**Two-year course overview**

 **IBDP (CHEMISTRY) SL/HL 2023-2025**

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| **IB DP1 (YEAR 1 – AUGUST 2023 - JUNE 2024)** |
| **Title of unit/course component + duration** | **Essential Questions** | **Content, skills, concepts****and links to the IB Learner Profile** | **Assessment types and tasks** | **Summative assessment task(s)** | **Resources** | **TOK Links** |
| **Skills in the study of chemistry****2 weeks** | What must we take into account while evaluating experimental results? | **Contents**Uncertainties and errors in measurement and resultsGraphical techniques**Skills** **-**Distinction between random errors and systematic errors. **-**Record uncertainties in all measurements as a range (+) to an appropriate precision.**-**Discussion of ways to reduce uncertainties in an experiment.-Propagation of uncertainties in processed data, including the use of percentage uncertainties.-Discussion of systematic errors in all experimental work, their impact on the results and how they can be reduced.-Estimation of whether a particular source of error is likely to have a major or minor effect on the final result. -Calculation of percentage error when the experimental result can be compared with a theoretical or accepted result. -Distinction between accuracy and precision in evaluating results. -Drawing graphs of experimental results including the correct choice of axes and scale. -Interpretation of graphs in terms of the relationships of dependent and independent variables. -Calculation of quantities from graphs by measuring slope (gradient) and intercept, including appropriate signs**ATL -Thinking - Communication**  | FormativeLabs:* measuring the density of water

densities labTests/Worksheets/Quizzes on covered concept(s) | The summative task will be assessed through the reports of compulsory labs/PSOW and IA. | Resources include handouts, question sheets, labs, tests, exams, videos, PPT’s and more.:Resources are uploaded to Managebac® for students to use when the topic is being covered. | Science has been described as a self-correcting and communal publicendeavour. To what extent do these characteristics also apply to the other areas of knowledge? |
| **Structure 1.1****& Reactions 2.1****SL 4 Weeks****Structure 1.5 (HL only)****1 week** | How can we model the particulate nature of matter?How can we correlate the number of particles with the mass?How can we calculate the reacting ratios by mass and gaseous volume?How do we quantify matter on the atomic scale?How are chemical equations used to calculate reacting ratios? | **Contents**1.1.1 —Elements are the primary constituents of matter, which cannot be chemically broken down into simpler substances2.2.10—Chromatography is a technique used to separate the components of a mixture based on their relative attractions involving intermolecular forces to mobile and stationary phases.1.1.2 —The kinetic molecular theory is a model to explain physical properties of matter (solids, liquids and gases) and changes of state1.1.3 —The temperature, T, in Kelvin (K) is a measure of average kinetic energy Ek of particles1.4.1—Counting particles by mass: The mole1.4.2—Masses of atoms are compared on a scale relative to 12C1.4.3—Molar mass M1.4.4—The empirical formula of a compound1.4.5—The molar concentration is determined by the amount of solute and the volume of solution2.1.1—Chemical equations show the ratio of reactants and products in a reaction2.1.3—The limiting reactant2.1.4—The percentage yield2.1.5—The atom economy**(AHL ONLY)**1.5.1—An ideal gas consists of moving particles with negligible volume and no intermolecular forces.1.5.2—Real gases deviate from the ideal gas model, particularly at low temperature and high pressure.1.5.3—The molar volume of an ideal gas is a constant at a specific temperature and pressure.1.5.4—The relationship between the pressure, volume, temperature and amount of an ideal gas**Skills**Deduction of chemical equations when reactants and products are specified.Calculation of the molar masses of atoms, ions, molecules and formula units.Solution of problems involving the relationships between the number of particles, the amount of substance in moles and the mass in grams. Interconversion of the percentage composition by mass and the empirical formula.**Concept (s)** Mole, Equilibrium, Change**ATL-** Communication, Thinking-Students will write a detailed lab report with special emphasis on communicating uncertainties in the calculated values based on stoichiometric relationships.**Learner Profile**Inquirer, Knowledgeable, Thinker, Communicator | **Formative**Labs Reports:* empirical formula of magnesium oxide
* formula of a hydrate
* measurement and uncertainty
* finding the limiting reagent
* preparing solutions

