

# Leaving Certificate Chemistry Higher Level Definitions

## 1 – Periodic Table and Atomic Structure

Atomic Orbital	12	Region (with no definite boundary) in space around nucleus in which there is <b>high probability of finding an electron</b>
Relative Atomic Mass	8	<b>Average mass of atoms of element compared (relative) to <math>^{1/12}</math> mass of carbon-12 isotope</b>
First Ionisation Energy	8	Minimum <b>energy to remove most loosely-bound electron</b> from an isolated gaseous atom in its ground state
Oxidation	6	<b>Loss of electrons <u>or</u> Increase in oxidation number</b> (may be asked for one or both specifically)
Isotopes	6	<b>Atoms of same element with different mass numbers</b> due to different number of neutrons <u>or</u> <b>atoms with same atomic number (Z) but different mass numbers (A)</b>
(Atomic) Energy Level	6	<b>Fixed amount of energy of an electron</b> in an atom
Radioactivity	5	<b>Spontaneous breaking up of a nucleus to release <math>\alpha</math>, <math>\beta</math> or <math>\gamma</math> radiation</b>
Atomic Radius	4	<b>Half the distance between the nuclei of two identical atoms (of the same element) joined by a single covalent bond</b>
Heisenberg's Uncertainty Principle	3	<b>It is not possible to measure the exact position and momentum of electron in atom simultaneously (at the same time)</b>
Alpha particle	3	<b>Helium (He) nucleus <u>or</u> particle consisting of 2 protons + 2 neutrons</b>
Principle of Mass Spectrometry	2	Positively charged <b>ions are separated by mass</b> when moving in a magnetic field
Ground State	2	In <b>lowest energy state <u>or</u> in n = 1 level (shell)</b>
Excited State	2	<b>Higher energy state or in n &gt; 1 level (shell)</b>
Atomic Number	2	<b>Number of protons</b> in nucleus of an atom
Radioisotope	2	<b>Radioactive isotope <u>or</u> isotope (atom) with unstable nucleus</b>
(Energy) Sub-Level	2	Sub-division of a main energy level <b>consisting of one or more orbitals of the same energy</b>
Mass Number	2	<b>Number of nucleons (protons + neutrons)</b> in the atoms of an isotope
Half Life	2	<b>Time taken for half of the nuclei in a sample to decay <u>or</u> Time taken for activity to reduce by (to) a half</b>
Oxidation number	1	<b>charge on atom if electrons distributed by rules (if bonds assumed ionic)</b>
Second ionisation energy	1	<b>Electron removed from monopositive ion <u>or</u> <math>X^+ \rightarrow X^{2+} + e^-</math></b>
Reduction	1	<b>Gain of electrons or decrease in oxidation number</b> (may be asked for one or both specifically)
Cathode Rays	1	Streams of negatively charged <b>electrons</b> which travel from the cathode to anode, are deflected by magnetic and electric fields, and have sufficient energy to move a small object e.g. paddle wheel
(Bohr) Orbit	1	2-D <b>pathway at fixed distance from nucleus</b> where <b>electron is definitely located</b>
Element	1	an element cannot be broken down into anything simpler
Mendeleev's Periodic Law/System	1	When <b>elements are listed according to relative atomic mass</b> , their chemical <b>properties repeat periodically</b>
Modern Periodic Law/System	0	When <b>elements are listed according to atomic number</b> , their chemical <b>properties repeat periodically</b>
Aufbau Principle	0	Electrons occupy the lowest available energy levels
Dalton's Atomic Theory	0	All matter is made of indivisible small particles called atoms
Empirical Formula	0	Shows simplest whole number ratio of the different atoms in a molecule
Molecular Formula	0	Shows the number and type of each atom in a molecule of a compound
Hund's Rule	0	When two or more orbitals of equal energy are available, electrons occupy them singly before filling them in pairs
Law of Conservation of Matter/Mass	0	During chemical reaction matter is neither created or destroyed <u>or</u> Total mass of reactants = total mass of products
Newland's Octaves	0	Arrangement of elements in which the first and the eighth have similar properties

