

## Module 2: Foundations in Chemistry

### Atomic Structure and isotopes

**Atomic number:** number of protons (or electrons in an element)

**Mass number:** number of protons plus neutrons

**Isotopes:** atoms of the same element that have different number of neutrons

**Relative atomic mass:** the average mass of an atom of an element relative to  $1/12^{\text{th}}$  of the mass of a  $^{12}\text{C}$  atom

**Relative isotopic mass:** the mass of an isotope relative to  $1/12^{\text{th}}$  of the mass of a  $^{12}\text{C}$  atom

**m/z:** mass to charge ratio

### Amount of Substance

**Avogadro:** the number of particles in one mole

### Acids

**Acid:** releases  $\text{H}^+$  ions in solution

**Alkali:** releases  $\text{OH}^-$  ions in solution

**Strong acid/alkali:** fully dissociates in solution

**Weak acid/alkali:** partial dissociation in solution

**Neutralisation:** reaction of  $\text{H}^+$  and  $\text{OH}^-$  ions  $\rightarrow \text{H}_2\text{O}$

**Standard solution:** a solution of accurate concentration

### Redox

**Oxidising agent:** electron acceptor

**Reducing agent:** electron donor

### Electronic Structure

**Orbital:** a region that can hold 2 electrons of opposite spins

## Bonding

**Covalent bond:** electrostatic attraction that occurs due to the sharing of two electrons between two non-metal atoms

**Ionic bond:** electrostatic attraction that occurs due to the electron transfer from a metal to a non-metal forming positive and negative ions

## Electronegativity & Polarity

**Electronegativity:** ability of an atom to attract electrons towards itself in a covalent bond

## Module 3: Periodic Table & Energy

**Ionisation Energy:** the energy required to remove 1 mole of electrons from gaseous atoms to form 1 mole of gaseous ions

**Metallic bond:** electrostatic attraction that occurs when a positive metal ion is surrounded by a sea of delocalised electrons

## Group 7

**Disproportionation:** simultaneous oxidation and reduction of a species

## Physical Chemistry

### Enthalpy Changes

**Activation Energy:** minimum energy required for a reaction to occur

**Enthalpy of combustion:** enthalpy change when one mole of a substance is completely burned in excess oxygen

**Enthalpy of formation:** enthalpy change when one mole of a compound is formed from its elements in their standard states under standard conditions

**Enthalpy of neutralisation:** enthalpy change when one mole of water is formed in an acid-base neutralization reaction

**Standard conditions:** 100 kPa and 298 K

**Standard states:** physical states under standard conditions

## Equilibrium

**Equilibrium:** the rate of the forwards and backwards reactions are equal

**Equilibrium:** the concentrations of reactants and products are constant

## Module 4: Core Organic Chemistry

### Basic Concepts

**Homologous series:** family of compounds with same general formula, same empirical formula, similar reactivity and shows a trend in physical properties.

**Functional group:** the reactive part of the molecule

**Alkyl Group:** has formula  $C_nH_{2n+1}$

**Aliphatic:** a compound containing carbon and hydrogen in straight chains, branched compounds or cyclic compounds (but not aromatic)

**Alicyclic:** a cyclic aliphatic compound (not aromatic)

**Aromatic:** a compound containing benzene

**Saturated:** contains single C-C bonds only

**Unsaturated:** contains double or triple bonds

**Structural isomers:** two molecules with the same molecular formula but different structural formula

### Reaction Mechanisms

**Homolytic fission:** splitting of a bond to form two radicals

**Heterolytic fission:** splitting of a bond to form two oppositely charged ions

**Radical:** a species with an unpaired electron

**Curly arrow:** shows the movement of two electrons in reaction mechanisms

### Alkanes

**Sigma bond:** overlap of two s-orbitals

**Pi bond:** overlap of two p-orbitals

### Alkenes

**Stereoisomers/geometric isomers:** same molecular formula but different spatial arrangement

**Nucleophile:** electron pair donor

**Electrophile:** electron pair acceptor

**Radical:** a species with an unpaired (or lone) electron

## Organic Synthesis

**Reflux:** a continuous cycle of boiling and condensation

## Module 5: Physical Chemistry & Transition Elements

### Rates

**Quenching:** stopping the reaction by adding acid, base or cold water

**Order:** the factor by which each reactant affects the rate

**Overall order:** the sum of the individual orders

**Half-life:** the time it takes for the concentration to half

**Rate-determining step:** the slow step in a multi-step reaction

### Acids and Bases

**Bronsted-Lowry acid:** proton donor

**Bronsted-Lowry base:** proton acceptor

**Strong acid/base:** completely dissociates in water

**Weak acid/base:** incomplete dissociation in water

**Definition of pH...**use  $\text{pH} = -\log_{10} [\text{H}^+]$

**Definition of  $K_w$ ...**use  $K_w = [\text{H}^+][\text{OH}^-]$

**Buffer solution:** a solution that resists changes in pH when small amounts of acid or base are added

### Enthalpy, Entropy & Free Energy

#### Born-Haber Cycles

**Enthalpy of atomisation:** enthalpy change when one mole of gaseous atoms is formed from an element in its standard state

**Electron affinity:** enthalpy change when one mole of gaseous ions is formed from one mole of gaseous atoms

**Lattice enthalpy:** enthalpy change when one mole of an ionic solid is formed from its gaseous ions

**Enthalpy of solution:** the enthalpy change that occurs when 1 mole of an ionic compound dissolves in water

**Enthalpy of hydration:** the enthalpy change that occurs when 1 mole of gaseous ions forms aqueous/hydrated ions.

**Entropy:** the measure of dispersal of energy in a system

## Redox & Electrode Potentials

**Standard conditions:** concentration  $1 \text{ mol dm}^{-3}$   $\text{H}^+$  ions, temperature = 298 K and pressure = 101 kPa (1 atm).

## Transition Metals

**Transition metal:** a metal that can form one or more ions that have partially filled d orbitals

**Ligand:** a molecule that has at least one lone pair of electrons

**Complex ion:** a central metal ion surrounded by ligands

**Coordination number:** how many bonds there are to the metal ion

**Monodentate:** a ligand with only one lone pair of electrons

**Bidentate:** a ligand with only two lone pair of electrons

**Multi or polydentate:** a ligand with more than two lone pair of electrons

## Module 6: Organic Chemistry & Analysis

### Carbonyl Compounds

**Chiral centre:** a carbon atom surrounded by 4 different groups

**Optical isomers/Enantiomers:** two non-superimposable mirror images

### Amino Acids

**$\alpha$ -Amino acid:** the  $\text{NH}_2$  and  $\text{COOH}$  groups are attached to the same carbon

## **Polyesters & polyamides**

**Condensation:** removal of a small molecule, usually the removal of water (or HCl)

**Hydrolysis:** the breaking of a bond, usually by adding water

## **Chromatography & Spectroscopy**

**TLC:** thin layer chromatography

**GC:** Gas Chromatography

**Retention time:** how long it takes for a compound to come off the column or to be detected

**NMR:** Nuclear Magnetic Resonance

**TMS:** tetramethylsilane