Worksheets/Quizzes | **Unit Test**MCQ+ Database questions, Short answer questionsThe score will be converted to 100% and graded (1-7) using IB grade boundaries. | Resources include handouts, question sheets, labs, tests, exams, videos, PPT’s and more.:Resources are uploaded to Managebac® for students to use when the topic is being covered. | The magnitude of Avogadro’s constant is beyond the scale of our everydayexperience. How does our everyday experience limit our intuition? |
| **Structure 1.2—The nuclear atom****Structure 1.3—Electron configurations****SL 2 weeks****Structure 1.2-3****(AHL only)****1 week** | How do the nuclei of atoms differ?What determines the quantized nature of energy transition?How can we model the energy states of electrons in atoms? | 1.2.1—Atoms contain a positively charged, dense nucleus composed of protons and neutrons (nucleons). Negatively charged electrons occupy the space outside the nucleus.1.2.2—Isotopes are atoms of the same element with different numbers of neutrons.1.3.1—Emission spectra are produced by atoms emitting photons when electrons in excited states return to lower energy levels.1.3.2—The line emission spectrum of hydrogen provides evidence for the existence of electrons in discrete energy levels, which converge at higher energies.1.3.3—The main energy level is given an integer number, n,1.3.4—A more detailed model of the atom describes the division of the main energy level into s, p, d and f sublevels of successively higher energies1.3.5—Each orbital has a defined energy state for a given electron configuration and chemical environment, and can hold two electrons of opposite spin.**(Additional Higher Level)**1.2.3—Mass spectra are used to determine the relative atomic masses of elements from their isotopic composition1.3.6—In an emission spectrum, the limit of convergence at higher frequency corresponds to ionization.1.3.7—Successive ionization energy (IE) data for an element give information about its electron configuration.**Skills**Use of the nuclear symbol notation to deduce the number of protons, neutrons and electrons in atoms and ions.Calculations involving non-integer relative atomic masses and abundance of isotopes from given data, including mass spectra.Description of the relationship between colour, wavelength, frequency and energy across the electromagnetic spectrum.Distinction between a continuous spectrum and a line spectrum.**Concept**Change, Atomic Structure, Electron arrangement**ATL-Thinking** , **Social** **Research** When creating models students will be working collaboratively in teams to research on Bohr's model of the atom.**Learner Profile**Inquirer, Knowledgeable, Thinker | Formative:Lab:flame testsTests/Worksheets/Quizzeson covered concept(s) | **Unit Test** MCQ+ Database questions, Short answer questionsThe score will be converted to 100% and graded (1-7) using IB grade boundaries. | Resources include handouts, question sheets, labs, tests, exams, videos, PPT’s and more.:Resources are uploaded to Managebac® for students to use when the topic is being covered. | What is the significance of the model of the atom in the different areas of knowledge? Are the models and theories that scientists create accurate descriptions of the natural world, or are they primarily useful interpretations for prediction, explanation and control of the natural world? |
| **Structure 3.1 Periodicity****SL 2 weeks****AHL****1 week** | How does the periodic table help us to predict patterns and trends in the properties of elements? | 3.1.1—The periodic table consists of periods, groups and blocks3.1.2—The period number shows the outer energy level that is occupied by electrons. Elements in a group have a common number of valence electrons.3.1.3—Periodicity refers to trends in properties of elements across a period and down a group.3.1.4—Trends in properties of elements down a group include the increasing metallic character of group 1 elements and decreasing non-metallic character of group 17 elements.3.1.5—Metallic and non-metallic properties show a continuum. This includes the trend from basic metal oxides through amphoteric to acidic non-metal oxides.2.1.1—When metal atoms lose electrons, they form positive ions called cations. When non-metal atoms gain electrons, they form negative ions called anions.Structure 3.1.6—The oxidation state is a number assigned to an atom to show the number of electrons transferred in forming a bond.**(Additional higher Level)**3.1.7—Discontinuities occur in the trend of increasing first ionization energy across a period3.1.8—Transition elements have incomplete d-sublevels that give them characteristic properties.3.1.9—The formation of variable oxidation states in transition elements can be explained by the fact that their successive ionization energies are close in value.3.4.8—Coordination bonds are formed when ligands donate an electron pair to transition element cations, forming complex ions.3.1.10—Transition element complexes are coloured due to the absorption of light when an electron is promoted between the orbitals in the split d-sublevels. The colour absorbed is complementary to the colour observed.**Skills**Prediction and explanation of the metallic and non-metallic behaviour of an element based on its position in the periodic table.Discussion of the similarities and differences in the properties of elements in the same group, with reference to alkali metals (group 1) and halogens (group 17).**Concept**Periodicity, Mole**ATL Thinking Social Communication Self-Management Research** | Labs:* trends in atomic radius and ionization energy
* reactivity of halogens
* complex ions
* practice design lab - volume of a drop