<b>Nuclear Reaction</b>	0	Process that alters the composition, structure, or energy of a nucleus
<b>Pauli Exclusion Principle</b>	0	No more than two electrons may occupy an orbital and they must have opposite spin
<b>(Radio)Carbon Dating</b>	0	Dates an object containing carbon based on C-14 to C-12 ratio
<b>Triad</b>	0	Group of 3 elements with similar chemical properties where the atomic weight of the middle one is approx. equal to the average of the other two
<b>Oxidising Agent</b>	0	Substance that brings about oxidation in other substances (is reduced)
<b>Reducing Agent</b>	0	Substance that brings about reduction in other substances (is oxidised)
<b>Electrolysis</b>	0	Use of electricity to bring about chemical reaction in an electrolyte
<b>Electrolyte</b>	0	Compound which conducts electricity when molten or dissolved in water

## 2 – Chemical Bonding

<b>Electronegativity</b>	9	<b>Measure of attraction of an atom for shared electrons</b> in a covalent bond
<b>Pi Bond</b>	6	<b>Sideways overlap of p-orbitals</b>
<b>Sigma Bond</b>	6	<b>Head-on (end-on) overlap of orbitals</b> (any type of orbitals)
<b>Intermolecular</b>	2	Forces <b>between molecules</b>
<b>Ionic bonding</b>	1	Bond <b>between oppositely-charged ions</b>
<b>Polar Covalent Bonding</b>	1	<b>Unequal sharing</b> of bonding <b>electrons</b> <u>or</u> bond has <b>slight positive and slight negative</b> ends
<b>Intramolecular</b>	1	Forces between atoms (with) <b>in a molecule</b>
<b>Covalent Bond</b>	1	Involving the <b>sharing</b> of one or more pair(s) of <b>electrons</b>
<b>Compound</b>	0	Single substance made of two or more different elements (types of atoms)
<b>Dipole-Dipole Forces</b>	0	Attraction between polar molecules ( $\delta^+$ of one and $\delta^-$ of the other)
<b>Hydrogen Bonds</b>	0	Particular dip-dip for molecules where H is bonded to N, O, or F
<b>Ion</b>	0	Charged atom or group of atoms
<b>Octet Rule (of thumb)</b>	0	When bonding, atoms tend to reach an electron configuration with eight electrons in the outermost energy level
<b>Van der Waals Forces</b>	0	Weak attraction between non-polar molecules due to temporary dipoles
<b>Valency</b>	0	Number of H atoms with which each atom of the element combines
<b>Transition Metal</b>	0	Forms at least one ion with a partially filled d sub-level
<b>Molecule</b>	0	Group of covalently bonded atoms which is the smallest particle of an element or compound that can exist independently

## 3 – Stoichiometry, Formulas, and Equations

<b>Avogadro's Law</b>	9	<b>Equal volumes of gases at the same temperature and pressure have equal numbers of particles</b> (not all conditions or at STP)
<b>Mole</b>	4	Contains the <b>Avogadro number</b> ( $6 \times 10^{23}$ ) <b>of particles</b> <u>or</u> relative <b>molecular mass in grams (g)</b> <u>or</u> amount containing <b>as many particles as</b> the no. of atoms in <b>12g of carbon-12</b>
<b>Charles' Law</b>	3	<b>Volume varies directly with Kelvin temperature</b> for definite <b>mass</b> of gas at <b>constant pressure</b> <u>or</u> $V/T^* = k$ for definite <b>mass</b> of gas at <b>constant pressure</b> *Capital letter.
<b>Ideal Gas</b>	3	A gas that <b>obeys the gas laws under all conditions</b> of temperature and pressure
<b>Gay Lussac's Law</b>	2	<b>Volumes</b> of reacting gases and their gaseous products are in <b>small whole number ratios</b> provided they are measured <b>at the same temperature and pressure</b> ( <u>not all conditions or STP</u> )
<b>Boyles' Law</b>	0	<b>pressure inversely proportional to volume</b> for definite <b>mass of gas at constant temp</b> <u>or</u> $PV = k$

## 4 – Volumetric Analysis

<b>Acid (Brønsted-Lowry)</b>	5	<b>Proton (H<sup>+</sup>) donor</b>
<b>Base (Brønsted-Lowry)</b>	4	<b>Proton (H<sup>+</sup>) acceptor</b>
<b>Conjugate Pair</b>	3	Acid-Base <b>differing by a proton (H<sup>+</sup>)</b>

