

IGCSE Chemistry (0620) Revision Sheet

Aligned with CAIE Syllabus (2023–2028)

<https://igcsegradecalc.site>

1. States of Matter

- **Solid:** Fixed shape & volume; particles vibrate in fixed positions; strong forces.
- **Liquid:** Fixed volume, takes shape of container; particles slide past each other.
- **Gas:** No fixed shape/volume; particles move freely & randomly; weak forces.
- **Changes of state:** Melting, boiling, freezing, condensation, sublimation.
- **Diffusion:** Net movement of particles from higher to lower concentration.
- **Kinetic particle theory:** Explains properties & changes of state via particle motion & forces.

2. Atoms, Elements & Compounds

- **Atom:** Smallest particle of an element that retains its identity.
- **Element:** Substance made of only one type of atom.
- **Compound:** Two or more elements chemically bonded.
- **Mixture:** Two or more substances not chemically combined.
- **Proton:** Relative charge +1, relative mass 1.
- **Neutron:** Relative charge 0, relative mass 1.
- **Electron:** Relative charge -1 , relative mass $\approx \frac{1}{1836}$.
- **Atomic number (Z):** Number of protons.
- **Mass number (A):** Protons + neutrons.
- **Isotopes:** Atoms of the same element with different numbers of neutrons.
- **Electron configuration:** For elements 1–20 (e.g. 2, 8, 1 for Na).

3. Chemical Bonding

- **Ionic bond:** Electrostatic attraction between oppositely charged ions (metal + non-metal).
- **Covalent bond:** Shared pair of electrons (non-metal + non-metal).
- **Metallic bond:** Attraction between positive metal ions and delocalised electrons.
- **Simple molecular:** Low melting/boiling points; poor conductors; weak intermolecular forces.
- **Giant ionic:** High melting points; conduct when molten or aqueous.
- **Giant covalent:** Very high melting points (diamond, graphite, SiO₂).
- **Graphite:** Layers of hexagons; delocalised electrons → conducts electricity; soft & slippery.
- **Diamond:** Tetrahedral structure; very hard; does not conduct.

4. Stoichiometry

- **Relative formula mass (M_r):** Sum of relative atomic masses.

- **Mole:** Amount containing Avogadro constant particles: $N_A = 6.02 \times 10^{23}$.
- **Moles from mass:** $n = \frac{m}{M_r}$.
- **Gas volume (r.t.p.):** 1 mole = 24 dm³; $n = \frac{V}{24}$.
- **Concentration:** $c = \frac{n}{V}$ (mol dm⁻³).
- **Empirical formula:** Simplest whole-number ratio of atoms.
- **Percentage yield:** $\frac{\text{actual yield}}{\text{theoretical yield}} \times 100\%$.
- **Percentage purity:** $\frac{\text{mass of pure substance}}{\text{mass of impure sample}} \times 100\%$.

5. Electrochemistry

- **Electrolysis:** Decomposition of an ionic compound (molten or aqueous) by electricity.
- **Anode:** Positive electrode; oxidation occurs.
- **Cathode:** Negative electrode; reduction occurs.
- **OIL RIG:** Oxidation Is Loss (of electrons); Reduction Is Gain.
- **Electrolyte:** Ionic compound that conducts when molten or in solution.
- **Examples:** Molten PbBr₂, aqueous NaCl (brine), CuSO₄.
- **Electroplating:** Coating an object with a metal using electrolysis.
- **Hydrogen–oxygen fuel cell:** $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$ (produces electricity).

6. Chemical Energetics

- **Exothermic:** Releases heat energy; $\Delta H < 0$.
- **Endothermic:** Absorbs heat energy; $\Delta H > 0$.
- **Bond breaking:** Endothermic.
- **Bond forming:** Exothermic.
- **Energy level diagrams:** Show relative energy of reactants & products.
- **Activation energy:** Minimum energy needed for a reaction to occur.

7. Chemical Reactions

- **Rate of reaction:** Affected by concentration, temperature, surface area, catalysts, pressure (gases).
- **Collision theory:** Particles must collide with sufficient energy & correct orientation.
- **Catalyst:** Speeds up reaction by providing alternative pathway with lower activation energy; unchanged at end.
- **Reversible reactions:** Can go in both directions; reach dynamic equilibrium.
- **Le Chatelier's principle:** System shifts to oppose changes in conditions.
- **Redox:** Oxidation and reduction occurring simultaneously.

- **Oxidation:** Gain of oxygen / loss of electrons / increase in oxidation number.
- **Reduction:** Loss of oxygen / gain of electrons / decrease in oxidation number.

