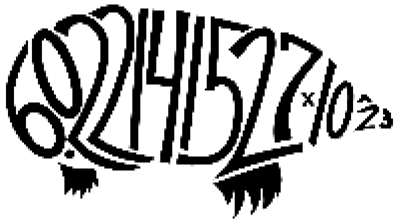
Moles

A mole of something is like a dozen of something, only much, much more.



- A dozen is 12 of something.
- A mole is 602214152700000000000000 of something (often written as $6.022141527 \times 10^{23}$).

Such a huge number isn't much use for everyday items. A mole of eggs would cover the surface of the Earth 10 km deep. But it is very useful when you have an awful lot of very small things. Like atoms. Or molecules.

You can fit a mole of carbon atoms into an eggcup. A mole of water molecules is about a mouthful (depending on the size of your mouth).

Moles are useful. They let chemists work out how much of a chemical you need to make a certain amount of a product.

For example, when you heat calcium carbonate ($CaCO_3$), it breaks down into calcium oxide (CaO) and carbon dioxide (CO_2).

$$CaCO_3 \rightarrow CaO + CO_2$$

The equation shows that you need one mole of $CaCO_3$ to make one mole of CaO.

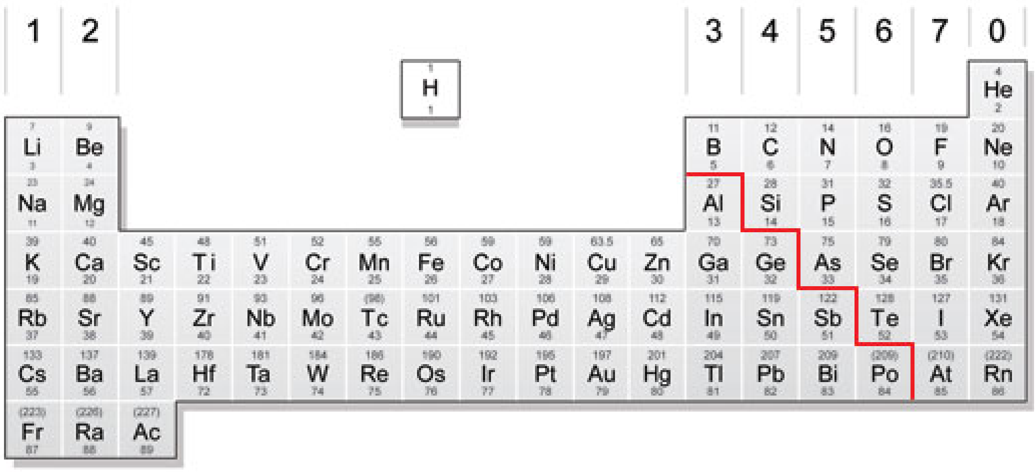
And, when methane gas burns….

$$CH_4 + 2O_2 \rightarrow 2H_2O + CO_2$$

...you need 2 moles of oxygen to burn one mole of methane.

But you can't just count out the number of methane and oxygen molecules. It would take ridiculously long. Instead chemists usually weigh the substance. You need 16g of methane for a mole. 32g of O_2 is one mole, but you need 2 moles for the reaction above, so 64g of oxygen.

You can calculate the mass you need to have a mole of a substance using the periodic table. The table shows you the mass of one mole of any atom. Carbon is 12g for one mole. Hydrogen is 1g for a mole.



For molecules, you have to add together the mass of the atoms in it. CaO is 20g + 18g = 38g for a mole. CH_4 is 12g plus 4 lots of 1g so 16g for a mole. An O_2 molecule is two oxygen atoms bonded, so one mole of oxygen is 16g + 16g = 32g.

Back to burning methane:

$$CH_4 + 2O_2 \rightarrow 2H_2O + CO_2$$

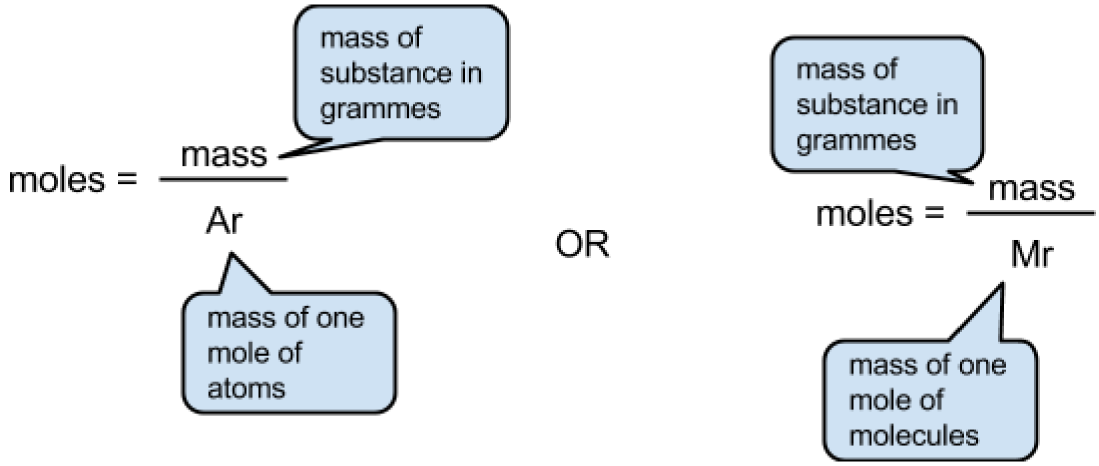
You need 64g of oxygen to react with 16g of methane.

The number of items in a mole (6.022×10^{23}) is called Avogadro's number even though it wasn't discovered by Avogadro.

Avogadro's number is defined as the number of atoms in 12 grammes of carbon. Unfortunately it turns out you need to have the right type of carbon, so we now say Avogadro's number is the number of atoms in 12g of carbon-12.

Instructions

The basic mole equation is:



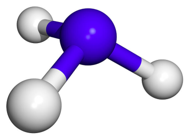
These are the same equation, but Ar is for atoms (just look on the periodic table) and Mr is for molecules (you have to add the masses of the atoms in the molecule together).

Example 1:

You have 16g of helium. Ar is 4g (check on the periodic table).

$$moles \;=\; mass \;\div Ar \;=\; 16 \;\div 4 \;=\; 4 \; moles$$

Example 2:



You have 34g of ammonia (NH_3). Mr is 14 +1 +1 +1 = 17g

$$moles \;=\; mass \;\div Mr \;=\; 17 \;\div 34 \;=\; 0.5 \; moles$$

There are several other equations for working out moles that you can find in a text book. The first one was about volumes of gases and was Avogadro's work, which is why the number is named after him.

Moles are used all the time for calculating amounts. You could calculate the same thing one atom or molecule at a time, but you would never get far. Avogadro's number is far more sensible in real life.