Primary Standard	2	Pure, stable, water soluble, high molecular mass substance from which solutions of known concentration can be made
Base (Arrhenius)	2	Produces OH <sup>-</sup> ions in aqueous solution <u>or</u> dissociates into OH <sup>-</sup> in water
Conjugate Acid (B-L)	2	Produced by gain of one proton (H <sup>+</sup> ) <u>or</u> Base + H <sup>+</sup>
Standard Solution	1	Solution of known concentration (molarity)
Standardised	1	concentration known by another titration (or by colorimetry or by u.v. spectroscopy)
Acid (Arrhenius)	1	produces H <sup>+</sup> (hydrogen ion) by dissociation in water (aqueous solution)
Concentration(Molarity)	0	Amount of solute dissolved in given volume of solution (moles/L)
Titration	0	Measured vol of one solution added to known vol of another until reaction is complete
Salt	0	When the H in an acid is replaced by a metal or ammonium ion
Neutralisation	0	Reaction where Acid + Base → Salt + Water
Solution	0	Homogeneous mixture of solute and solvent

### 5 – Fuels and Heats of Reaction

Heat of Combustion	5	Heat change when <b>one mole</b> of a substance is <b>burned completely</b> in excess oxygen
Octane Number	4	<b>Measure of the tendency</b> of a fuel to <b>auto-ignite</b>
Structural Isomers	4	compounds having the <b>same molecular formula</b> but <b>different structural formulas</b> (different arrangement of atoms)
Unsaturated	3	Having at least one carbon to carbon <b>double or triple bond present</b> <u>or</u> <b>Undergoes addition reactions</b>
Homologous Series	3	Group of organic chemicals which have the <b>same general formula</b> <u>or</u> <b>differ by CH<sub>2</sub></b> <u>or</u> <b>same functional group</b>
Bond Energy	3	Average <b>energy</b> required to <b>break 1 mole of a particular bond</b> into <b>separate atoms</b> in the gaseous state
Catalytic Cracking	2	<b>Splitting of long chain molecules by heat</b> and catalyst(s) [Accept “hydrocarbons” for “molecules”]
Heat of Formation	1	Heat change when <b>1 mole</b> of compound <b>formed from</b> its <b>elements</b> in their standard states
Heat of Reaction	1	Heat change when the <b>number of moles of reactants</b> in the balanced <b>equation react</b> completely <u>or</u> Heat change for <b>reaction according to balanced equation</b>
Hydrocarbon	1	Compounds composed of <b>carbon (C) and hydrogen (H) only</b>
Auto-ignition	1	Tendency to <b>premature ignition</b> (explosion/knocking)
Isomerisation	1	<b>Different structure</b> <u>or</u> <b>different arrangement of atoms</b> <u>or</u> <b>changing straight to branched and vice versa</b>
Saturated	1	<b>All single (no double or triple) carbon-carbon bonds</b> <u>or</u> <b>Have maximum number of H (monovalent) atoms attached</b> to carbon skeleton
Fractionation	1	<b>Separation</b> into components <b>according to size</b> (mass, boiling pt) <u>or</u> <b>splitting</b> into components <b>by distillation</b>
Aliphatic Compound	0	Organic compound containing open chains or closed rings of carbon atoms
Aromatic Compound	0	Organic compounds that contain a benzene ring structure in their molecules
Heat of Neutralisation	0	Heat change when 1 mole of H <sup>+</sup> from acid reacts with 1 mole of OH <sup>-</sup> ions from base

### 6 – Rates of Reaction

Rate of a Chemical Reaction	10	<b>Change in concentration per unit time of any <u>one</u> reactant or product</b>
Activation Energy	8	<b>Minimum combined energy</b> of particles for <b>effective collisions</b> <u>or</u> <b>minimum combined energy of colliding particles for reaction to take place</b> between them
Heterogeneous Catalysis	3	<b>Catalyst in different phase (not state) from reactants (not products)</b>
Catalyst	2	Substance that <b>alters the rate of a reaction</b> and is <b>not used up (consumed)</b> in reaction <u>or</u> Substance that <b>provides alternative pathway</b> for reaction that has a <b>different activation energy</b>

<b>Effective Collision</b>	1	One that <b>results in a reaction</b> (product formation) <u>or</u> <b>reaches activation energy</b>
<b>Autocatalysis</b>	0	A product of a reaction acts as a catalyst for the reaction
<b>Catalytic Poison</b>	0	Substance that makes catalyst inactive
<b>Catalytic Converter</b>	0	Device in exhaust which converts pollutants to less harmful substances
<b>Enzyme</b>	0	Biological catalyst
<b>Homogeneous Catalysis</b>	0	Catalyst in same phase ( <u>not state</u> ) as reactants ( <u>not products</u> )

