



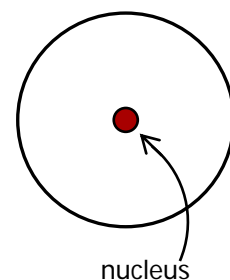
# Super Small Standard Form

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.

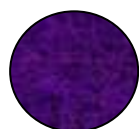
The nucleus of an oxygen atom has a radius of roughly  $3.15 \times 10^{-12}$  mm.

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



Have a go yourself...

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



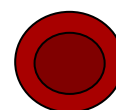
$2.8 \times 10^{-8}$  m

*Echovirus*



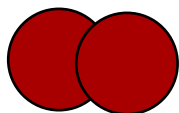
Width:  $8 \times 10^{-5}$  m

Average human hair



$7 \times 10^{-6}$  m

Red Blood Cell



$1.21 \times 10^{-10}$  m

Oxygen molecule ( $O_2$ )



$2 \times 10^{-6}$  m

*E. Coli* bacterium

# Super Small Standard Form

## 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 ...  $3.2 \times 4$  ... and multiply the second part of each number together ...  $10^{-5} \times 10^{-7}$

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

Division follows the same ideas as multiplication:

$$\begin{aligned}(3.2 \times 10^{-5}) \div (2 \times 10^{-11}) &= (3.2 \div 2) \times (10^{-5} \div 10^{-11}) \\ &= 1.6 \times 10^{-5-(-11)} \\ &= 1.6 \times 10^6\end{aligned}$$

(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  $1.66 \times 10^{-24}$  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  $1.4 \times 10^{21}$  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?**

