Diploma Programme subject outline—Group 4: Chemistry

School name	Ela Green School	**School code**	060876
Name of the DP subject *(indicate language)*	IB Chemistry		
Level *(indicate with X)*	Higher ☒ Standard completed in two years ☒ Standard completed in one year * ☐		
Name of the teacher who completed this outline	Reshma R Bhat	**Date of IB training**	3rd May 2023- 30th May 2023
Date when outline was completed	24TH April 2023	**Name of workshop** *(indicate name of subject and workshop category)*	IB Category 1

* All Diploma Programme courses are designed as two-year learning experiences. However, up to two standard level subjects, excluding languages ab initio and pilot subjects, can be completed in one year, according to conditions established in the *Handbook of procedures for the Diploma Programme*.

1. Course outline

- Use the following table to organise the topics to be taught in the course. If you need to include topics that cover other requirements you have to teach (for example, national syllabus), make sure that you do so in an integrated way, but also differentiate them using italics. Add as many rows as you need.
- This document should not be a day-by-day accounting of each unit. It is an outline showing how you will distribute the topics and the time to ensure that students are prepared to comply with the requirements of the subject.
- This outline should show how you will develop the teaching of the subject. It should reflect the individual nature of the course in your classroom and should not just be a "copy and paste" from the subject guide.
- If you will teach both higher and standard level, make sure that this is clearly identified in your outline.

Topic/unit (as identified in the IB subject guide) *State the topics/units in the order you are planning to teach them.*	Contents	Allocated time	Assessment instruments to be used	Resources *List the main resources to be used, including information technology if applicable.*
YEAR 1 **Structure 1. Models of the particulate nature of matter** Structure 1.1—Introduction to the particulate nature of matter Structure 1.2—The nuclear atom Structure 1.3—Electron configurations Structure 1.4—Counting particles by mass: The mole **Reactivity 2. How much, how fast and how far?** Reactivity 2.1—How much? The amount of chemical change Structure 1.5—Ideal gases	**Structure 1.1—Introduction to the particulate nature of matter** Structure 1.1.1—Elements are the primary constituents of matter, which cannot be chemically broken down into simpler substances. Compounds consist of atoms of different elements chemically bonded together in a fixed ratio. Mixtures contain more than one element or compound in no fixed ratio, which are not chemically bonded and so can be separated by physical methods. Structure 1.1.2—The kinetic molecular theory is a model to explain physical properties of matter (solids, liquids and gases) and changes of state. Structure 1.1.3—The temperature, T, in Kelvin (K) is a measure of average kinetic energy E_k of particles. **Structure 1.2—The nuclear atom** Structure 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. Structure 1.2.2—Isotopes are atoms of the same element with different numbers of neutrons.	**Standard level 17+ 7 hours and higher level: 21 hours** **Standard level and higher level: 2 hours** **Standard level and higher level: 2 hours**	**Summative Assessment** Summative task based on objectives 1& 2 1.Demonstrate knowledge and understanding 2. Apply Written test and structured questions **FormativeAssessment** Observation of practical skills and ability to follow steps and show working,Quiz,Worksheets and practicals Simulation Lab, % Yield MgO lab **ATLskills:** Research and communication	1.http://antoine.frostburg.edu/chem/senese/101/history/faq/discovery-of-oxygen.shtml 2. https://philosophicallydisturbed.wordpress.com/2011/02/22/phlogiston-theory/ 3.http://mw2.concord.org/public/student/gaslaws/gaslab.cml 4.http://www2.gsu.edu/~mstnrhx/9870/science.htm 5. http://trailblazing.royalsociety.org/ 6. http://chemcollective.org/activities/type_page/1 7. Chemistry by Hodder Education Edition 3 8. A-Level chemistry books 9. Pradeep's chemistry (numerical and