Tests/Worksheets/Quizzes on covered concept(s) | Unit Test MCQ+ Database question+ Short answer questionsThe score will be converted to 100% and graded (1-7) using IB grade boundaries. | Resources include handouts, question sheets, labs, tests, exams, videos, PPT’s and more.:Resources are uploaded to Managebac® for students to use when the topic is being covered. | The elements allowed chemistry to make great steps with limited apparatus, often derived from the pseudoscience of alchemy. Lavoisier’s work with oxygen, which overturned the phlogiston theory of heat, could be discussed as an example of a paradigm shift. |
| **Structure 2. Models of bonding and structure****SL 4 weeks** **AHL****2 weeks** | How are ionic compounds held together?How are covalent compounds formed? How can we predict the nature of a compound?How do we predict the molecular shapes?What determines the physical properties of molecular substances?How do the metallic bonds form?What is hybridization of atomic orbitals? | **Structure 2.1—The ionic model**2.1.2—The ionic bond is formed by electrostatic attractions between oppositely charged ions.2.1.3—Ionic compounds exist as three-dimensional lattice structures, represented by empirical formulas**Structure 2.2—The covalent model**2.2.1—A covalent bond is formed by the electrostatic attraction between a shared pair of electrons and the positively charged nuclei.2.2.2—Single, double and triple bonds involve one, two and three shared pairs of electrons respectively2.2.3—A coordination bond is a covalent bond in which both the electrons of the shared pair originate from the same atom.2.2.4—The valence shell electron pair repulsion (VSEPR) model enables the shapes of molecules to be predicted from the repulsion of electron domains around a central atom.2.2.5—Bond polarity 2.2.6—Molecular polarity2.2.8—Intermolecular forces2.2.9—Relative strengths of intermolecular forces 2.2.7—Covalent network structures.2.3.1,2,3 —The metallic bond2.4.3—Alloys2.4.2,2 —The bonding triangle.**(Additional higher level)**2.2.15—Sigma bonds σ & Pi bonds π 2.2.11—Resonance structures2.2.12—Benzene, 2.2.13—Expanded octet of electrons.2.2.14—Formal chargee 2.2.16—Hybridization**Skills**-Deduction of the formula and name of an ionic compound from its component ions, including polyatomic ions.-Explanation of the physical properties of ionic compounds (volatility, electrical Conductivity and solubility) in terms of their structure. -Deduction of the polar nature of a covalent bond from electronegativity values. -Deduction of Lewis (electron dot) structure of molecules and ions showing all valence electrons for up to four electron pairs on each atom.The use of VSEPR theory to predict the electron domain geometry and the molecular geometry for species with two, three and four electron domains.Prediction of bond angles from molecular geometry and presence of nonbonding pairs of electrons.Prediction of molecular polarity from bond polarity and molecular geometry.Deduction of resonance structures, examples include but are not limited to C6H6, CO32-and O3.Deduction of the types of intermolecular force present in substances, based on their structure and chemical formula.**Concepts**Bonding, **ATL****THINKING-** students will have to apply theoretical knowledge to lab work**SOCIAL-** students work in group during the lab work**COMMUNICATION-** students will write a lab report**SELF MANAGEMENT-** students will have a set time to complete the lab work**RESEARCH-** they will get into details of how periodic table was developed**Learner Profile**Inquirer. Knowledgeable, Thinker, Communicator | Labs:* modeling molecules using molymolds
* meting point experiments
* properties of ionic and covalent compounds

