

# OCR (A) Chemistry A-Level

## Module 2 - Foundations in Chemistry Definitions and Concepts



# Definitions and Concepts for OCR (A) Chemistry A-level

## Module 2 - Foundations in Chemistry

### 2.1.1 - Atomic Structure and Isotopes and 2.1.2 - Compounds, Formulae and Equations

**Atomic Number:** the number of protons in the nucleus of an atom.

**Bohr Model:** describes an atom as a small dense nucleus with electrons orbiting around the nucleus. This model explains different periodic properties of atoms.

**Electron:** a negatively charged subatomic particle which orbits the nucleus at various energy levels. The relative mass of an electron is  $1/1836$ .

**Ion:** a charged atom or molecule.

**Isotopes:** atoms of the same element with the same number of protons and electrons but different numbers of neutrons. Isotopes of an element have different masses.

**Mass Number:** the total number of protons and neutrons in the nucleus of an atom.

**Mass Spectrometry:** an instrument which gives accurate information about relative isotopic mass and the relative abundance of isotopes.

**Neutron:** a neutral subatomic particle found in the nucleus of an atom. The relative mass of a neutron is 1.

**Proton:** a positively charged subatomic particle found in the nucleus of an atom. The relative mass of a proton is 1.

**Relative Abundance:** the amount of one substance compared with another.

**Relative Atomic Mass:** the weighted mean mass of an atom compared with  $1/12$ th mass of an atom of carbon-12.

**Relative Isotopic Mass:** the mass of an atom of an isotope compared with  $1/12$ th mass of an atom of carbon-12.

**Relative Formula Mass:** the mass of the formula unit of a compound with a giant structure. For example, NaCl has a relative formula mass of  $58.44 \text{ g mol}^{-1}$ .

**Relative Molecular Mass ( $M_r$ ):** the mass of a simple molecule.



**Ammonium ion:** an ion with the formula  $\text{NH}_4^+$ .

**Carbonate:** an ion with the formula  $\text{CO}_3^{2-}$ .

**Hydroxide:** an ion with the formula  $\text{OH}^-$ .

**Ionic Compound:** a compound which is made up of oppositely charged ions that are held together by electrostatic forces.

**Nitrate:** an ion with the formula  $\text{NO}_3^-$ .

**Silver ion:** has the formula  $\text{Ag}^+$ .

**State symbols:** symbols within a chemical equation which indicate the state of each compound under the reaction conditions. (g) gaseous, (l) liquid, (s) solid and (aq) aqueous.

**Sulfate:** an ion with the formula  $\text{SO}_4^{2-}$ .

**Zinc ion:** has the formula  $\text{Zn}^{2+}$ .

### **2.1.3 - Amount of Substance**

**Amount of substance:** the quantity that has moles as its units, used as a way of counting atoms. The amount of substance can be calculated using mass ( $n = m/M$ ), gas volumes ( $n = pV/(RT)$ ) or solution volume and concentration ( $n = CV$ ).

**Anhydrous:** a crystalline compound containing no water.

**Atom Economy:** a measure of the amount of starting materials that end up as useful products. A high atom economy means a process is more sustainable as there is less waste produced.

$$\text{Percentage atom economy} = \frac{\text{Molecular mass of desired product}}{\text{Sum of molecular masses of all reactants}} \times 100$$

**Avogadro Constant ( $N_A$ ):** the number of particles per mole of substance ( $6.02 \times 10^{23} \text{ mol}^{-1}$ ).

**Composition by mass:** the relative mass of each element in a compound.

**Empirical Formula:** the simplest whole number ratio of atoms of each element present in a compound.

**Hydrated:** a crystalline compound that contains water.



**Ideal Gas:** a gas which has molecules that occupy negligible space with no interactions between them. The ideal gas equation is:  $pV = nRT$ .

**Molar Gas Volume:** the volume of 1 mole of gas (units:  $\text{dm}^3 \text{mol}^{-1}$ ).

**Molar Mass:** mass per mole of a substance (units:  $\text{g mol}^{-1}$ ).

**Mole (mol):** the amount of any substance containing as many particles as there are carbon atoms in exactly 12g of carbon-12 isotope.

**Molecular Formula:** the number and type of atoms of each element in a molecule.

**Percentage Yield:** the percentage ratio of the actual yield of product from a reaction compared with the theoretical yield.

$$\text{Percentage yield} = \frac{\text{Actual yield}}{\text{Theoretical yield}} \times 100$$

**Relative Molecular Mass:** the average mass of one molecule of an element or compound compared to 1/12th the mass of an atom of carbon-12.

**Stoichiometry:** the relative quantities of substances in a reaction.

**Water of Crystallisation:** water molecules that form part of the crystalline structure of a compound.

## 2.14 - Acids

**Acid:** compounds that release  $\text{H}^+$  ions in aqueous solution. Common acids include:  $\text{HCl}$ ,  $\text{H}_2\text{SO}_4$ ,  $\text{HNO}_3$  and  $\text{CH}_3\text{COOH}$ .

**Alkali:** water soluble bases. Alkalis release  $\text{OH}^-$  ions into aqueous solution. Common alkalis include:  $\text{NaOH}$ ,  $\text{KOH}$  and  $\text{NH}_3$ .

