# Edexcel IAL Chemistry A-Level

## Topic 1 - Formulae, Equations and Amount of Substance

Flashcards

# What is an atom?

# What is an atom?

The smallest particle of a chemical element.

# What is an element?

# What is an element?

An element contains only one type of atom.

# What is an ion?

# What is an ion?

An atom or a group of atoms that are charged due to the gain or loss of at least one electron.

# What is a molecule?

# What is a molecule?

Molecules are made up of at least two atoms chemically bonded together.

# What is a compound?

# What is a compound?

Compounds are molecules which contain different elements, so they are made up of different types of atoms.

# Define empirical formula

# Define empirical formula

The simplest whole number ratio of atoms of each element in a compound.

# Define molecular formula

# Define molecular formula

The actual number of atoms of each element present in a compound.

What is the empirical formula of $Fe_2O_4$?

What is the empirical formula for $Fe_2O_4$?

$FeO_2$

A molecule has the empirical formula $C_4H_3O_2$ and a relative molecular mass of 166. What is the molecular formula?

# A molecule has the empirical formula $C_4H_3O_2$ and a relative molecular mass of 166. What is the molecular formula?

Empirical mass = 4(12) + 3(1) + 2(16) = 83

Relative molecular mass = 166

Compare molecular mass with empirical mass = 166 / 83 = 2

So the molecular formula is double the empirical formula: $C_8H_6O_2$

# What is the unit for amount of substance?

# What is the unit for amount of substance?

The mole (mol)

# Define the term mole

# Define the term mole

The amount of any substance containing the same number of particles as there are atoms in exactly 12 g of carbon-12.

# Define the Avogadro constant

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The number of particles in one mole of a substance. This is $6.02 \times 10^{23}$ particles.

# What is the equation linking Avogadro's constant to moles?

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Number of particles/atoms/ions =

Moles x Avogadro's constant

There are $4.816 \times 10^{24}$ atoms of iron in a sample. How many moles of iron are in the sample?

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$N_A = 6.02 \times 10^{23}$ $mol^{-1}$

Moles = number of atoms ÷ Avogadro's constant

$= (4.816 \times 10^{24}) \div (6.02 \times 10^{23})$

= 8 mol of Fe

# What do each of the different state symbols mean?

# What do each of the different state symbols mean?

(g) = gas

(aq) = aqueous

(s) = solid

(l) = liquid

# What is an ionic equation?

# What is an ionic equation?

Ionic equations only show the reacting ions and can be written for any reaction involving ions in solution. The ions not included are called spectator ions.

E.g. $Ag^+_{(aq)} + Cl^-_{(aq)} \rightarrow AgCl_{(s)}$

# Define relative atomic mass

# Define relative atomic mass

The weighted average mass of an atom of an element compared to 1/12th of the mass of an atom of carbon-12.

# Define relative formula mass

# Define relative formula mass

The sum of the relative atomic masses of atoms in a formula unit. Used for giant ionic structures.

# Define relative molecular mass

# Define relative molecular mass

The sum of the relative atomic masses of atoms in a molecule.

# Define molar mass

# Define molar mass

The mass per mole of a substance, measured in g $mol^{-1}$.

# Define ppm

# Define ppm

Parts per million:

The ratio of one gas to another.

# What is 1 ppm equivalent to in terms of mass and volume?

What is 1 ppm equivalent to in terms of mass and volume?

- For mass/volume concentrations:

$1\ ppm = 1\ g\ m^{-3} = 1\ mg\ L^{-1} = 1\ \mu g\ cm^{-3}$

- For mass/mass concentrations:

$1\ ppm = 1\ mg\ kg^{-1} = 1\ \mu g\ g^{-1}$

What is 2 mg $cm^{-3}$ equivalent to in ppm?

# What is 2 mg $cm^{-3}$ equivalent to in ppm?

Convert mg to µg:

2 mg $cm^{-3}$ = 2 x $10^3$ µg $cm^{-3}$

1 ppm = 1 µg $cm^{-3}$

So 2000 µg $cm^{-3}$ = 2000 ppm

What is 0.75 g $kg^{-1}$ equivalent to in ppm?

# What is 0.75 g $kg^{-1}$ equivalent to in ppm?

Convert g to mg:

0.75 g $kg^{-1}$ =0.75 x $10^3$ mg $kg^{-1}$

1 ppm = 1 mg $kg^{-1}$

So 0.75 x $10^3$ mg $kg^{-1}$ = 750 ppm

# Define concentration

# Define concentration

Concentration is the amount of solute dissolved per $dm^3$ of solution.

How can concentration be calculated in g $dm^{-3}$?

# How can concentration be calculated in g $dm^{-3}$?

Concentration (g $dm^{-3}$) =

Mass (g) / Volume ($dm^3$)

How can concentration be calculated in mol $dm^{-3}$?

