SYLLABUS CHECKLIST

IB Diploma Programme Chemistry (SL and HL)

First assessment 2025 · (HL) marks additional higher level content · 130 items

Source: IB Diploma Programme Chemistry guide, first assessment 2025, and the IB Chemistry subject brief (ibo.org)

Tick each box when you can explain the point without notes. Item wording is shortened from the official document; check the original for exact wording. Not affiliated with or endorsed by the exam board.

Structure 1: models of the particulate nature of matter

Structure 1.1 Introduction to the particulate nature of matter

- [ ] **S1.1.1** Elements, compounds and mixtures; homogeneous and heterogeneous mixtures
- [ ] **S1.1.2** Separating mixtures: filtration, crystallisation, evaporation, distillation, paper chromatography, solvation
- [ ] **S1.1.3** Kinetic molecular theory: states of matter and changes of state
- [ ] **S1.1.4** Temperature in kelvin is proportional to average kinetic energy

Structure 1.2 The nuclear atom

- [ ] **S1.2.1** Atoms: a dense nucleus of protons and neutrons surrounded by electrons
- [ ] **S1.2.2** Isotopes; nuclear symbol notation
- [ ] **S1.2.3** Relative atomic mass from isotopic abundances
- [ ] **S1.2.4** (HL) Mass spectra and isotopic abundances

Structure 1.3 Electron configurations

- [ ] **S1.3.1** Emission spectra: continuous versus line spectra
- [ ] **S1.3.2** Hydrogen line spectrum: transitions converge at higher energy
- [ ] **S1.3.3** Energy levels, sublevels and orbitals; maximum electrons per level $2n^2$
- [ ] **S1.3.4** Shapes of s and p orbitals
- [ ] **S1.3.5** Aufbau principle, Hund's rule and Pauli exclusion principle; orbital diagrams
- [ ] **S1.3.6** (HL) Ionisation energy from the convergence limit of the hydrogen spectrum
- [ ] **S1.3.7** (HL) Successive ionisation energies and electron configuration

Structure 1.4 Counting particles by mass: the mole

- [ ] **S1.4.1** The mole and the Avogadro constant
- [ ] **S1.4.2** Molar mass
- [ ] **S1.4.3** Empirical and molecular formulas
- [ ] **S1.4.4** Molar concentration; dilution
- [ ] **S1.4.5** Avogadro's law: equal volumes of gases contain equal numbers of particles

Structure 1.5 Ideal gases

- [ ] **S1.5.1** Ideal gas model assumptions
- [ ] **S1.5.2** Real gases deviate at high pressure, low temperature and with strong forces
- [ ] **S1.5.3** Molar volume of an ideal gas at STP
- [ ] **S1.5.4** Pressure, volume and temperature relationships; combined gas law
- [ ] **S1.5.5** Ideal gas equation $pV = nRT$

Structure 2: models of bonding and structure

Structure 2.1 The ionic model

- [ ] **S2.1.1** Ions form by losing or gaining electrons; predicting charge from the periodic table
- [ ] **S2.1.2** Ionic bonding; electronegativity difference
- [ ] **S2.1.3** Ionic lattices; lattice enthalpy as a measure of bond strength
- [ ] **S2.1.4** Properties of ionic compounds: volatility, conductivity, solubility

Structure 2.2 The covalent model

- [ ] **S2.2.1** Covalent bond: shared pair attracted by two nuclei; octet rule
- [ ] **S2.2.2** Single, double and triple bonds; bond length and strength
- [ ] **S2.2.3** Coordination (dative) bonds
- [ ] **S2.2.4** VSEPR: shapes for up to four electron domains
- [ ] **S2.2.5** Bond polarity and molecular polarity
- [ ] **S2.2.6** Covalent network structures: carbon allotropes, silicon, silicon dioxide
- [ ] **S2.2.7** Intermolecular forces: London dispersion, dipole–induced dipole, dipole–dipole, hydrogen bonding
- [ ] **S2.2.8** Effect of intermolecular forces on physical properties
- [ ] **S2.2.9** Chromatography: Rf values and separating by polarity
- [ ] **S2.2.10** (HL) Resonance structures; delocalised electrons in benzene
- [ ] **S2.2.11** (HL) Expanded octets: VSEPR for five and six electron domains
- [ ] **S2.2.12** (HL) Formal charge
- [ ] **S2.2.13** (HL) Sigma and pi bonds
- [ ] **S2.2.14** (HL) Hybridisation sp, sp^2, sp^3

