

Topic 1a – Atomic Structure Revision Notes

1) Fundamental particles

- Atoms consist of protons, neutrons and electrons
- Protons and neutrons are found in the nucleus which contains most of the mass of the atom and all of the positive charge
- The neutrons help to reduce repulsion between the positively charged protons
- The electrons are arranged in energy levels (shells) around the nucleus
- The electron arrangement of an element determines its chemical properties i.e. what reactions it does

	Relative mass	Relative charge
Proton	1	+1
Neutron	1	0
Electron	1/2000	-1

2) Mass number and isotopes

- Atomic number = number of protons in the nucleus
- Mass number = number of protons and neutrons in the nucleus
- Number of neutrons = mass number – atomic number
- Number of electrons = number of protons (in a neutral atom)

9	Mass number = 9	Atomic number = 4
Be		
4	4 protons, 5 neutrons, 4 electrons	

3) Isotopes

- Isotopes have the same number of protons but different numbers of neutrons
- For example, chlorine has two isotopes ^{35}Cl and ^{37}Cl . Both have 17 protons but they have 18 and 20 neutrons, respectively
- Isotopes of an element have the same chemical properties because they have the same electron arrangement
- Isotopes of an element may have different physical properties, such as rate of diffusion, because they have different masses

4) Ions

- Ions are formed when atoms gain or lose electrons
- As an atom Cl has 17 electrons. A Cl^- ion has gained one electron so it now has 18
- As an atom Na has 11 electrons. An Na^+ ion has lost one electron so it now has 10
- Early models of atomic structure predicted that atoms and ions with noble gas electron arrangements should be stable e.g. Cl^- has the same electron arrangement as argon and Na^+ has the same electron arrangement as neon

Topic 1b – Formulae & Equations

Revision Notes

1) Formulae

a) Elements

- For most elements the formula is just the symbol e.g. Na for sodium, S for sulphur
- The exceptions are the seven diatomic elements – H₂, N₂, O₂, F₂, Cl₂, Br₂ and I₂

b) Ionic compounds

- Compounds of a metal and a non-metal are made of ions.
- Metal ions have a positive charge and non-metal ions have a negative charge.
- To work out the formula of an ionic compound
 - Write the formulae of the ions
 - Adjust the number of each ion so that there is no overall charge

Example 1 – magnesium bromide

Ions are Mg²⁺ and Br⁻
Need 2 x Br⁻ to balance Mg²⁺
Formula is MgBr₂

Example 2 – aluminium nitrate

Ions are Al³⁺ and NO₃⁻
Need 3 x NO₃⁻ to balance Al³⁺
Formula is Al(NO₃)₃

- The formulae for ions are given on the attached sheet. This sheet is not available in exams so the formulae will have to be learnt.

c) Covalent compounds

- Some formulae for covalent compounds can be worked out from the name.
- The prefix mono- means one, di- means two and tri- means three.
- Therefore, carbon monoxide is CO, silicon dioxide is SiO₂ and sulphur trioxide is SO₃
- Other formulae have to be learnt e.g. ammonia is NH₃ and methane is CH₄

2) Equations

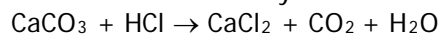
- **There are no word equations at A-level. An equation means a balanced symbol equation.**
- To write a balanced symbol equation:
 - Identify the reactants and products
 - Write a word equation
 - Write down the formula for each substance
 - Balance the equation by putting numbers in front of formulae
 - Add state symbols (s), (l), (g) or (aq)

Example – marble chips and hydrochloric acid

Reactants are calcium carbonate and hydrochloric acid

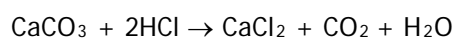
Products are calcium chloride, carbon dioxide and water

Calcium carbonate + hydrochloric acid → calcium chloride + carbon dioxide + water

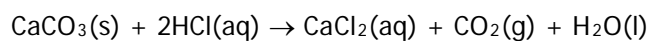


Ca	1	1
C	1	1
O	3	3
H	1	2
Cl	1	2

2 in front of HCl balances the equation



Adding state symbols



Topic 1c – Calculations Revision Notes

1. Molar Mass

- Molar mass is calculated by adding up the masses of the atoms in the formula
- The percentage of the total made up by a particular element can also be calculated

Example - sodium carbonate, Na₂CO₃

Na	2 x 23.0	= 46.0
C	1 x 12.0	= 12.0
O	3 x 16.0	= 48.0
Total		= 106.0
% by mass of oxygen		= 48.0 x 100/106.0 = 45.3%

2. Empirical & Molecular Formulae

- Write down mass or % of each element
- Divide each one by the atomic mass of that element
- Find the ratio of the numbers (divide them all by the smallest one)

In a substance containing only sodium, sulphur and oxygen, the composition is found to be 32.4% sodium and 45.0% oxygen. Calculate the substance's empirical formula.

$$\begin{aligned}\% \text{ sulphur} &= 100 - 32.4 - 45.0 \\ &= 22.6\%\end{aligned}$$

	Na	S	O
Composition	32.4	22.6	45.0
R.a.m.	23.0	32.1	16.0
Comp/r.a.m.	1.41	0.70	2.81
÷ by smallest	2.01	1	4.01

Empirical formula is Na₂SO₄

- Molecular formula is a multiple of empirical formula

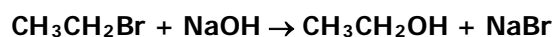
Empirical formula = CH₂O & M_r = 60. Find molecular formula.
 Empirical mass = 30 so molecular formula = 2 x empirical formula = C₂H₄O₂

3) Atom economy

$$\text{Atom economy} = \frac{\text{Molecular mass of desired product}}{\text{Molecular masses of all products}} \times 100\%$$

Example

Bromoethane, CH₃CH₂Br, reacts with sodium hydroxide to produce ethanol, CH₃CH₂OH.



In the above example

Molecular mass of desired product	= 46.0
Molecular masses of all products	= 46.0 + 102.9
	= 148.9
 Atom economy	 = 46.0/148.9 x 100%
	= 30.9%

- Chemical processes with a high atom economy produce fewer waste materials
- Atom economy can be improved by finding a use for waste product