examples:

$$1)\ 2.5\times 10^{4}+3\times 10^{4}=(2.5+3)\times 10^{4}=5.5\times 10^{4}$$
$$2)\ 5\times 10^{-4}-2\times 10^{-4}=(5-2)\times 10^{-4}=3\times 10^{-4}$$

If you need to add or subtract two numbers that have different powers, you will need to change one of them to match the other. **Example 1** shows how that's done.

Example 1

★★☆

Find the value of $3.7\times 10^{4}+1.2\times 10^{5}$

Steps	Explanation
$3.7\times 10^{4}+1.2\times 10^{5}$	One of these numbers needs to be changed out of scientific notation to ensure a match of exponents.
$1.2\times 10^{5}=1.2\times 10\times 10^{4}=12\times 10^{4}$	This number is no longer in scientific notation, but we can add it to 3.7×10^{4} because the exponents match.
$3.7\times 10^{4}+12\times 10^{4}=(3.7+12)\times 10^{4}=15.7\times 10^{4}$	You now need to convert this answer back to scientific notation.
$15.7\times 10^{4}=1.57\times 10^{4+1}=1.57\times 10^{5}$	Remember that moving the decimal point to the left adds to the power of 10.

Watch the video below to see some more examples of addition and subtraction in scientific notation.

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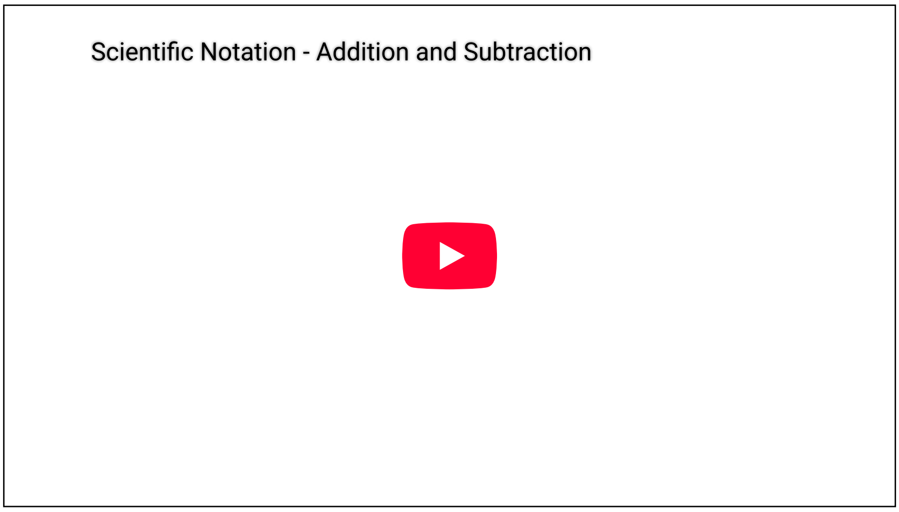

This can be summarised as follows.

Important

To add or subtract $a \times 10^{k}$ to $b \times 10^{m}$ without using a calculator, you must first ensure that $k = m$.

This process can be simplified by using your calculator. When you are using your calculator, you do not need to make sure that the exponents are equal.

Example 2

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Evaluate $3.7 \times 10^{-20} + 1.5 \times 10^{-21}$

Write your answer in scientific notation correct to 3 significant figures.

Steps	Explanation
$3.7 \times 10^{-20} = 37 \times 10^{-21}$	Exponents on the 10 should match for both numbers for addition.
$37 \times 10^{-21} + 1.5 \times 10^{-21} = (37 + 1.5) \times 10^{-21} = 38.5 \times 10^{-21}$	
3.85×10^{-20}	Write the answer in scientific notation correct to 3 significant figures.

Activity

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Use your calculator to evaluate $1.3 \times 10^{24} + 2 \times 10^{6}$. How does the answer on the calculator compare with the original numbers used in the question? Why do you think this happens?

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1. Number and algebra / 1.1 Scientific notation

Powers

You need to know how to raise a number in scientific notation to a given power.

Consider

$$(2.5 \times 10^{4})^{2}$$

You can rewrite this as

$$(2.5 \times 10^{4}) \times (2.5 \times 10^{4}) = 2.5 \times 2.5 \times 10^{4+4} = 2.5^{2} \times 10^{2\times 4}$$

Now consider

$$(2.5 \times 10^{4})^{3}$$

You can use your previous result to rewrite this as

$$2.5^{2} \times 10^{2\times 4} \times 2.5 \times 10^{4} = 2.5^{3} \times 10^{2\times 4+4} = 2.5^{3} \times 10^{3\times 4}$$

What pattern do you see emerging?

Important

If $a \times 10^{k}$ where $1 \leq a < 10$ and k is an integer, then $(a \times 10^{k})^{m} = a^{m} \times 10^{k\times m}$.

Example 1

★★☆

Write $(2 \times 10^{-3})^{4}$ in scientific notation.

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Steps	Explanation
$(2\times 10^{-3})^4 = 2^4 \times 10^{-3\times 4}$	Use $(a\times 10^k)^m = a^m \times 10^{k\times m}$.
$= 16\times 10^{-12} = 1.6\times 10^{-11}$	Convert to scientific notation. You can check your work on a calculator.

