

IB Chemistry
Telescoping the syllabus

| SYLLABUS TOPIC / SUB-TOPIC | Estimated time | Practical Skills | Primary NoS topics | Practical Investigations (These are prescribed in the syllabus) |
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| Core + HL topics first year | | <i>An example has been provided for you</i> | | |
| 1.1 introduction to particulate nature of matter and chemical change | 3 hours | Physical and chemical properties of matter | 3.1 | Scientific investigation on colligative properties |
| 1.2 The mole concept | 5 hours | 1. Calculation of molar masses 2. solution of problems involving the relationship between the number of particles, the amount of particles and moles 3. empirical formula | 2.3 | 1. weight 1 mole of several substances and compare masses and volumes, 2. Mg burning and empirical formula of Magnesium Oxide |
| 1.3 Reacting masses and volumes | 6 hours | 1. Solution of problems relating to reacting quantities 2. limiting reactant, 3. yield | 1.8 | 1. Simulation of gases laws 2. Preparation of standard solutions 3. Titration NaOHvsHCl |
| 2.1 The nuclear atom | 3 hours | 1. Atomic structure 2. Calculation of non-integer Ar and abundance of isotopes, including mass spectra | 1.8 | 1. Simulation of Rutherford Experiment, 2. essay on negative effects of radionuclides |
| 2.2 Electron configuration | 3 hours | 1. electron sub-shells, 2. Description of relationship between colour, wavelength, frequency and energy across the electromagnetic spectrum | 1.8, 1.9, 2.2 | 1. Simulation of lines spectra and continuous spectrum using a spectrometer 1.Flame test |
| 12.1 Electrons in atoms | 2 hours | Emission spectrum, the limit of convergence at higher frequency 2. Explanation of trends and discontinuities in first ionization energy across a period | 1.8 | usage of a data base for compiling graph trends in ionization energies |
| 3.1 Periodic table | 2 hours | relation between periodic table's arrangement into blocks and electron sub-levels | 9.1 | |
| 3.2 Periodic trends | 4 hours | Vertical and horizontal trends in the periodic table exist for Atomic radius, ionization energy, electron affinity and electronegativity | 3.1 | use of Mn oxide as catalysts in carbonate plus acid reaction |
| 13.1 First-row d-block elements | 1 hours | Transition metals have different oxidation states, form complex with ligands, have colored compounds and display catalytic properties | 3.1 | |
| 13.2 Coloured complexes | 3 hours | 1. Explanation of effect of identity of metal ion, oxidation number, nature of ligand on the colour of complex 2. Explanation of the effect of different ligands on splitting d-orbitals in transition metal complexes | 1.10 4.1 | |
| 4.1 Ionic bonding and structure | 2 hours | 1. Electrons exchange and relation with electron configuration 2. Deduction of formula and name of an ionic compound from its component ions, including polyatomic atoms | 2.2 | study of physical properties of different compound in relation to their structure |
| 4.2 Covalent bonding | 2 hours | Deduction of the polar nature of a covalent bond from electronegativity values | 2.5 2.2 | |
| 4.3 Covalent structures | 5 hours | 1. Deduction of Lewis structure 2. Use of VSEPR theory 3. prediction of bond angles 4.Giant covalent structures | 10.1 | computer simulation on VSEPR structures |
| 4.4 Intermolecular forces | 3 hours | 1. deduce the types of intermolecular force present in substances based on their structure and intermolecular forces 2.Explanation of the physical properties of covalent compounds in term of their structure and intermolecular forces | 2.2 | Polarity of liquids and deviation of their flux by a charged rod |
| 4.5 Metallic bonding | 2 hours | 1. explain physical properties of metals in terms of their structure 2. Explain the properties of Alloys in terms of non-directional bonding | 2.2 | |
| 14.1 Further aspects of covalent bonding and structure | 4 hours | 1. Prediction whether sigma or pi bonds from the linear combination of atomic orbitals 2. application of FC to ascertain which Lewis structure is preferred from different Lewis structures 3. explanation of the wavelength of light required to dissociate oxygen and ozone. effects of CFC and NOx | 2.7 | |
| 14.2 Hybridization | 3 hours | Hybrid orbitals results from different types of atomic orbitals on the same atom | 2.2 | 3d models to simulate hybrid orbitals |