Structure 2.3 The metallic model

- [ ] **S2.3.1** Metallic bond: cations in a sea of delocalised electrons
- [ ] **S2.3.2** Properties of metals: conductivity, malleability
- [ ] **S2.3.3** (HL) Strength of metallic bonding; transition elements have delocalised d electrons

Structure 2.4 From models to materials

- [ ] **S2.4.1** Bonding triangle: ionic, covalent and metallic character
- [ ] **S2.4.2** Predicting properties from position on the triangle
- [ ] **S2.4.3** Alloys
- [ ] **S2.4.4** Polymers: monomers and repeating units
- [ ] **S2.4.5** Addition polymers
- [ ] **S2.4.6** (HL) Condensation polymers: polyamides, polyesters, biological polymers

Structure 3: classification of matter

Structure 3.1 The periodic table: classification of elements

- [ ] **S3.1.1** Periods, groups and blocks
- [ ] **S3.1.2** Period number and group number from configuration
- [ ] **S3.1.3** Periodicity: atomic radius, ionic radius, ionisation energy, electron affinity, electronegativity
- [ ] **S3.1.4** Trends in group 1 and group 17
- [ ] **S3.1.5** Metallic and non-metallic character; oxides: basic, acidic, amphoteric

- [ ] **S3.1.6** Oxidation states; naming with Roman numerals
- [ ] **S3.1.7** (HL) Discontinuities in ionisation energy across a period
- [ ] **S3.1.8** (HL) Transition elements: incomplete d sublevel, variable oxidation states
- [ ] **S3.1.9** (HL) Coloured complexes: d-orbital splitting and complementary colours

Structure 3.2 Functional groups: classification of organic compounds

- [ ] **S3.2.1** Molecular, empirical, structural (full, condensed, skeletal) and stereochemical formulas
- [ ] **S3.2.2** Functional groups and classes of organic compound
- [ ] **S3.2.3** Homologous series and trends in physical properties
- [ ] **S3.2.4** IUPAC nomenclature
- [ ] **S3.2.5** Structural isomers
- [ ] **S3.2.6** (HL) Stereoisomers: cis–trans and optical isomers
- [ ] **S3.2.7** Mass spectrometry: fragmentation patterns
- [ ] **S3.2.8** Infrared spectroscopy: functional groups
- [ ] **S3.2.9** (HL) ^{1}H NMR: chemical shift, integration, splitting
- [ ] **S3.2.10** (HL) Combining spectra to identify structure

Reactivity 1: what drives chemical reactions?

Reactivity 1.1 Measuring enthalpy changes

- [ ] **R1.1.1** Energy transfer as heat; system and surroundings
- [ ] **R1.1.2** Exothermic and endothermic reactions
- [ ] **R1.1.3** Energy profiles and relative stability
- [ ] **R1.1.4** Calorimetry: $Q = mc\Delta T$ and ΔH

Reactivity 1.2 Energy cycles in reactions

- [ ] **R1.2.1** Bond enthalpy and average bond enthalpies
- [ ] **R1.2.2** Hess's law
- [ ] **R1.2.3** (HL) Standard enthalpies of formation and combustion
- [ ] **R1.2.4** (HL) Born–Haber cycles

Reactivity 1.3 Energy from fuels

- [ ] **R1.3.1** Combustion of organic compounds: complete and incomplete
- [ ] **R1.3.2** Fossil fuels: advantages and disadvantages; specific energy and energy density
- [ ] **R1.3.3** Biofuels and the carbon cycle
- [ ] **R1.3.4** Fuel cells

Reactivity 1.4 Entropy and spontaneity (HL)

- [ ] **R1.4.1** (HL) Entropy and the dispersal of energy and matter
- [ ] **R1.4.2** (HL) Gibbs energy $\Delta G = \Delta H - T\Delta S$
- [ ] **R1.4.3** (HL) Effect of temperature on spontaneity
- [ ] **R1.4.4** (HL) $\Delta G^\circ = -RT \ln K$

Reactivity 2: how much, how fast and how far?

