EDEXCEL TOPIC 5: Separate Chemistry 2

Quantitative analysis

Balanced symbol equations

Represent chemical reactions and have the same number of atoms of each element on both sides of the equation

$H_2 + Cl_2 \rightarrow 2HCl$

Subscript — Normal script

Subscript numbers show the number of atoms of the element to its left.

Normal script numbers show the number of molecules.

Molar volume of gas (HT)

The volume of one mole of any gas at room temperature and pressure (20°C and 1 atmospheric pressure) is 24cm³

Number of moles = $\frac{\text{mass}}{\text{relative formula mass}}$

Avogadro constant

One mole of any substance will contain the same number of particles, atoms, molecules or ions.

6.02×10^{23} per mole

One mole of H_2O will contain 6.02×10^{23} molecules
One mole of NaCl will contain 6.02×10^{23} Na^+ ions

Number of moles = $\frac{\text{mass (g)}}{A_r}$ or $\frac{\text{mass (g)}}{M_r}$

How many moles of sulfuric acid molecules are there in 4.7g of sulfuric acid (H_2SO_4)?
Give your answer to 1 significant figure.

$\frac{4.7}{98} = 0.05$ mol ← (M_r of H_2SO_4)

Concentration of solutions

Measured in mass per given volume of solution (g/dm³)	*Conc. = $\frac{\text{mass (g)}}{\text{volume (dm}^3\text{)}}$*	HT only Greater mass = higher concentration. Greater volume = lower concentration.

The balancing numbers in a symbol equation can be calculated from the masses of reactants and products

Convert the masses in grams to amounts in moles and convert the number of moles to simple whole number ratios.

Chemical equations show the number of moles reacting and the number of moles made

$Mg + 2HCl \rightarrow MgCl_2 + H_2$

One mole of magnesium reacts with two moles of hydrochloric acid to make one mole of magnesium chloride and one mole of hydrogen

If you have a 60g of Mg, what mass of HCl do you need to convert it to $MgCl_2$?

A_r : Mg =24 so mass of 1 mole of Mg = 24g
M_r : HCl (1 + 35.5) so mass of 1 mole of HCl = 36.5g

So 60g of Mg is 60/24 = 2.5 moles

Balanced symbol equation tells us that for every one mole of Mg, you need two moles of HCl to react with it.

So you need 2.5x2 = 5 moles of HCl

You will need 5 x 36.5g of HCl= 182.5g

Atom economy

Atom economy

Calculate the atom economy for making hydrogen by reacting zinc with hydrochloric acid:

$Zn + 2HCL \rightarrow ZnCl_2 + H_2$

M_r of H_2 = 1 + 1 = 2
M_r of Zn + 2HCl = 65 + 1 + 1 + 35.5 + 35.5 = 138

Atom economy = $\frac{2}{138} \times 100$
= $\frac{2}{138} \times 100$ = 1.45%
This method is unlikely to be chosen as it has a low atom economy.

Percentage yield

Percentage yield = $\frac{\text{actual yield}}{\text{theoretical yield}}$

x 100 (when as a percentage)

It is not always possible to obtain the calculated amount of product because:
- Incomplete reactions (due to being reversible)
- Some product may be lost
- Some of the reactants may react in unexpected ways

Atom economy = $\frac{\text{Relative formula mass of desired product from equation}}{\text{Sum of relative formula mass of all reactants from equation}} \times 100$

A measure of the amount of starting materials that end up as useful products

High atom economy is important or sustainable development and economic reasons

Fuel cells

Fuel cells

Produces a voltage

Until one of the reactants is used up.

Hydrogen fuel cells

Word equation:

hydrogen + oxygen → water

Symbol equation:

$2H_2 + O_2 \rightarrow 2H_2O$

Advantages:
- No pollutants produced
- Can be a range of sizes

Disadvantages:
- Hydrogen is highly flammable
- Hydrogen is difficult to store