

OCR (B) Chemistry A-level

Storyline 1: Elements of Life

Definitions and Concepts

This work by [PMT Education](https://www.pmt.education) is licensed under [CC BY-NC-ND 4.0](https://creativecommons.org/licenses/by-nc-nd/4.0/)





Definitions and Concepts for OCR (B) Chemistry A-level Elements of Life

Formulae, Equations and Amount of Substance

Ammonium ion: An inorganic ion with the formula NH_4^+ .

Amount of substance: The quantity of a chemical species, measured in moles. Used as a way of counting atoms. The amount of substance can be calculated using:

$$\begin{aligned} \text{Number of moles} &= \text{Mass} \div M_r \\ \text{Number of moles} &= (\text{Pressure} \times \text{Volume}) \div (\text{Gas constant, } R \times \text{Temperature}) \\ \text{Number of moles} &= \text{Concentration} \times \text{Volume} \end{aligned}$$

Atomic number: The number of protons in the nucleus of an atom.

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.

Avogadro constant (NA): The number of particles per mole of a substance ($6.02 \times 10^{23} \text{ mol}^{-1}$).

Carbonate: An ion with the formula CO_3^{2-} .

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

Concentration: The amount of substance per unit volume. Units are given in g/dm^3 or mol/dm^3 .

Electron: A negatively charged subatomic particle that orbits the nucleus at various energy levels. The relative mass of an electron is $1/1840$.

Electronic configuration: The arrangement of electrons into orbitals and energy levels around the nucleus of an atom/ion. E.g. Ca: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$.

Empirical formula: The simplest whole-number ratio of atoms of each element present in a compound.

Energy level: The shell that an electron is in.

Fusion reactions: Lighter nuclei join to give heavier nuclei (under conditions of high temperature and pressure). This is how certain elements are formed.





Hydroxide: An ion with the formula OH^- .

Ion: Particle formed when an atom/molecule loses or gains electrons. This gives it an overall charge - a positive charge if it has lost at least one electron and a negative charge if it has gained at least one electron.

Ionic compound: A compound made up of oppositely charged ions that are held together by electrostatic forces.

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 mass numbers.

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

Molecular formula: Formula which shows the actual number and type of atoms of each element in a molecule.

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

Nitrate: An ion with the formula NO_3^- .

p orbital: A dumbbell-shaped region in which up to two electrons can be found. There are three p orbitals at right angles to each other, so in total, the p subshell can hold up to 6 electrons.

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

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

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

Relative atomic mass: The weighted mean mass of an atom compared with 1/12th 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 g mol^{-1} .

Relative isotopic mass: The mass of an atom of an isotope compared with 1/12th mass of an atom of carbon-12.





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.

s orbital: Spherical and symmetrical regions around the nucleus, they can each hold up to two electrons.

Shell: The energy level 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.

Standard solution: A solution that has a known concentration of a compound/element.

State symbol: Symbols which show the physical state of the substance during the reaction, they are usually in brackets: gas (g), liquid(l), solid(s) and aqueous(aq). Aqueous means the substance is dissolved in water.

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

Sulfate: An ion with the formula SO_4^{2-}

Titration: An experimental technique used to determine the concentration of an unknown solution by using a second solution with a known concentration.

Water of crystallisation: Water molecules that form part of the crystalline structure of a compound.

Bonding and Structure

Covalent bond: The strong electrostatic attraction between two nuclei and the shared pair of electrons between them. Polar covalent bonds occur when there is an asymmetric electron distribution within the covalent bond due to a difference in electronegativities.

Covalent substance: A substance that is made up of atoms that are covalently bonded to each other.

Dative covalent bonding: Occurs when one atom donates both electrons in a covalent bond. For example, in $^+\text{NH}_4$ for one of the N-H bonds, nitrogen provides both of the bonding electrons.





Dot-and-cross diagram: Diagrams used to model the bonding that occurs in a simple molecule. The shells of an atom are drawn as circles, with crosses or dots marked on the circles to represent the electrons. The circles overlap when there is a covalent bond. The electrons from one atom are drawn as dots, and the electrons from a different atom as crosses.

Electrical conductivity: A measure of the amount of electrical current a material can carry or its ability to carry the current.

Electron pair repulsion: The repulsion between pairs of electrons which mean the shape that a molecule adopts has the pairs of electrons positioned as far apart as possible. As a result, carbon atoms in alkanes have a tetrahedral shape and a bond angle of 109.5° .

Electrostatic attraction: The attraction between two species with opposite charges.

Giant atomic structure: Large structures containing lots of atoms that are covalently bonded to each other, they are usually arranged in a regular lattice. E.g. Diamond.

Giant ionic lattice: A regular repeating structure made up of oppositely charged ions.

Ionic bond: Strong electrostatic attraction between two oppositely charged ions. The strength of attraction depends on the relative sizes and charges of ions.