	Additional higher level Structure 1.2.3—Mass spectra are used to determine the relative atomic masses of elements from their isotopic composition. **Structure1.3—Electron configurations** Structure 1.3.1—Emission spectra are produced by atoms emitting photons when electrons in excited states return to lower energy levels. Structure 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. Structure 1.3.3—The main energy level is given an integer number, *n*, and can hold a maximum of $2n^2$ electrons. Structure 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 energies. Structure 1.3.5—Each orbital has a defined energy state for a given electron configuration and chemical environment, and can hold two electrons of opposite spin. Sublevels contain a fixed number of orbitals, regions of space where there is a high probability of finding an electron. **Additional higher level** Structure 1.3.6—In an emission spectrum, the limit of convergence at higher frequency corresponds to ionization. Structure 1.3.7—Successive ionization energy (IE) data for an element give information about its electron configuration. **Structure1.4—Counting particles by mass**: The mole Structure 1.4.1—The mole (mol) is the SI unit of amount of substance. One mole contains exactly the number of elementary entities given by the Avogadro constant. Structure 1.4.2—Masses of atoms are compared on a scale relative to ^{12}C and are expressed as relative atomic mass A_r and relative formula mass M_r . Structure 1.4.3—Molar mass *M* has the units g mol^{-1}.Structure 1.4.4—The empirical formula of a compound gives the simplest ratio of atoms of each element present in that compound. The molecular formula gives the actual number of atoms of each element present in a molecule.	**Additional higher level: 1 hour** **Standard level and higher level: 3 hours** **Additional higher level: 3 hours** **Standard level and higher level: 7 hours**	skills **LPA:** Knowledgeable and Inquirers	derivation of Van der waal equation) 10. Simulations (Phet, etc),Data logging, databases, and spreadsheets are in use in class

	Structure 1.4.5—The molar concentration is determined by the amount of solute and the volume of solution. Structure 1.4.6—Avogadro’s law states that equal volumes of all gases measured under the same conditions of temperature and pressure contain equal numbers of molecules. **Reactivity 2. How much, how fast and how far?** Reactivity 2.1.1—Chemical equations show the ratio of reactants and products in a reaction. Reactivity 2.1.2—The mole ratio of an equation can be used to determine: • the masses and/or volumes of reactants and products • the concentrations of reactants and products for reactions occurring in solution. Reactivity 2.1.3—The limiting reactant determines the theoretical yield. Reactivity 2.1.4—The percentage yield is calculated from the ratio of experimental yield to theoretical yield. Reactivity 2.1.5—The atom economy is a measure of efficiency in green chemistry. **Structure 1.5—Ideal gases** Structure 1.5.1—An ideal gas consists of moving particles with negligible volume and no intermolecular forces. All collisions between particles are considered elastic. Structure 1.5.2—Real gases deviate from the ideal gas model, particularly at low temperature and high pressure. Structure 1.5.3—The molar volume of an ideal gas is a constant at a specific temperature and pressure. Structure 1.5.4—The relationship between the pressure, volume, temperature and amount of an ideal gas is shown in the ideal gas equation $PV = nRT$ and the combined gas law $P_1V_1/T_1 = P_2V_2/T_2$	**Standard level and higher level: 7 hours** **Standard level and higher level: 3 hours**		

Topic/unit (as identified in the IB subject guide) *State the topics/units in the order you are planning to teach them.*	Contents	Allocated time	Assessment instruments to be used	Resources *List the main resources to be used, including information technology if applicable.*
Reactivity 1. What drives chemical reactions? Reactivity 1.1—Measuring enthalpy change Reactivity 1.2—Energy cycles in reactions Reactivity 1.3—Energy from fuels Reactivity 1.4—Entropy and spontaneity (Additional higher level)	**Reactivity 1.1—Measuring enthalpy changes** Reactivity 1.1.1—Chemical reactions involve a transfer of energy between the system and the surroundings, while total energy is conserved. Reactivity 1.1.2—Reactions are described as endothermic or exothermic, depending on the direction of energy transfer between the system and the surroundings. Reactivity 1.1.3—The relative stability of reactants and products determines whether reactions are endothermic or exothermic. Reactivity 1.1.4—The standard enthalpy change for a chemical reaction, $\Delta H^{\ominus}$, refers to the heat transferred at constant pressure under standard conditions and states. It can be determined from the change in temperature of a pure substance. **Reactivity 1.2—Energy cycles in reactions** Reactivity 1.2.1—Bond-breaking absorbs and bond-forming releases energy. Reactivity 1.2.2—Hess's law states that the enthalpy change for a reaction is independent of the pathway between the initial and final states. **Additional higher level** Reactivity 1.2.3—Standard enthalpy changes of combustion, $\Delta H_c^{\ominus}$, and formation, $\Delta H_f^{\ominus}$, data are used in thermodynamic calculations	**Standard level 12 hours and higher level: 22 hours** **Standard level and higher level: 5 hours** **Standard level and higher level: 3 hours** **Additional higher level: 5 hours**	**Summative Assessment** Summative task based on objectives 1-3 1. Demonstrate knowledge and understanding of 2. Electron configurations Past paper questions Experimental evidence to support theories - emission spectra provide evidence for the existence of energy levels. **FormativeAssessment:** Quiz, Worksheets Presentation - atomic structure research Construction of energy cycles from hydration, lattice and solution enthalpy Worksheets, Seminar on Enthalpy	BDP chemistry book by Hodder Education Edition 3 A-Level chemistry **https://www.youtube.com/watch?v=tOGM2gOHKPc – animation on mass spectroscopy** **http://www.trschools.com/staff/g/cgirtain/Weblabs/spectrolab.htm - Emission spectrum study** https://peacechem.weebly.com/dp-ib-chemistry-i.html Intro to atoms: https://www.khanacademy.org/sc... Orbitals: https://www.khanacademy.org/sc... Hydrogen emission spectrum: https://www.khanacademy.org/sc... Electron configurations:

	Reactivity 1.2.4—An application of Hess’s law uses enthalpy of formation data or enthalpy of combustion data to calculate the enthalpy change of a reaction. Reactivity 1.2.5—A Born–Haber cycle is an application of Hess’s law, used to show energy changes in the formation of an ionic compound. **Reactivity 1.3—Energy from fuels** Reactivity 1.3.1—Reactive metals, non-metals and organic compounds undergo combustion reactions when heated in oxygen. Reactivity 1.3.2—Incomplete combustion of organic compounds, especially hydrocarbons, leads to the production of carbon monoxide and carbon. Reactivity 1.3.3—Fossil fuels include coal, crude oil and natural gas, which have different advantages and disadvantages. Reactivity 1.3.4—Biofuels are produced from the biological fixation of carbon over a short period of time through photosynthesis. Reactivity 1.3.5—A fuel cell can be used to convert chemical energy from a fuel directly to electrical energy. **Reactivity 1.4—Entropy and spontaneity (Additional higher level)** Reactivity 1.4.1—Entropy, *S*, is a measure of the dispersal or distribution of matter and/or energy in a system. The more ways the energy can be distributed, the higher the entropy. Under the same conditions, the entropy of a gas is greater than that of a liquid, which in turn is greater than that of a solid. Reactivity 1.4.2—Change in Gibbs energy, ΔG, relates the energy that can be obtained from a chemical reaction to the change in enthalpy, ΔH, change in entropy, ΔS, and absolute temperature T. Reactivity 1.4.3—At constant pressure, a change is spontaneous if the change in Gibbs energy, ΔG, is negative. Reactivity 1.4.4—As a reaction approaches equilibrium, ΔG becomes less negative and finally reaches zero.	**Standard level and higher level: 4 hours** **Additional higher level: 5 hours**	**ATL**: Social Self management Research **LPA**: Thinkers Students should be able to relate the structure of an atom to that elements' reactivity Knowledgeable Students should be able to describe the combustion, fuels. Thinkers Students should be able to relate relationship between heat and temperature and a reaction Knowledgeable Students should be able to describe what happens to energy when bonds are broken and made?	https://www.khanacademy.org/sc... Ionization energies: https://www.khanacademy.org/sc... Successive ionization energies: https://www.google.com/search