### 7 – Organic Chemistry

<b>Delocalised electron</b>	1	<b>Shared between more than two atoms</b> <u>or</u> <b>moving between one pair of bonded atoms and another</b>
<b>Primary Alcohol</b>	1	<b>One carbon atoms attached to the carbon to which the OH group is attached</b>
<b>Secondary Alcohol</b>	1	<b>Two carbon atoms attached to the carbon to which the OH group is attached</b>
<b>Emulsion</b>	1	<b>Oil droplets in water</b> <u>or</u> <b>Dispersion of one liquid in a second liquid in which it is insoluble</b>
<b>Volatile</b>	1	<b>Easily vaporised</b>
<b>Immiscible Liquids</b>	1	<b>Do not mix</b> <u>or</u> <b>do not dissolve in each other</b>
<b>Free Radicals</b>	1	<b>Atoms that have an unpaired electron</b>
<b>Tertiary Alcohol</b>	0	<b>Three carbon atoms attached to the carbon to which the OH group is attached</b>

### 8 – Chemical Equilibrium

<b>Le Chatelier's Principle</b>	10	Reactions at <b>equilibrium oppose</b> applied stresses
<b>Chemical Equilibrium</b>	6	State in which <b>rate of forward reaction = rate of reverse reaction</b>
<b>Dynamic</b>	3	<b>Reaction has not stopped</b> <u>or</u> <b>forward &amp; reverse reactions occurring</b> <u>or</u> <b>Reactants producing products and products producing reactants simultaneously</b>
<b>Reversible (reaction)</b>	1	<b>Products can react to give back the reactants</b> <u>or</u> <b>Reaction is going in both directions</b>

### 9 – Water

<b>pH</b>	6	<b><math>-\log_{10}[\text{H}^+]</math> <u>or</u> <math>-\log_{10}[\text{H}_3\text{O}^+]</math></b> (must have negative sign & square brackets)
<b>Strong Acid (Brønsted-Lowry)</b>	5	<b>Good proton donor</b> <u>or</u> <b>readily donates proton</b> <u>or</u> <b>almost fully dissociated</b>
<b>Weak Acid (Bronsted-Lowry)</b>	5	<b>Poor proton donor</b> <u>or</u> <b>slightly dissociated</b>
<b>Secondary Treatment (of Sewage)</b>	4	<b>Biological oxidation</b>
<b>Biochemical Oxygen Demand (BOD)</b>	3	<b>Amount of oxygen consumed</b> in p.p.m. ( $\text{mg l}^{-1}$ ) when sample kept in the <b>dark for five days at 20°C</b>
<b><math>K_w</math></b>	3	<b><math>[\text{H}^+][\text{OH}^-]</math> <u>or</u> <math>[\text{H}_3\text{O}^+][\text{OH}^-]</math></b> (square brackets essential)
<b>Tertiary Treatment (of Sewage)</b>	2	<b>Removal of nitrogen compounds</b> (nitrates) and <b>phosphorus compounds</b> (phosphates)
<b>Hard Water</b>	1	Water which <b>does not</b> easily <b>form lather</b> (forms scum instead) with soap
<b>Flocculation</b>	1	The <b>clumping</b> of suspended solids in the water by <b>addition of chemical</b> (flocculation agent)
<b>Eutrophication</b>	1	<b>Excessive nutrients in water</b> which cause excessive plant growth (algal bloom – decreases water transparency & depletes $\text{O}_2$ available for fish)
<b>Primary Treatment (of Sewage)</b>	1	<b>Removal of solids</b> by screening and settlement (sedimentation)
<b>Free chlorine</b>	1	<b>Chlorine (<math>\text{Cl}_2</math>) available as oxidising agent</b>
<b>Strong Acid (Arrhenius)</b>	1	(almost) <b>Fully dissociates</b> into ions in dilute aqueous solution.
<b>Weak Acid (Arrhenius)</b>	1	<b>Slightly dissociates</b> into $\text{H}_3\text{O}^+$ ions in dilute aqueous solution. [Accept “does not readily dissociate” <u>but not</u> “does not completely (fully) dissociate”]
<b>Principle of Colorimetry</b>	0	Amount of light absorbed by coloured solution is proportional to its concentration