3 section questions

1. Number and algebra / 1.1 Scientific notation

Checklist

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Section Student... (0/0) Feedback Print (/study/app/preview-p/sid-122-cid-754029/book/powers-id-26088/print/) Assign

What you should know

By the end of this subtopic you should be able to:

- understand that scientific notation, $a\times 10^k$, where $1 \le a < 10$ and k is an integer, is used to efficiently express very large or very small numbers
- convert between ordinary number format and scientific notation $a\times 10^k$ where $1 \le a < 10$ and k is an integer
- recognise that
  - when $1 \le a < 10$ and k is a negative integer, $a\times 10^k$ is a number between 0 and 1,
  - when $1 \le a < 10$ and k is a positive integer, $a\times 10^k$ is a number greater or equal to 10.
- distinguish between correct and incorrect scientific notation based on the conditions that $1 \le a < 10$ and k is an integer in $a\times 10^k$
- add, subtract, multiply, divide, and raise to powers any number written in scientific notation
- convert results that are in nearly scientific notation form to correct scientific notation when performing computations with numbers in scientific notation.

1. Number and algebra / 1.1 Scientific notation

Investigation

Section Student... (0/0) Feedback Print (/study/app/preview-p/sid-122-cid-754029/book/investigation-id-26090/print/) Assign

Student view

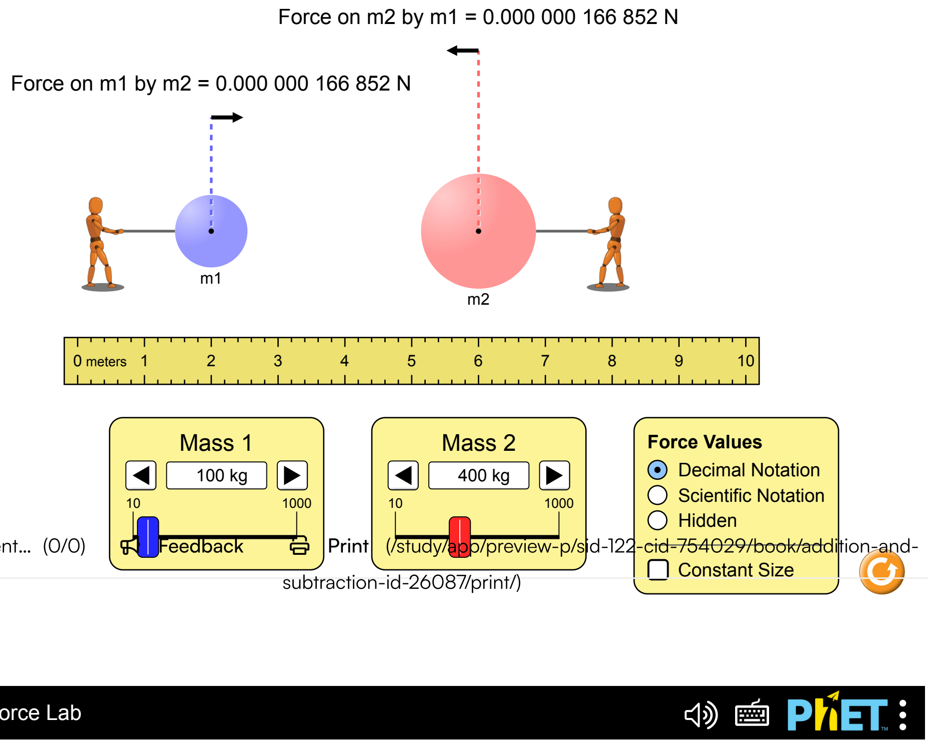
Overview (/study/app/sid-122-cid-754029/

Scientific notation is used extensively in physics, particularly when it comes to astrophysics and forces of gravity between planets.

Part 1

Use the applet below to investigate how the force of gravity between two objects is affected by the following two factors:

1. the masses of the objects
2. the distance between the objects.



Section Student... (0/0) Feedback Print (/study/app/preview-p/sid-122-cid-754029/book/addition-and-subtraction-id-26087/print/) Assign

Interactive 1. Scientific Notation to Express Force of Gravity.

More information for interactive 1

This interactive allows users to explore how gravitational force between two objects depends on their masses and separation distance through Newton's Law of Universal Gravitation:

$F = \frac{Gm_1m_2}{r^2}$,

where F is the gravitational force, G is the gravitational constant $(6.674 \times 10^{-11} \frac{\text{N m}^2}{\text{kg}^2})$, m_1 and m_2 are the masses, and r is the distance between them.

The masses are round balls with stick figures holding them. Users can adjust both masses m_1 and m_2 within a range of 10 to 1000 kg using intuitive sliders. The distance between objects can be modified either by dragging them closer together or farther apart, with the added functionality of a movable ruler for precise distance measurement. Additionally, users can select their preferred display format for the force values, choosing between decimal notation, scientific notation, or opting to hide them completely for estimation exercises.

For example, when one object weighs 500 kg and another 250 kg, placed 5 meters apart, and the selected display format for force is scientific notation, then the tool calculates and displays the gravitational force as 3.34×10^{-7}N, demonstrating the practical application of the gravitational

Student view

force equation.

The interactive elements and real-time calculations effectively showcase the inverse-square relationship between gravitational force and distance while maintaining all the original functionality described.

Describe your findings. Consider other ways to present this information. Try to use graphs or algebraic expressions to communicate your findings.

Part 2

Research how the force of gravity is calculated and determine the force of gravity between the Earth and other objects such as planets, stars, or spaceships.

How do the values that you calculated compare with your findings in **Part 1** ?