# How can concentration be calculated in mol $dm^{-3}$?

Concentration =

Moles / Volume ($dm^3$)

What can you deduce about the number of moles of each reactant/product from a chemical equation like the one below?

$$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$$

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$$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$$

We can see from this equation that the ratio of propane to water is 1:4, hence for every one mole of propane that reacts, 4 moles of water is produced.

# How do you calculate the number of moles of a given substance using the mass and molecular mass?

How do you calculate the number of moles of a given substance using the mass and molecular mass?

Number of moles =

Mass ÷ Relative Molecular Mass

What is the molar volume of any gas at room temperature and pressure?

What is the molar volume of any gas at room temperature and pressure?

$24\ dm^3$

# What is RTP?

# What is RTP?

## Room temperature and pressure:

- 20ºC
- 1 atmosphere

# What equation links molar volume at RTP and moles?

What equation links molar volume at RTP and moles?

Volume of gas at RTP ($dm^3$) = moles x 24

How many moles of oxygen are in 72 $dm^3$ at RTP?

How many moles of oxygen are in 72 $dm^3$ at RTP?

Moles = volume / 24

= 72 / 24

= 3 moles

# What is the ideal gas law formula?

# What is the ideal gas law formula?

$$PV = nRT$$

P - pressure (Pa)

V - volume ($m^3$)

n - number of moles

R - gas constant (8.31 J $K^{-1}mol^{-1}$)

T - temperature (K)

At a temperature of 55.0 $^{o}$C and a pressure of 275 kPa, a gas occupies a volume of 1.10 $dm^3$. How many moles of the gas are present? The gas constant is 8.31 J $K^{-1}mol^{-1}$.

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**PV = nRT**

- 275 kPa in Pa is 275000 Pa
- 55.0 $^{o}$C in K is 328 K
- 1.10 $dm^3$ is 0.001 $m^3$

n=(PV)/(RT)

n=(275000 x 0.001)/(8.31 x 328)

n= 0.10 moles

# How can percentage yield be calculated?

# How can percentage yield be calculated?

Percentage yield =

(Actual yield ÷ Theoretical yield) x 100

What is the percentage yield of $NH_3$ if 40.5 g of $NH_3$ is produced from 20.0 mol $H_2$ and excess $N_2$?

What is the percentage yield of $NH_3$ if 40.5 g of $NH_3$ is produced from 20.0 mol $H_2$ and excess $N_2$?

Equation: $N_2 + 3H_2 \rightarrow 2NH_3$

Moles of ammonia = 20/1.5 = 13.3 moles

Mass of ammonia = 13.3 x (14+1+1+1) = 227 g

Percentage yield = (40.5/227) x 100 = 17.9%

# Why might the actual yield of product be less than expected?

# Why might the actual yield of product be less than expected?

- Incomplete reaction
- Unwanted side reactions
- Practical losses, for example some solid may get lost when being transferred between beakers

# What is the atom economy of a reaction?

# What is the atom economy of a reaction?

Atom economy is a measure of the efficiency of the reaction. It looks at the amount of reactants that get turned into useful products.

# How can atom economy be calculated?

# How can atom economy be calculated?

Atom economy=

(Molar mass of desired product ÷ total molar mass of products) x 100

Fill in the gap: ‘The _____ the atom economy, the more sustainable and efficient the process’

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Higher

# What are displacement reactions?

# What are displacement reactions?

A displacement reaction occurs when one element replaces another element in a compound.

$$A + BC \rightarrow B + AC$$

Write the chemical equation for the reaction that takes place between bromine and potassium iodide

Write the chemical equation for the reaction that takes place between bromine and potassium iodide

$$Br_2 + 2KI \rightarrow I_2 + 2KBr$$

# What are the general products when an acid reacts with a metal?

What are the general products when an acid reacts with a metal?

Salt and hydrogen

$$\text{Acid} + \text{metal} \rightarrow \text{salt} + \text{hydrogen}$$

# What are the general products when an acid reacts with a metal carbonate?

What are the general products when an acid reacts with a metal carbonate?

Salt, water and carbon dioxide

Acid + metal carbonate → salt + water + carbon dioxide

# What are the general products when an acid reacts with a metal oxide?

What are the general products when an acid reacts with a metal oxide?

Salt and water

$$\text{Acid} + \text{metal oxide} \rightarrow \text{salt} + \text{water}$$

What is the chemical equation for the reaction that takes place between hydrochloric acid and sodium?

What is the chemical equation for the reaction that takes place between hydrochloric acid and sodium?

$$2HCl + 2Na \rightarrow 2NaCl + H_2$$

What is the chemical equation for the reaction that takes place between sulfuric acid and magnesium oxide?

What is the chemical equation for the reaction that takes place between sulfuric acid and magnesium oxide?

$$H_2SO_4 + MgO \rightarrow MgSO_4 + H_2O$$

# What are precipitation reactions?

# What are precipitation reactions?

Precipitation reactions are reactions between two soluble salts which form an insoluble salt - the precipitate.