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| **Reactivity 1.1—Measuring enthalpy changes.****SL 4 weeks****AHL****1 week** | What can be deduced from the temperature change that accompanies chemical or physical change?How does application of the law of conservation of energy help us to predict energy changes during reactions?What are the challenges of using chemical energy to address our energy needs?What determines the direction of chemical change? | 1.1.1—Chemical reactions involve a transfer of energy between the system and the surroundings1.1.2—Reactions are described as endothermic or exothermic1.1.3—The relative stability of reactants and products1.1.4—The standard enthalpy change for a chemical reaction.1.2.1—Bond-breaking absorbs and bond-forming releases energy1.2.2—Hess’s law.1.3.1,2—Energy from fuels1.3.3—Fossil fuels advantages and disadvantages1.3.4—Biofuels1.3.5—Fuel cells.**Additional higher level:** 1.2.3—Thermodynamic calculations.1.2.4—An application of Hess’s law1.2.5—Born–Haber cycles.1.4.1—Entropy1.4.2,3,4—Gibbs free energy**Skills**Calculation of the heat change when the temperature of a pure substance is changed using 𝑞 =𝑚cΔ𝑇.A calorimetry experiment for an enthalpy of reaction should be covered and the results evaluated.Calculation of Δ𝐻𝐻 reactions using ΔHf ° data.Calculation of the enthalpy changes from known bond enthalpy values and comparison of these to experimentally measured values.Sketching and evaluation of potential energy profiles in determining whether reactants or products are more stable and if the reaction is exothermic or endothermic.**Concept**Enthalpy, Entropy, Energy Conservation**ATL Thinking** **Social** **Research** Determining energy content of important substances in food and fuels.**Learner Profile**Caring Knowledgeable, Inquirer | Labs:* heat of combustion of ethanol
* determining the enthalpy change for the thermal decomposition of potassium hydrogen carbonate by Hess’ Law
* using bond enthalpies to calculate the enthalpy of combustion for alcohols using a spreadsheet

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| **Reactivity 2. How fast?****SL 3 weeks****AHL****2 weeks** | How can the rate of a reaction be controlled? | 2.2.1—The rate of reaction2.2.2—Species react as a result of collisions2.2.3—Factors that influence the rate of a reaction2.2.4—Activation energy2.2.5—Catalysts**Additional higher level**: 2.2.6—Many reactions occur in a series of elementary steps.2.2.7—Energy profiles2.2.8—The molecularity of an elementary step2.2.9—Rate equations2.2.10—The order of a reaction.2.2.11—The rate constant, k2.2.12—The Arrhenius equation2.2.13—The Arrhenius factor**Skills**Calculation of the heat change when the temperature of a pure substance is changed using 𝑞 =𝑚cΔ𝑇.A calorimetry experiment for an enthalpy of reaction should be covered and the results evaluated.Calculation of Δ𝐻𝐻 reactions using ΔHf ° data.Calculation of the enthalpy changes from known bond enthalpy values and comparison of these to experimentally measured values.Sketching and evaluation of potential energy profiles in determining whether reactants or products are more stable and if the reaction is exothermic or endothermic.**Concept**Enthalpy, Entropy, Energy Conservation**ATL Thinking** **Social** **Research** Determining energy content of important substances in food and fuels.**Learner Profile**Inquirer Knowledgeable Thinker Communicator. | Labs:* iodine clock experiment virtual lab
* on-line science simulation - marble chip
* rate of reaction design lab
* determining Ea for a reaction

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| **IB DP2 (YEAR 2 – AUGUST 2024 - JUNE 2025)** |
| **Title of unit/course component + duration** | **Essential Questions** | **Content, skills, concepts****and links to the IB Learner Profile** | **Assessment types and tasks** | **Summative assessment task(s)** | **Resources** | **TOK Links** |
| **Reactivity 2. How far?****SL 2 weeks****AHL 1 week** | How can the extent of a reversible reaction be influenced? | 2.3.1—Dynamic equilibrium2.3.2—The equilibrium law2.3.3—The equilibrium constant2.3.4—Le Châtelier’s principle**Additional higher level:** 2.3.5—The reaction quotient, Q2.3.6—Equilibrium calculations2.3.7—The equilibrium constant and Gibbs energy change.**Skills**Deduction of the equilibrium constant expression (*Kc*) from an equation for ahomogeneous reaction.Determination of the relationship between different equilibrium constants (*K*c) for the same reaction at the same temperature.**Concept**Equilibrium, Rate of chemical reaction**ATL: Thinking,** **Communication** Think how the following can be applied to a balanced equation at equilibrium-Application of Le Châtelier’s principle to predict the qualitative effects of changes of temperature, pressure and concentration on the position of equilibrium and on the value of the equilibrium constant.**Learner Profile**Inquirer Knowledgeable Thinker Communicator. | Labs:* equilibrium simulation
* Le Châtelier’s Principle