8. Acids, Bases & Salts

- **Acid:** Produces H^+ ions in aqueous solution.
- **Base:** Accepts H^+ ions / neutralises an acid.
- **Alkali:** Soluble base; produces OH^- ions.
- **pH scale:** 0–6 acidic; 7 neutral; 8–14 alkaline.
- **Strong vs weak:** Strong acids fully ionise; weak acids partially ionise.
- **Neutralisation:** Acid + base $\rightarrow$ salt + water.
- **Acid + metal:** Salt + hydrogen.
- **Acid + carbonate:** Salt + water + carbon dioxide.
- **Salt preparation:** Soluble salts (titration or excess solid); insoluble salts (precipitation).
- **Indicators:** Litmus, methyl orange, phenolphthalein, thymolphthalein.

9. The Periodic Table

- **Group number:** Number of outer-shell electrons.
- **Period number:** Number of electron shells.
- **Metals:** Left side of the Periodic Table.
- **Non-metals:** Right side of the Periodic Table.
- **Trends across a period:** Metallic character decreases; atomic radius decreases.
- **Transition elements (Extended):** Variable oxidation states; coloured compounds; catalytic activity.

10. Group Chemistry

- **Group I (Alkali metals):** Soft, low density, react vigorously with water; reactivity increases down the group.
- **Group VII (Halogens):** Coloured non-metals; reactivity decreases down the group; displacement reactions.
- **Group VIII / 0 (Noble gases):** Very unreactive; full outer shells; monatomic.
- **Halogen colours:** Cl_2 green-yellow gas; Br_2 red-brown liquid; I_2 grey solid / purple vapour.

11. Metals

- **Reactivity series:** $K > Na > Ca > Mg > Al > C > Zn > Fe > H > Cu > Ag > Au$.
- **Extraction:** Metals above C extracted by electrolysis; metals below C can be extracted by reduction with carbon.
- **Blast furnace (iron):** Haematite + coke + limestone; reduction by CO.
- **Alloys:** Mixtures of metals (or metal + non-metal) with improved properties (e.g. steel, brass).
- **Rusting:** Requires both oxygen and water; prevented by painting, galvanising, sacrificial protection.

12. Chemistry of the Environment

- **Air composition:** N_2 78%; O_2 21%; Ar 0.9%; CO_2 0.04%.
- **Greenhouse gases:** CO_2 , CH_4 , H_2O vapour; cause global warming.
- **Acid rain:** Caused by SO_2 and NO_x .
- **Water treatment:** Filtration $\rightarrow$ sedimentation $\rightarrow$ chlorination.
- **Fertilisers:** NPK fertilisers; Haber process for ammonia; Contact process for sulfuric acid.

13. Organic Chemistry

- **Homologous series:** Same functional group & general formula; successive members differ by CH_2 .
- **Alkanes:** General formula C_nH_{2n+2} ; saturated; substitution with Cl_2 (UV).
- **Alkenes:** General formula C_nH_{2n} ; unsaturated; addition reactions (Br_2 , H_2 , steam).
- **Alcohols:** Functional group $-OH$; general formula $C_nH_{2n+1}OH$.
- **Ethanol manufacture:**
 - Fermentation: glucose $\xrightarrow{\text{yeast, } 25-35^\circ C}$ ethanol + CO_2 .
 - Catalytic addition of steam to ethene.
- **Uses of ethanol:** Solvent, fuel.
- **Carboxylic acids:** Functional group $-COOH$; ethanoic acid is a weak acid.
- **Esters:** Formed from carboxylic acid + alcohol (acid catalyst); functional group $-COO-$ (ester linkage); fruity smell.
- **Polymers:**
 - Addition polymers (e.g. poly(ethene)) from alkenes.
 - Condensation polymers: polyesters (ester linkage) from diol + dicarboxylic acid; polyamides (amide linkage $-CONH-$) from diamine + dicarboxylic acid.
- **Cracking:** Large hydrocarbons $\rightarrow$ smaller alkanes + alkenes.

14. Experimental Techniques & Analysis

- **Separation methods:** Filtration, crystallisation, distillation, fractional distillation, chromatography, paper chromatography.
- **Chromatography:** $R_f = \frac{\text{distance travelled by substance}}{\text{distance travelled by solvent}}$.
- **Purity:** Pure substance has sharp melting/boiling point.
- **Gas tests:**
 - H_2 : burning splint $\rightarrow$ squeaky pop.
 - O_2 : relights glowing splint.
 - CO_2 : turns limewater milky.
 - Cl_2 : bleaches damp litmus paper.
 - NH_3 : turns damp red litmus blue.
- **Cation tests ($NaOH$ / NH_3):** Characteristic precipitates (e.g. Cu^{2+} blue; Fe^{2+} green; Fe^{3+} brown).
- **Anion tests:** Carbonate (acid $\rightarrow CO_2$); halide ($AgNO_3$); sulfate ($BaCl_2$); nitrate ($Al + NaOH \rightarrow NH_3$).