| 6.1 Collision theory and rate of reactions | 9 hours | 1. Description of kinetic theory 2. Analysis of graphical and numerical data from rate experiments 3. Explanation of effect of temperature 4. Construction of Maxwell and Boltzmann energy distribution curves 4. sketching and explanation of energy profiles with and without catalyst | 2.7 | Investigation on rate of reaction |
| 16.1 Rate expression and reaction mechanism | 5 hours | 1. Deduction of rate expression for an equation from experimental data and solving problems involving the rate expression 2. Sketching, identifying and analysing graphical representation for zero, first and second order reactions | 2.7 | effect of concentration changes and determination of order of reaction? Find a simulation |
| 16.2 Activation energy | 2 hours | 1. analysing graphical representation of Arrhenius equation 2. the frequency factor (A) | 2.5 | |
| 7.1 Equilibrium | 5 hours | 1. deduction of the equilibrium constant expression (Kc) from an equation for an homogenous reaction 2. Relationship between different equilibrium constants for the same reaction at the same temperature 3. Application of Le Chatelier principle | 1.8 5.5 | |
| 17.1 The equilibrium law | 4 hours | 1. Solution of homogeneous equilibrium problems using Kc 2. relationship between ΔG and Kc, 3. solve problems using ΔG=-RTlnK | 1.8 1.9 | |
| 8.1 Theories of acids and bases | 1 hours | 1. Deduction of the Brønsted-Lowry acid and base in a chemical reaction. 2.Deduction of the conjugate acid or conjugate base in a chemical reaction. | 2.5 1.9 5.5 | |
| 8.2 Properties of acids and bases | 3 hours | 1. Balancing chemical equations for the reaction of acids. 2.Identification of the acid and base needed to make different salts. 3.Candidates should have experience of acid-base titrations with different indicators | 1.9 | 1.Titration of NaOH vs HCl using Methyl orange and Phenolphthalein 2. Computer simulation of determination of equivalence Point using different indicators |
| 8.3 The pH scale | 2 hours | 1. Solving problems involving pH, [H ⁺] and [OH ⁻]. 2. Students should be familiar with the use of a pHmeter and universal indicator | 2.7 | Preparing a pH scale using acids and bases at different concentration |
| 8.4 Strong and weak acids and bases | 1 hours | Distinction between strong and weak acids and bases in terms of the rates of their reactions with metals, metal oxides, metal hydroxides, metal hydrogen carbonates and metal carbonates and their electrical conductivities for solutions of equal concentrations. | 1.8, 1.9, 3.1 | |
| 8.5 Acid deposition | 2 hours | 1. Balancing the equations that describe the combustion of sulfur and nitrogen to their oxides and the subsequent formation of H ₂ SO ₄ , H ₂ SO ₃ , HNO ₂ and HNO ₃ . 2. Distinction between the pre-combustion and post-combustion methods of reducing sulfur dioxide emissions. 3. Deduction of acid deposition equations for acid deposition with reactive metals and carbonates. | 4.8 | |
| 18.1 Lewis acids and bases | 1 hour | Application of Lewis' acid-base theory to inorganic and organic chemistry to identify the role of the reacting species | 2.5 | |
| 18.2 Calculations involving acids and bases | 3 hours | 1. Solution of problems involving [H ⁺ (aq)], [OH ⁻ (aq)], pH, pOH, K _a , pK _a , K _b and pK _b . 2. Discussion of the relative strengths of acids and bases using values of K _a , pK _a , K _b and pK _b . | 1.9 | |

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| 18.3 pH curves second year | 6 hours | 1. The general shapes of graphs of pH against volume for titrations involving strong and weak acids and bases with an explanation of their important features. 2. Selection of an appropriate indicator for a titration, given the equivalence point of the titration and the end point of the indicator. 3. While the nature of the acid-base buffer always remains the same, buffer solutions can be prepared by either mixing a weak acid/base with a solution of a salt containing its conjugate, or by partial neutralization of a weak acid/base with a strong acid/base. 4. Prediction of the relative pH of aqueous salt solutions formed by the different combinations of strong and weak acid and base. | 3.7 | 1. Computer simulation of titrations with production of titrating curves 2. Plot a titrating curve using a pHmeter 3. Prepare a buffer solution using Acetic acid and NaOH, predict its pH and check the pH stability after little addition of acids and bases. Compare the results using water and strong acid solution as system |
