

## Topic 3 – Moles Revision Notes

### 1. Moles

- In Chemistry, amounts are measured in moles
- A mole contains  $6.02 \times 10^{23}$  particles. Particles can be atoms, molecules, ions or electrons
- For a solution, moles = concentration x volume/1000 (volume in  $\text{cm}^3$ )

### 2. Reacting Mass Calculations

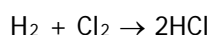
Step 1 - Find the number of moles of the thing you are told about

Step 2 – Use the equation to find out the moles of the thing you are asked about.

Step 3 – Find the mass of the thing you are asked about.

#### Example

Work out the mass of HCl formed from 6.0g of hydrogen



Step 1: Moles  $\text{H}_2 = 6.0 \div 2.0 = 3.0$  (mass  $\div$  molar mass)

Step 2: Moles HCl =  $3.0 \times 2/1$  (from equation) = 6.0

Step 3: Mass HCl =  $6.0 \times \text{molar mass} = 6 \times 36.5 = 219\text{g}$  (moles x molar mass)

### 3. Titration Calculations

- Concentration is usually measured in moles of solute per cubic decimetre of solution,  **$\text{mol dm}^{-3}$**
- A cubic decimetre,  $1\text{dm}^3$ , has the same volume as a litre i.e.  $1000\text{cm}^3$
- The volume of a solution is often measured in  $\text{cm}^3$ . This needs to be converted to  $\text{dm}^3$  by dividing by 1000 before calculating a concentration in  $\text{mol dm}^{-3}$

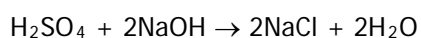
Step 1 - Find the number of moles of the thing you know the concentration and volume of.

Step 2 – Use the equation to find out the moles of the thing you are asked about.

Step 3 – Find the unknown concentration or molar mass

#### Example

$25 \text{ cm}^3$  of NaOH needed  $21.5 \text{ cm}^3$  of  $0.1 \text{ mol dm}^{-3} \text{ H}_2\text{SO}_4$  for neutralisation. Calculate the concentration of the NaOH solution.



Step 1: Moles  $\text{H}_2\text{SO}_4 = 0.1 \times 21.5 \div 1000 = 2.15 \times 10^{-3}$  (conc x vol  $\div$  1000)

Step 2: Moles NaOH =  $2.15 \times 10^{-3} \times 2$  (from equation) =  $4.30 \times 10^{-3}$

Step 3: Conc NaOH =  $4.30 \times 10^{-3} \div (25 \div 1000) = 0.172 \text{ mol dm}^{-3}$  (moles  $\div$  volume in  $\text{dm}^3$ )

#### 4. Ideal Gas Equation

The ideal gas equation is:

$$PV = nRT$$

Where: P = pressure in Pa

V = volume in m<sup>3</sup> (1 m<sup>3</sup> = 10<sup>3</sup> dm<sup>3</sup> = 10<sup>6</sup> cm<sup>3</sup>)

n = number of moles

R = gas constant (8.31 J K<sup>-1</sup> mol<sup>-1</sup>)

T = Kelvin temperature (°C + 273)

##### Example

0.166 mol of oxygen is in a sealed container whose volume is 1725 cm<sup>3</sup>. The temperature is 300 K. Calculate the pressure of the oxygen inside the container.  
(The gas constant R = 8.31 J K<sup>-1</sup> mol<sup>-1</sup>)

$$\begin{aligned} PV &= nRT \\ P &= nRT/V \end{aligned}$$

T has correct units but V is in cm<sup>3</sup> rather than m<sup>3</sup>

$$\begin{aligned} 1725 \text{ cm}^3 &= 1725 \times 10^{-6} \text{ m}^3 \\ &= 1.725 \times 10^{-3} \text{ m}^3 \end{aligned}$$

$$\begin{aligned} P &= 0.166 \times 8.31 \times 300 / (1.725 \times 10^{-3}) \\ &= 239906 \text{ Pa} \\ &= 240 \text{ kPa} \end{aligned}$$

For a fixed number of moles of gas, the ideal gas equation reduces to:

$$P_1V_1/T_1 = P_2V_2/T_2$$

This version can be used to calculate the effect of changes in P, V or T on such a sample.

The ideal gas equation can be combined with  $n = m/M_r$  or with  $\rho$  (density) =  $m/V$

$$PV = mRT/M_r$$

$$P = \rho RT/M_r$$

If these versions are used, mass must be in grams and density in g m<sup>-3</sup>

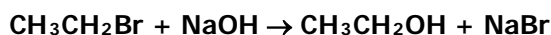
### 5) Percentage yield

- Most organic reactions do not give 100% conversion of reactant to product
- Reasons for this include the fact that most organic reactions are reversible, there may be side products and there will be loss of the desired product during purification

$$\% \text{ yield} = \frac{\text{Actual moles of product}}{\text{Possible moles of product}} \times 100\%$$

#### Example

In the following reaction, 2.18g of bromoethane produce 0.75g of ethanol. Calculate the percentage yield.



Moles of reactant (bromoethane)	= mass/molar mass
	= 2.18/109
	= 0.020 mol
Possible moles of ethanol	= 0.020 mol (from equation)
Actual moles of ethanol	= 0.75/46.0
	= 0.0163 mol
Percentage yield	= 0.0163/0.020 x 100%
	= 82%

### 6) Ionic equations

- Ionic equations leave out ions that are unchanged in a reaction. They give a clearer picture of what is happening in a reaction
- To go from a symbol equation to an ionic equation:
  - Split up anything that is (aq) and ionic (acids, alkalis and salts)
  - Cancel ions that are on both sides

#### Example

