Module: 1 Topic: 9C2 Atoms & how they go together

Lesson: 1-2 (C1.2.1 Atomic Structure)

Keywords:
Elements, atom, molecule, subatomic particles, protons, neutrons, nucleus, electrons, shells, relative

Math Skills:
Unit conversions and comparing relative quantities:
Mass of a proton 1.673×10^{-27} kg
Mass of a neutron 1.675×10^{-27} kg
Mass of the atom $\sim 10^{-23}$ g and 10^{-21} g

Nucleus radius $\sim 10^{-15}$ m and 10^{-14} m
Atomic radius $\sim 10^{-10}$ m

Minimum Knowledge

Subatomic particle	Relative mass	Relative charge
proton	1	+1
neutron	1	0
electron	0.0005	-1

- Inside of an atom is mostly empty space, but it does contain three even smaller **subatomic particles**
- Protons and neutrons, joined as the nucleus at the centre
- Electrons surrounding the nucleus in shells

Lesson: 3-4 (C3.1.1 Formulae of Elements and Molecules)

Keywords:
Chemical symbols, formulae, diatomic molecules, molecular formula, molecule, compounds, models

Minimum Knowledge
How do you write the formulae of metal elements? Each chemical symbol:
- has one, two, or three letters
- Starts with a capital letter, with any other letters in lowercase
- E.g. Mercury has the symbol Hg. It is not HG, hg, or hG
- Written as empirical formulae (shows the simplest whole number ratio of each type of atom)

How do you write the formulae of non-metal elements?
- Group 0 exist as individual atoms, attracted to each other by *weak intermolecular forces*. Therefore, their formulae are the same as their chemical symbol
- E.g. Helium is He and not He_2
- Group 7 exist as diatomic molecules (contains two atoms covalently bonded), attracted to each other by *weak intermolecular forces*. All have a subscript 2 in them.
- Seven diatomic molecules:
  - Not in Group 7: hydrogen, nitrogen, oxygen,
  - In Group 7: fluorine, chlorine, bromine, iodine
- E.g. H_2, N_2, O_2, F_2, Cl_2, Br_2, I_2

Lesson: 5-6 (C2.1.1 Relative Formula Mass)

Keywords:
Relative Atomic Mass (A_r), Chemical Formula, Relative Formula Mass (M_r), molar masses, Periodic Table, relative

Math Skills:
Step 1) Write down the A_r values of the elements in the compound.
Step 2) Work out the number of atoms of each element from the compounds chemical formula.
Step 3) Multiply these values to calculate (add up) the relative formula mass.

Lesson: 7-8 (C2.1.2 Empirical Formula)

Keywords:
Empirical formula, balanced chemical equation, chemical formula, molecular formula, displayed formula or a molecular diagram

Equations:
Step 1) Find the highest common factor for all the element numbers present.
Step 2) Divide the chemical formula by the highest common factor.

Example:
Calculating Relative Formula Mass (M_r) of **Mg(OH)$_2$**.
1) From the Periodic Table: **Mg** = 24.3, **O** = 16.0, **H** = 1.0
2) How many atoms of each atom in the molecule: **Mg** x1, **O** x2, **H** x2
3) Calculate: **Mr of Mg(OH)$_2$** = (1 x 24.3) + (2 x 16.0) + (2 x 1.0)
$$= 24.3 + 32.0 + 2.0$$
$$= \underline{58.3}$$

Minimum Knowledge
Relative atomic mass (A_r), is the mean mass of an atom of an element compared to   the mass of a Carbon-12) atom.
- less mass than a carbon-12 atom if its A_r, is below 12.0
- more mass than a carbon-12 atom if its A_r, is above 12.0

Chemical formula of a substance tells you the number of each type of atom, in a unit of that substance.
- E.g. H_2O, the chemical formula of water. Tells us each molecule of water has two hydrogen and one oxygen joined together.

Reminders:
- If a larger number is in front, multiply the entire molecule.
- If a subscript number is after a particular symbol, this shows you that number of those atoms in that molecule.
- If symbols are within brackets, the number in subscript after a bracket tells you there are a certain number times the number of each atom inside the brackets.

Example:
Calculating the empirical formula for: **C$_4$H$_{10}$**
1) C = 4   (Factors of 4 = 1, 2),
   H = 10 (Factors of 10 = 1, 2, 5).
   So, the highest common factor is 2.
2) C = 4/2 = 2   H = 10/2 = 5
3) So, the empirical formula is: **C$_2$H$_5$**

Minimum Knowledge
- Empirical formula is the simplest way of writing a molecule
- Tells you the ratio between elements
- Involves finding greatest common factor
- Example: C_4H_{10}

Lesson: 9 (C2.2.2 Electronic Structures)
Keywords: electronic structure, period, group
Minimum Knowledge
Within the Periodic Table:
- a **period** is a horizontal **row** (the number represents another full shell of electrons)
- a **group** is a vertical **column** (the number corresponds to the number of electrons it has in its outer shell).
  - E.g. Group 1 elements have 1 outer shell electron, Group 7 has 7, etc.

For the first 20 elements, electron shells follow some rules:
1) Electrons occupy shells (sometimes called energy levels)
2) The lowest energy levels are always filled first
3) Only a certain number of electrons are allowed in each shell: 2 on the 1st, 8 on the 2nd, and 8 on the 3rd shell

Lesson: 10 (C2.2.3 Forming Ions)
Keywords:
sharing electrons, ions, ionic bonding, covalent bonding
Minimum Knowledge
Atoms become ions when they gain or lose electrons to or from their outer shell in order to fill their outer shell.
- Recall that atoms have an equal amount of positive and negative charges.
- When atoms gain electrons, they become negative ions (anions)
- When atoms lose electrons, they become positive ions (cations)

Ions form a closely packed regular lattice with strong electrostatic forces of attraction between oppositely charged ions, in all directions.