Reactivity 2.1 How much? The amount of chemical change

- [ ] **R2.1.1** Balanced equations and mole ratios

- [ ] **R2.1.2** Reacting masses, volumes of gases and concentrations
- [ ] **R2.1.3** Limiting reactant; theoretical and percentage yield
- [ ] **R2.1.4** Atom economy

Reactivity 2.2 How fast? The rate of chemical change

- [ ] **R2.2.1** Rate of reaction and how to measure it
- [ ] **R2.2.2** Collision theory; Maxwell–Boltzmann distribution
- [ ] **R2.2.3** Factors affecting rate
- [ ] **R2.2.4** Activation energy and catalysts
- [ ] **R2.2.5** (HL) Reaction mechanisms, intermediates and the rate-determining step
- [ ] **R2.2.6** (HL) Rate equations, orders and the rate constant
- [ ] **R2.2.7** (HL) Arrhenius equation; activation energy from graphs

Reactivity 2.3 How far? The extent of chemical change

- [ ] **R2.3.1** Dynamic equilibrium
- [ ] **R2.3.2** Equilibrium constant K and its meaning
- [ ] **R2.3.3** Le Châtelier's principle
- [ ] **R2.3.4** (HL) Reaction quotient Q
- [ ] **R2.3.5** (HL) Calculating K and equilibrium concentrations

Reactivity 3: what are the mechanisms of chemical change?

Reactivity 3.1 Proton transfer reactions

- [ ] **R3.1.1** Brønsted–Lowry acids and bases; conjugate pairs; amphiprotic species
- [ ] **R3.1.2** pH scale; pH = $-\log[H^+]$; Kw
- [ ] **R3.1.3** Strong and weak acids and bases
- [ ] **R3.1.4** Neutralisation; pH curves
- [ ] **R3.1.5** (HL) pOH, Ka, Kb, pKa, pKb
- [ ] **R3.1.6** (HL) Salt hydrolysis: pH of salt solutions
- [ ] **R3.1.7** (HL) Buffers
- [ ] **R3.1.8** (HL) Indicators and pH curves

Reactivity 3.2 Electron transfer reactions

- [ ] **R3.2.1** Oxidation and reduction; oxidation states; half-equations
- [ ] **R3.2.2** Activity series of metals
- [ ] **R3.2.3** Primary (voltaic) cells and electrolytic cells
- [ ] **R3.2.4** Secondary (rechargeable) cells
- [ ] **R3.2.5** Oxidation of alcohols; reduction of carboxylic acids, aldehydes and ketones
- [ ] **R3.2.6** Hydrogenation of alkenes
- [ ] **R3.2.7** (HL) Standard electrode potentials and the standard hydrogen electrode
- [ ] **R3.2.8** (HL) $\Delta G^\circ = -nFE^\circ$
- [ ] **R3.2.9** (HL) Electrolysis of aqueous solutions; electroplating

Reactivity 3.3 Electron sharing reactions

- [ ] **R3.3.1** Radicals and homolytic fission
- [ ] **R3.3.2** Free-radical substitution of alkanes

Reactivity 3.4 Electron-pair sharing reactions

- [ ] **R3.4.1** Nucleophiles and nucleophilic substitution
- [ ] **R3.4.2** Electrophiles and electrophilic addition to alkenes
- [ ] **R3.4.3** Lewis acids and bases
- [ ] **R3.4.4** (HL) Coordination bonds and complex ions
- [ ] **R3.4.5** (HL) SN1 and SN2 mechanisms; factors affecting rate
- [ ] **R3.4.6** (HL) Heterolytic fission; curly arrows
- [ ] **R3.4.7** (HL) Markovnikov's rule and carbocation stability
- [ ] **R3.4.8** (HL) Electrophilic substitution of benzene