**THE MOLE**

When chemists manufacture a substance they need to be able to calculate the amounts of reactants and products involved.

When we refer to amount we mean **the number of particles in a substance** (particles could be atoms, molecules, ions or electrons).

The amount of substance is measured in **MOLES**.

The mole can be thought of as a counting unit used by chemists.  You will have come across some other counting units such as:

Pair      =       2             things/entities

Dozen  =                      things/ entities

Score   =                      things/ entities

Gross   =                      things/ entities

Mole = things/ entities

**Definition**:

**1 mole is the amount of substance which contains as many particles as there are atoms in exactly 12g of carbon-12**.

**1 mole** of any substance **contains 6.022 x 1023 particles**.

This number is called the **Avogadro Number** or **Avogadro Constant**. It has the symbol **L**, and units, **mol-1**.

Even though a mole of any substance has the **same number of particles** as a mole of another substance, since atoms have different masses a mole of any one substance has a **different mass** to a mole of another substance.

**Weighing out the Ar of an element in grams gives 1 mole of atoms**.

**Similarly, the Mr of a compound in grams gives 1 mole of entities**.

So, 12g of C contains 6.022x1023 atoms of C (1 mol)

                  63.5g of Cu contains 6.022x1023 atoms of Cu (1 mol)

                  14g of N contains 6.022x1023 atoms of N (1 mol)

                  28g of N2 contains 6.022x1023 molecules of N2 (1 mol)

**Exercise**

Give the mass of:

1. 1 mol S atoms
2. 1 mol Cl2 molecules
3. 1 mol Fe atoms

**Molar Mass**

This is **the mass of 1 mole of a substance**. It has the symbol **M**, units **g mol-1**.

It is used with elements, molecules and ionic compounds.

It is equal to the relative mass (Ar or Mr) expressed in grams.

So, the molar mass of water, H2O is 2 x 1 + 16 = 18g mol-1.

This means 1 mole of water has a mass of 18 grams.

Chemists use moles to measure out reactants, or calculate the mass of product of a reaction.

The number of moles of a substance in a given mass of substance can be calculated if the chemical formula is known.

For **pure solid and liquid** elements and compounds the formula below is used:

  **mass/g**

 **number of moles = —————————**

 **molar mass/gmol-1**

**Worked Examples**

1. How many moles of Ca are there in 120g of Ca?

Ar Ca = 40, therefore M Ca = 40gmol-1

           120g

number of moles  =     ————     =   3.0 mol

       40gmol-1

1. What mass of NaCl contains 10 moles of NaCl?

To calculate a mass we need to rearrange the formula above.

**mass = number of moles x molar mass**

Mr NaCl = 23 + 35.5 = 58.5, therefore M NaCl = 58.5 gmol-1

mass  =  10 mol x 58.5 gmol-1     =   585g

**Questions**

1. How many moles of each substance are contained in the following?

(i) 69g Pb

(ii) 70g Fe

(iii) 5.30g Na2CO3

1. Calculate the mass of:

(i) 0.013 mol Cl

(ii) 3.00 mol Mg

(iii) 2.00 mol SO3

# Exercise          Complete the following table

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Compound** | **Formula** | **molar mass /g mol1** | **Number of moles** | **Mass of compound /g** |
| **Water** | H2O | 18 | 1 | 18 g |
| **Ammonia** | NH3 |  | 1 |  |
| **Carbon dioxide** |  |  | 0.5 |  |
| **Methane** | CH4 |  |  | 64 g |
| **Methanol** | CH3OH |  |  | 16g |
| **Hydrogen bromide** | HBr |  |  | 161.8g |
| **Ethanol** | C2H5OH |  | 1.5 |  |