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| **Reactivity 3.1—Proton transfer reactions (acids and Bases)****SL 3 weeks****AHL 1 week** | What happens when protons are transferred? | 3.2.4—Acids react with reactive metals to release hydrogen3.1.1—Brønsted–Lowry3.1.2—Conjugate acid–base pairs.3.1.3—Amphiprotic species3.1.4—The pH scale3.1.5—The ion product constant of water, Kw,3.1.6—Strong and weak acids and bases.3.1.7—Neutralisation3.1.8—pH curves strong acid vs base3.4.6,7—A Lewis acid is an electron-pair acceptor and a Lewis base is an electron-pair donor.**Additional higher level**: 3.1.9—The pOH scale3.1.10—Ka , Kb, pKa or pKb values.3.1.11—Ka × Kb = Kw 3.1.12—Salt hydrolysis3.1.13—pH curves of different combinations of strong and weak monoprotic acids and bases3.1.14,15—Acid–base indicators3.1.16,17 —Buffer solutions**Skills**Deduction of the Brønsted–Lowry acid and base in a chemical reaction.Deduction of the conjugate acid or conjugate base in a chemical reaction.Balancing chemical equations for the reaction of acids.Identification of the acid and base needed to make different salts.Solving problems involving pH, [H+] and [OH−].**Concept**pH, Buffer**ATL**THINKING- students will have to apply theoretical knowledge to lab work | Labs:* titration practice lab
* analysis of aspirin tablets
* ethanoic acid content in vinegar
* CaCO3 in egg shells
* determining pKa for a weak acid
* virtual lab buffers
* identification of carboxylic acid using titration curve
* virtual titration lab
* design lab - buffer or weak acid

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| **Reactivity 3.2—Electron transfer reactions (REDOX)****SL 2 weeks****AHL 1 week** | What happens when electrons are transferred? | 3.2.1—Oxidation and reduction can be described in terms of electron transfer, change in oxidation state, oxygen gain/loss or hydrogen loss/gain3.2.2—REDOX Half-equations3.2.3—The relative ease of oxidation and reduction3.2.5—Electrochemical cells3.2.6—Voltaic cells3.2.7—Secondary (rechargeable) cells3.2.8—Electrolytic cells**Additional higher level:** 3.2.12—The hydrogen half-cell3.2.13—Standard cell potential3.2.14—The relationship between standard change in Gibbs energy and standard cell potential.3.2.15—During electrolysis of aqueous solutions, competing reactions can occur.3.2.16—Electroplating.**Skills**Deduction of the oxidation states of an atom in an ion or a compound.Deduction of the name of a transition metal compound from a given formula, applying oxidation numbers represented by Roman numerals.Identification of the species oxidized and reduced and the oxidizing and reducing agents, in redox reactions.Deduction of redox reactions using half-equations in acidic or neutral solutions.Deduction of the feasibility of a redox reaction from the activity series or reaction data.Solution of a range of redox titration problems.Construction and annotation of both types of electrochemical cellsPerformance of laboratory experiments involving a typical voltaic cell using two metal/metal-ion half-cells.Explanation of the trends in boiling points of members of a homologous series.Distinction between empirical, molecular and structural formulas.**Concept:** Energy, Environment,**ATL****thinking** - students will have to apply their theoretical knowledge to lab work**social-** students will work in groups during the lab work**communication-** students will write a lab report**self-management-** students will have a set time to complete and hand in the lab work**Research-** students will research how electrolysis is used in large-scale industrial processes.**Learner Profile:** Inquirer Knowledgeable Thinker Communicator. | Labs:* chlorine content of swimming pools
* Fe redox titration with KMnO4
* reactivity experiments
* Electrolysis
* Electrochemical cells
* Design lab - electrochemical cells