| 11.1 Uncertainties and errors in measurement and results | 4 hours | 1. Distinction between random errors and systematic errors. 2. Record uncertainties in all measurements as a range (+) to an appropriate precision. 3. Discussion of ways to reduce uncertainties in an experiment. 4. Propagation of uncertainties in processed data, including the use of percentage uncertainties. 5. Discussion of systematic errors in all experimental work, their impact on the results and how they can be reduced. 6. Estimation of whether a particular source of error is likely to have a major or a minor effect on the final results | 3.2, 3.4 | |
| 11.2 Graphical techniques | 2 hours | 1. Drawing graphs of experimental results including the correct choice of axes and scale. 2. Interpretation of graphs in terms of the relationships of dependent and independent variables. 3. Production and interpretation of best-fit lines or curves through data points, including an assessment of when it can and cannot be considered as a linear function. 4. Calculation of quantities from graphs by measuring slope (gradient) and intercept, including appropriate units. | 2.8 | use of a spreadsheet to plot a graph a draw a best fit using excell |
| 10.1 Fundamental organic chemistry | 4 hours | 1. Explanation of the trends in boiling points of members of a homologous series 2. Identification of different classes: alkanes, alkenes, alkynes, halogenoalkanes, alcohols, ethers, aldehydes, ketones, esters, carboxylic acids, amines, amides, nitriles and arenes. 3. Identification of typical functional groups in molecules eg phenyl, hydroxyl, carbonyl, carboxyl, carboxamide, aldehyde, ester, ether, amine, nitrile, alkyl, alkenyl and alkynyl. 4. Distinction between empirical, molecular and structural formulas. 5. Application of IUPAC rules in the nomenclature of straight-chain and branched chain isomers. 6. Identification of primary, secondary and tertiary carbon atoms in halogenoalkanes and alcohols and primary, secondary and tertiary nitrogen atoms in amines. 7. Discussion of the structure of benzene using physical and chemical evidence | 1.4, 4.5 | Construction of 3-D models (real and virtual) of organic molecule |
| 5.1 Measuring energy changes | 3 hours | 1. Calculation of the heat change when the temperature of a pure substance is changed using $q = mc\Delta T$. | 2.6, 3.1 | Determination of enthalpy change of the reaction between HCl and NaOH, through determination temperature change using a calorimeter. |
| 5.2 Hess's law | 3 hours | 1. Application of Hess's Law to calculate enthalpy changes. 2. Calculation of ΔH of reactions using ΔH_f° data. 3. Determination of the enthalpy change of a reaction that is the sum of multiple reactions with known enthalpy changes. | 2.4 | |
| 5.3 Bond enthalpies | 3 hours | 1. Calculation of the enthalpy changes from known bond enthalpy values and comparison of these to experimentally measured values. 2. Sketching and evaluation of potential energy profiles in determining whether reactants or products are more stable and if the reaction is exothermic or endothermic. 3. Discussion of the bond strength in ozone relative to oxygen in its importance to the atmosphere. | 2.2 | Determination of enthalpy of combustion of propane |
| 15.1 Energy cycles | 4 hours | 1. Construction of Born-Haber cycles for group 1 and 2 oxides and chlorides. 2. Construction of energy cycles from hydration, lattice and solution enthalpy. For example dissolution of solid NaOH or NH ₄ Cl in water. 3. Calculation of enthalpy changes from Born-Haber or dissolution energy cycles. 4. Relate size and charge of ions to lattice and hydration enthalpies. | 3.2 | lab experiments which could include single replacement reactions in aqueous solutions (?) |
| 15.2 Entropy and spontaneity | 3 hours | 1. Prediction of whether a change will result in an increase or decrease in entropy by considering the states of the reactants and products. 2. Calculation of entropy changes (ΔS) from given standard entropy values (S°). 3. Application of $\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$ in predicting spontaneity and calculation of various conditions of enthalpy and temperature that will affect this. 4. Relation of ΔG to position of equilibrium. | 2.2 | Use of databases to research hypothetical reactions capable of generating free energy |
| 9.1 Oxidation and reduction | 3 hours | 1. Deduction of the oxidation states of an atom in an ion or a compound. 2. Deduction of the name of a transition metal compound from a given formula, applying oxidation numbers represented by Roman numerals. 3. Identification of the species oxidized and reduced and the oxidizing and reducing agents, in redox reactions. 4. Deduction of redox reactions using half-equations in acidic or neutral solutions. 5. Deduction of the feasibility of a redox reaction from the activity series or reaction data. 6. Solution of a range of redox titration problems. 7. Application of the Winkler Method to calculate BOD. | 1.9 | |
