Super Small Standard Form

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Starter worksheet

Standard form is a way of writing really big and really small numbers to make them easier to use. From astronomers comparing distances between galaxies to microbiologists measuring viruses, standard form is used all over the world. Scientists, in particular, find it very helpful.

For numbers smaller than **1**, standard form looks like this:

7.1×10^{-4}

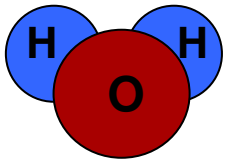
Number between 1 and 10

A negative power of 10

So, 7.1×10^{-4} means $7.1 \times 1/10\,000 = 7.1 \times 0.0001 = 0.00071$

Water is made up of lots of tiny molecules. Each water molecule is made of one **oxygen** atom (**O**) and two **hydrogen** atoms (**H**) … $\mathbf{H_20}$.

The diameter of an oxygen atom is roughly 0.00000014 mm
$= 1.4 \times 0.0000001$
$= \mathbf{1.4 \times 10^{-7}}$ mm



The diameter of a hydrogen atom is roughly 0.000000074 mm. What is this in standard form?

Match the number to its standard form!

0.0035

0.00000000000000035

0.000000000000000035

0.0000035

0.0000000000000035

0.000000000000000035

3.5×10^{-3}

3.5×10^{-5}

3.5×10^{-6}

3.5×10^{-15}

3.5×10^{-16}

3.5×10^{-17}

3.5×10^{-18}

3.5×10^{-19}

3.5×10^{-20}

3.5×10^{-25}

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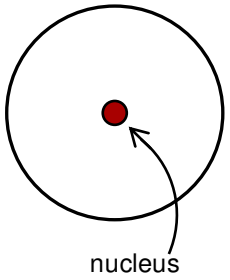
Core worksheet

Sometimes you may need to expand standard form and return a number to its ordinary form.

Take a closer look at an oxygen atom: scientists have discovered that at the centre of every atom is a tiny **nucleus**. A cloud of really really tiny particles called **electrons** circle around this nucleus.

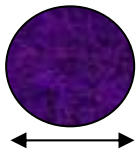
The nucleus of an oxygen atom has a radius of roughly 3.15×10^{-12} mm.

$$\begin{aligned} \mathbf{3.15 \times 10^{-12}} &= 3.15 \times 1 / 10^{12} \\ &= 3.15 \times 1 / 1\,000\,000\,000\,000 \\ &= 3.15 \times 0.000000000001 \\ &= \mathbf{0.00000000000315} \text{ mm} \end{aligned}$$



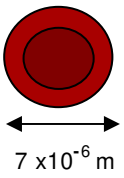
Have a go yourself…

Expand the standard form and rewrite these five lengths as normal numbers:

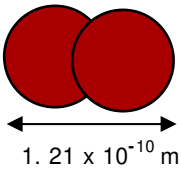


Echovirus

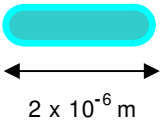
Average human hair



Red Blood Cell



Oxygen molecule (O_2)



E. Coli bacterium

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Advanced worksheet

Calculations using standard form

What is $(3.2 \times 10^{-5}) \times (4 \times 10^{-7})$?

We can use the same method we used for Super Big standard form:

Multiply the first part of each number together … **3.2 x 4** … and multiply the second part of each number together … **$10^{-5} \times 10^{-7}$**

So, the answer is $3.2 \times 4 \times 10^{-5} \times 10^{-7} = 12.8 \times 10^{-5+(-7)}$
$= 12.8 \times 10^{-12}$
$= 1.28 \times 10^{-13}$

Division follows the same ideas as multiplication:

$(3.2 \times 10^{-5}) \div (2 \times 10^{-11}) = (3.2 \div 2) \times (10^{-5} \div 10^{-11})$
$= 1.8 \times 10^{-5-(-11)}$
$= 1.8 \times 10^{6}$
(notice how big this is compared to the numbers being divided!)

Let's take a closer look at the nucleus of our oxygen atom.

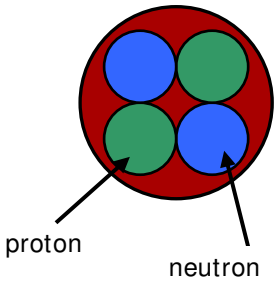
The nucleus is actually made from particles called **nucleons**. There are two types of nucleons: **protons** and **neutrons**. The number of **protons** in the nucleus tells you the name of the atom – every oxygen atom contains **8** protons, every hydrogen atom contains **1** proton.

The mass of one nucleon is approximately **1.66×10^{-24}** g.

Oxygen atoms contain 8 protons and 8 neutrons. Hydrogen atoms contain 1 proton and no neutrons. Remember that a water molecule has two hydrogen atoms and one oxygen atom.

What is the total number of nucleons in one water molecule?
What is the approximate mass of one water molecule?

In one drop of water there are 1.4×10^{21} water molecules.
What is the approximate mass of a drop of water?



Did you notice that we ignored the electrons when we calculated the mass of water? The mass of one electron is roughly 1800 times smaller than the mass of one nucleon.
What is the mass of one electron?

Every atom contains the same number of electrons as protons.
What is the total number of electrons in one water molecule?
What is the approximate mass of all the electrons in one drop of water?