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| **Structure 3.2— Reactivity 3.2** **(Organic Chemistry 1) . Functional group chemistry:****SL 4 weeks****AHL 2 weeks** | How does the classification of organic molecules help us to predict their properties?Why are some reactions of alkenes classified as reduction reactions while others are classified as electrophilic addition reactions?What happens when reactants share their electron pairs with others? | S. 3.2.1—Organic compounds can be represented by different types of formulas.S 3.2.2—Functional groups give characteristic physical and chemical properties to a compound.S 3.2.3,4—Homologous seriesS 3.2.5—“IUPAC nomenclature”S 3.2.6—Structural isomerism.R 3.2.9,10—Functional groups in organic compounds may undergo REDOX.R 3.2.11—Reduction of unsaturated compoundsR 3.3.1—A radical is a molecular entity that has an unpaired electron.R 3.3.2—Radicals are produced by homolytic fissionR 3.3.3—Radicals take part in substitution reactionsR 3.4.3—Heterolytic fissionR 3.4.4— electrophilesR 3.4.5—Alkenes are susceptible to electrophilic attack**Additional higher level:** S 3.2.7—StereoisomersR 3.4.1—NucleophilesR 3.4.2—Nucleophilic substitution reactionsR 3.4.9—Nucleophilic substitution reactions include the reactions between halogenoalkanes and nucleophilesR 3.4.10—The rate of the substitution reactions is influenced by the identity of the leaving groupR 3.4.11—Alkenes readily undergo electrophilic addition reactions.R 3.4.12—The relative stability of carbocationsR 3.4.13—Electrophilic substitution reactions include the reactions of benzene with electrophiles.**Skills**Identification of different classes: alkanes, alkenes, alkynes, halogenoalkanes, alcohols, ethers, aldehydes, ketones, esters, carboxylic acids, amines, amides,nitriles and arenes.Identification of typical functional groups in molecules eg phenyl, hydroxyl,carbonyl, carboxyl, carboxamide, aldehyde, ester, ether, amine, nitrile, alkyl, alkenyl and alkynyl.Construction of 3-D models (real or virtual) of organic molecules.**Concept**Orientation of Atoms and Molecules, Energy, Enthalpy**ATL****Thinking**-students will have to apply theoretical knowledge to lab work **Social-** Students work in groups during lab work**Communication-** Students will write a lab report**Self-management-** students will have a set time to complete the lab work | Labs:* boiling point trends in organic compounds (database)
* reactions of organic compounds
* hydrolysis of halogenoalkanes
* Identification of functional groups

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| **MOCK EXAMS - (2 weeks)****March 2025** |
| **Organic Chemistry 2.****Structure 2.****Polymers****SL 1 week****AHL only****2 weeks** **Structure 3.2 (spectroscopic Identification of organic compounds)**  | What are the structural features of some plastics that make them biodegradable?Why is the atom economy 100% for an addition polymerization reaction?What are the techniques used in structural determination of organic and inorganic compounds?Can we have a technique to determine a complete structure of a molecule? | **2**.4.4—Polymers2.4.5—Addition polymers**Additional higher level:** 2.4.6—Condensation polymers3.2.8—Mass spectrometry (MS) of organic compounds3.2.9—Infrared (IR) spectroscopy3.2.10—Proton nuclear magnetic resonance spectroscopy (1H NMR)3.2.11—High resolution 1HNMR.3.2.12—combined techniques.**Skills**Deduction of information about the structural features of a compound from percentage composition data, MS, 1H NMR or IR.**Concept**Fragmentation patternsATL**Thinking -**Students will learn to calculate the IHD of organic compounds and ﻿interpret spectrograms,**Learner Profile**Inquirer Principled Thinker | Data processing and Error analysis in IAsTests/Worksheets/Quizzes on covered concept(s) | Unit Test MCQ+ Database questions + Short answer questionsThe score will be converted to 100% and graded (1-7) using IB grade boundaries. | Resources include handouts, question sheets, labs, tests, exams, videos, PPT’s and more. Resources are uploaded to Managebac® for students to use when the topic is being covered. | Electromagnetic waves can transmit information beyond that of our senseperceptions. What are the limitations of sense perception as a way of knowing? |
| **IBDP EXAMS (3 weeks)** **May 2025** |

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