| 9.2 Electrochemical cells | 5 hours | 1. Construction and annotation of both types of electrochemical cells. 2. Explanation of how a redox reaction is used to produce electricity in a voltaic cell and how current is conducted in an electrolytic cell. 3. Distinction between electron and ion flow in both electrochemical cells. 4. Deduction of the products of the electrolysis of a molten salt. | 4.5 | 1. Making a Daniel voltaic cell 2. Video of electrolysis experiments could include that of a molten salt. |
| 19.1 Electrochemical cells | 3 hours | 1. Calculation of cell potentials using standard electrode potentials. 2. Prediction of whether a reaction is spontaneous or not using E° values. 3. Determination of standard free-energy changes (ΔG°) using standard electrode potentials. 4. Explanation of the products formed during the electrolysis of aqueous solutions. 5. Perform lab experiments that could include single replacement reactions in aqueous solutions. 6. Determination of the relative amounts of products formed during electrolytic processes. 7. Explanation of the process of electroplating. | 3.1, 4.5 | Microbiological fuels cells (video) |

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| | | Alkanes: •Writing equations for the complete and incomplete combustion of hydrocarbons. •Explanation of the reaction of methane and ethane with halogens in terms of a free-radical substitution mechanism involving photochemical homolytic fission. Alkenes: •Writing equations for the reactions of alkenes with hydrogen and halogens and of symmetrical alkenes with hydrogen halides and water. •Outline of the addition polymerization of alkenes. •Relationship between the structure of the monomer to the polymer and repeating unit. Alcohols: •Writing equations for the complete combustion of alcohols. •Writing equations for the oxidation reactions of primary and secondary alcohols (using acidified potassium dichromate(VI) or potassium manganate(VII) as oxidizing agents). Explanation of distillation and reflux in the isolation of the aldehyde and carboxylic acid products. •Writing the equation for the condensation reaction of an alcohol with a carboxylic acid, in the presence of a catalyst (eg concentrated sulfuric acid) to form an ester. Halogenoalkanes: •Writing the equation for the substitution reactions of halogenoalkanes with aqueous sodium hydroxide. | | |
| 10.2 Functional group chemistry | 7 hours | | 3.1 | preparing soap |
| 20.1 Types of organoc reactions | 4 hours | Nucleophilic Substitution Reactions: •Explanation of why hydroxide is a better nucleophile than water. •Deduction of the mechanism of the nucleophilic substitution reactions of halogenoalkanes with aqueous sodium hydroxide in terms of SN1 and SN2 mechanisms. Explanation of how the rate depends on the identity of the halogen (ie the leaving group), whether the halogenoalkane is primary, secondary or tertiary and the choice of solvent. •Outline of the difference between protic and aprotic solvents. Electrophilic Addition Reactions: •Deduction of the mechanism of the electrophilic addition reactions of alkenes with halogens/interhalogens and hydrogen halides. Electrophilic Substitution Reactions: •Deduction of the mechanism of the nitration (electrophilic substitution) reaction of benzene (using a mixture of concentrated nitric acid and sulfuric acid). Reduction Reactions: •Writing reduction reactions of carbonyl-containing compounds: aldehydes and ketones to primary and secondary alcohols and carboxylic acids to aldehydes, using suitable reducing agents. •Conversion of nitrobenzene to phenylamine via a two-stage reaction. | 4.1, 4.5 | separating organic compound (distillation and cristalization) |
| 20.2 Syntetic ruote | 2 hours | Deduction of multi-step synthetic routes given starting reagents and the product(s). | 1.3 | |
| 20.3 Stereoisomerism | 5 hours | Explanation of stereoisomerism in non-cyclic alkenes and C3 and C4 cycloalkanes. Comparison between the physical and chemical properties of enantiomers. •Description and explanation of optical isomers in simple organic molecules. •Distinction between optical isomers using a polarimeter. | 4.1 | Construction of 3-D models (real and virtual) of a wide range of stereoisomers. |