**Base:** a substance that can accept  $\text{H}^+$  ions from another substance.

**Neutralisation:** a reaction between  $\text{H}^+$  and  $\text{OH}^-$ , forming water. This may be a reaction between an acid and a base to form a salt (types of bases include carbonates, metal oxides and alkalis).

**Strong Acid:** an acid that completely dissociates in solution.

**Titration:** a technique used to determine the amount of one solution of a known concentration required to completely react with a known volume of another solution of unknown concentration.



**Weak Acid:** an acid that only partially dissociates in solution.

### 2.1.5 - Redox

**Oxidation:** loss of electrons/ increase in oxidation number.

**Oxidation Number:** a number that represents the number of electrons lost or gained by an atom of an element. A positive oxidation number indicates the loss of electrons. Roman numerals are typically used to indicate the oxidation number of elements that may have different oxidation states (e.g. iron(II) and iron(III)).

**Redox Reaction:** a reaction in which one element is oxidised and another is reduced.

**Reduction:** gain of electrons / decrease in oxidation number.

### 2.2.1 - Electron Structure

**Atomic Orbital:** a region of space around the nucleus that can hold up to 2 electrons with opposite spins. There is 1 orbital in the s subshell, 3 orbitals in the p subshell and 5 orbitals in the d subshell. Orbitals are filled in order of increasing energy, with orbitals of the same energy occupied singly before pairing.

**Electronic Configuration:** the arrangement of electrons into orbitals and energy levels around the nucleus of an atom / ion.

**Energy Level:** the shell that an electron is in.

**Shell:** the orbit that an orbital is in around the nucleus of an atom. The shell closest to the nucleus is the first shell. The outermost shell that is occupied by electrons is the valence shell.

**Sub-shell:** a subdivision of the electronic shells into different orbitals. The types of subshell are s, p, d and f.

### 2.2.2 - Bonding and Structure

**Average bond enthalpy:** the average energy required to break a bond, used as a measurement of the strength of a covalent bond. The average bond enthalpy is measured using a variety of molecules that contain a specific bond.

**Bonding pair:** a pair of outer-shell electrons involved in bonding.



**Covalent bond:** a strong bond formed between 2 atoms due to the electrostatic attraction between a shared pair of electrons and the atomic nuclei.

**Dative Covalent (Coordinate) bond:** a type of covalent bond in which both of the electrons in the shared pair come from one atom.

**Electronegativity:** the ability of an atom to attract bonding electrons in a covalent bond. This is often quantified using Pauling's electronegativity values. Electronegativity increases towards F in the periodic table.

**Electron Pair Repulsion Theory:** pairs of electrons around a nucleus repel each other so the shape that a molecule adopts has these pairs of electrons positioned as far apart as possible. Lone pairs offer more repulsion than bonding pairs as they are closer to the nucleus of the central atom.

**Hydrogen Bonding:** a type of intermolecular bonding that occurs between molecules containing N, O or F and a H atom of -NH, -OH or HF. A lone pair on the electronegative atom (N, O or F) allows the formation of a hydrogen bond.

**Intermolecular Forces:** interactions between different molecules. Types of intermolecular forces including permanent dipole-dipole interactions and induced dipole-dipole interactions (both of these are also known as van der Waals' forces) as well as hydrogen bonding.

**Ionic Bond:** electrostatic attraction between positive and negative ions.

**Ionic Compounds:** compounds made up of oppositely charged ions. These compounds generally have high melting and boiling points. Typically, ionic compounds are soluble and can conduct electricity when liquid or aqueous (but not when solid).

**Ionic Lattice:** a giant structure in which oppositely charged ions are strongly attracted in all directions.

**Linear:** the shape of a molecule in which the central atom has 2 bonding pairs.

**London (Dispersion) Forces:** induced dipole-dipole interactions caused when the random movement of electrons creates a temporary dipole in one molecule which then induces a dipole in a neighbouring molecule.

**Lone Pair:** a pair of outer-shell electrons not involved in bonding.

**Macroscopic Properties:** properties of a bulk material rather than the individual atoms/molecules that make up the material.

**Non-linear:** the shape of a molecule in which the central atom has 2 bonding pairs and 2 lone pairs.

**Octahedral:** the shape of a molecule in which the central atom has 6 bonding pairs.



**Permanent Dipole:** a permanent uneven distribution of charge.

**Polar Bond:** a covalent bond that has a permanent dipole due to the different electronegativities of the atoms that make up the bond.

**Polar Molecule:** a molecule that contains polar bonds with dipoles that don't cancel out due to their direction (must be unsymmetrical).

**Pyramidal:** the shape of a molecule in which the central atom has 3 bonding pairs and 1 lone pair.

**Simple Molecular Lattice:** a solid structure made up of covalently bonded molecules attracted by intermolecular force (e.g.  $I_2$  and ice). These compounds generally have relatively low melting and boiling points and are typically insoluble in water but soluble in organic solvents. Molecular substances don't conduct electricity.

**Tetrahedral:** the shape of a molecule in which the central atom has 4 bonding pairs.

**Trigonal bipyramidal:** the shape of a molecule in which the central atom has 5 bonding pairs.

**Trigonal Planar:** the shape of a molecule in which the central atom has 3 bonding pairs.