Ionic charge: The electrical charge of an ion caused by the gain (negative charge) or loss (positive charge) of electrons. The magnitude of the charge is related to how many electrons have been lost or gained as electrons have a relative charge of -1.

Ionic compound: A compound made up of anions and cations held together by ionic bonds, which arise due to the electrostatic attraction between oppositely charged ions. These structures are neutral overall.

Linear: The shape of a molecule when the central atom has 2 bonding pairs and no lone pairs of electrons.

Melting point: The temperature at which it changes from solid state to liquid state.

Metallic bonding: Strong electrostatic attraction between positive metal ions and the sea of delocalised electrons that surround them.

Non-linear/bent: The shape of a molecule when the central atom has 2 bonding pairs and 2 lone pairs of electrons.

Octahedral: The shape of a molecule when the central atom has 6 bonding pairs.





Pyramidal: The shape of a molecule when the central atom has 3 bonding pairs and 1 lone pair.

Simple molecular structure: Atoms that are covalently bonded together to form relatively small molecules.

Solubility in water: The degree to which a substance can dissolve in water at a certain temperature.

Tetrahedral: The shape of a molecule when the central atom has 4 bonding pairs.

Trigonal bipyramidal: The shape of a molecule when the central atom has 5 bonding pairs.

Trigonal planar: The shape of a molecule when the central atom has 3 bonding pairs.

Inorganic Chemistry and the Periodic Table

Anion: A negatively charged ion, formed when an atom gains at least one electron, e.g. S^{2-} .

Cation: A positively charged ion, formed when an atom loses at least one electron, e.g. Na^+ .

Charge density: The ratio of the charge of an ion compared to its volume, for example, a $3+$ ion will have a higher charge density than a $1+$ ion of similar size.

First ionisation energy: The energy required to remove 1 mole of electrons from 1 mole of gaseous atoms to form 1 mole of gaseous 1^+ ions. For example, $Mg_{(g)} \rightarrow Mg^+_{(g)} + e^-$

Precipitation reaction: A reaction in which solutions react to form an insoluble product. When combined with acidified silver nitrate, halide ions react to form different coloured precipitates depending on the ion present. The colour of the precipitate formed can be used to identify which halide is present in a solution.

Precipitate: The solid formed from a reaction in solution.

p-block element: Elements in Groups 3-8/0 of the periodic table. p-block non-metals generally undergo reduction reactions.

s-block element: Elements in Groups 1 and 2 of the periodic table. s-block elements generally undergo oxidation reactions.





Equilibria (Acid–Base)

Alkali: A base which is soluble in water.

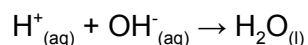
Brønsted-Lowry acid: Proton donors. These species release hydrogen ions in solution.

Brønsted-Lowry base: Proton acceptors.

Diprotic acid: An acid that can release two H^+ ions upon dissociation, e.g. H_2SO_4 .

Monoprotic acid: An acid that can release only one H^+ upon dissociation, e.g. HCl .

Neutralisation: A reaction between an acid and a base which react together to form water and a salt. The ionic equation for neutralisation:



Polyprotic acid: An acid that can release more than one H^+ ions upon dissociation, e.g. H_3PO_4 .

Strong acid: An acid that dissociates/ionises almost completely in water. This means nearly all the H^+ ions will be released. E.g. HCl .

Strong base: A base that dissociates/ionises almost completely in water. E.g. NaOH .

Weak acid: An acid that only dissociates/ionises very slightly in water so that only a small number of H^+ ions are released. E.g. Ethanoic acid.

Weak base: A base that only slightly dissociates/ionises in water. E.g. NH_3 .

Energy and Matter

Absorption spectra: A spectrum of frequencies of electromagnetic radiation that has been transmitted through an atom or molecule, that shows dark bands due to the absorption of the radiation at those specific wavelengths.

Electromagnetic spectrum: The range of frequencies of electromagnetic radiation and the respective wavelengths.

Emission spectra: A spectrum of frequencies of electromagnetic radiation that has been emitted by an atom or molecule undergoing a transition from a state with higher energy to a state with lower energy.





Flame test: An analytical technique used to identify certain elements and ions based on the colour produced when a nichrome wire is dipped into a solution of the species and held in a blue bunsen flame.

Infrared: The part of the electromagnetic spectrum that has wavelengths between 780 nm and 1 mm.

Ultra-violet: The part of the electromagnetic spectrum that has wavelengths between 10 nm and 400 nm.

Visible light: The part of the electromagnetic spectrum that has wavelengths between 380 and 700 nm.

Modern Analytical Techniques

Mass spectrometry: A technique used to identify compounds and determine their relative molecular mass and the relative abundance of isotopes in a sample.

Relative abundance: The amount of one substance compared with another.

Relative abundance (of isotopes): The percentage of atoms found within a naturally occurring sample of an element that has a specific atomic mass.

Relative atomic mass: The weighted mean mass of an atom compared with 1/12th mass of an atom of carbon-12.