Structure 2. Models of bonding and structure Structure 2.1—The ionic model Structure 2.2—The covalent model Structure 2.3—The metallic model Structure 2.4—From models to materials	**Structure 2.1—The ionic model** Structure 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 2.1.2—The ionic bond is formed by electrostatic attractions between oppositely charged ions. Structure 2.1.3—Ionic compounds exist as three-dimensional lattice structures, represented by empirical formulas. **Structure 2.2—The covalent model** Structure 2.2.1—A covalent bond is formed by the electrostatic attraction between a shared pair of electrons and the positively charged nuclei. Structure 2.2.2—Single, double and triple bonds involve one, two and three shared pairs of electrons respectively. Structure 2.2.3—A coordination bond is a covalent bond in which both the electrons of the shared pair originate from the same atom. Structure 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. Structure 2.2.5—Bond polarity results from the difference in electronegativities of the bonded atoms. Structure 2.2.6—Molecular polarity depends on both bond polarity and molecular geometry. Structure 2.2.7—Carbon and silicon form covalent network structures. Structure 2.2.8—The nature of the force that exists between molecules is determined by the size and polarity of the molecules. Intermolecular forces include London (dispersion),	**Standard level 20 hours and higher level: 30 hours** **Standard level and higher level: 4 hours** **Standard level and higher level: 10 hours**	**Summative Assessment** Summative task based on objectives 1,2,3 1.Demonstrate knowledge and understanding 2. Apply 3. Formulate, analyse and evaluate **FormativeAssessment** Summarise the trends in Group 1 and Period 3, Worksheets, Seminar on groups and periods **ATLskills:** Thinking Social Communication Research **LPA:** Knowledgeable and Inquirers	**Simulations** **Lab. Experiments** **IB Chemistry Book: 2023 Edition: Hodder Education** Pradeep's chemistry for Data based questions and also to refer exceptional cases in the periodic trends http://www2.gsu.edu/~mstnrhx/9870/science.htm http://trailblazing.royalsociety.org/ http://chemcollective.org/activities/type_page/1 **Chemistry extended essay exemplar previous years** http://www2.gsu.edu/~mstnrhx/9870/science.htm http://trailblazing.royalsociety.org/ http://chemcollective.org/activities/type_page/1 IBDP chemistry-Hodder Educaiton

	dipole-induced dipole, dipole–dipole and hydrogen bonding. Structure 2.2.9—Given comparable molar mass, the relative strengths of intermolecular forces are generally: London (dispersion) forces < dipole–dipole forces < hydrogen bonding. Structure 2.2.10—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.			
	Additional higher level Structure 2.2.11—Resonance structures occur when there is more than one possible position for a double bond in a molecule. Structure 2.2.12—Benzene, C_6H_6, is an important example of a molecule that has resonance. Structure 2.2.13—Some atoms can form molecules in which they have an expanded octet of electrons. Structure 2.2.14—Formal charge values can be calculated for each atom in a species and used to determine which of several possible Lewis formulas is preferred. Structure 2.2.15—Sigma bonds σ form by the head-on combination of atomic orbitals where the electron density is concentrated along the bond axis. Pi bonds π form by the lateral combination of p-orbitals where the electron density is concentrated on opposite sides of the bond axis. Structure 2.2.16—Hybridization is the concept of mixing atomic orbitals to form new hybrid orbitals for bonding.	**Additional higher level: 8 hours**		
	Structure 2.3—The metallic model Structure 2.3.1—A metallic bond is the electrostatic attraction between a lattice of cations and delocalized electrons. Structure 2.3.2—The strength of a metallic bond depends on the charge of the ions and the radius of the metal ion.	**Standard level and higher level: 2 hours**		
	Additional higher level Structure 2.3.3—Transition elements have delocalized d-	**Additional higher level:**		

	electrons **Structure 2.4—From models to materials** Structure 2.4.1—Bonding is best described as a continuum between the ionic, covalent and metallic models, and can be represented by a bonding triangle. Structure 2.4.2—The position of a compound in the bonding triangle is determined by the relative contributions of the three bonding types to the overall bond. Structure 2.4.3—Alloys are mixtures of a metal and other metals or non-metals. They have enhanced properties. Structure 2.4.4—Polymers are large molecules, or macromolecules, made from repeating subunits called monomers. Structure 2.4.5—Addition polymers form by the breaking of a double bond in each monomer. **Additional higher level** Structure 2.4.6—Condensation polymers form by the reaction between functional groups in each monomer with the release of a small molecule.	**1 hour** **Standard level and higher level: 4 hours** **Additional higher level: 1 hour**		

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YEAR 2 **Structure 3. Classification of matter**		**Standard level 16 hours and higher level 31 hours**	**Summative Assessment** Summative task based on objectives 1,2,3 1.Demonstrate knowledge and understanding	**Simulations** **Lab. Experiments** **IB Chemistry Book: 2023 Edition: Hodder Education** Pradeep’s chemistry

Structure 3.1—The periodic table: Classification of elements Structure 3.2—Functional groups: Classification of organic compounds	**Structure 3.1—The periodic table: Classification of elements** Structure 3.1.1—The periodic table consists of periods, groups and blocks. Structure 3.1.2—The period number shows the outer energy level that is occupied by electrons. Elements in a group have a common number of valence electrons. Structure 3.1.3—Periodicity refers to trends in properties of elements across a period and down a group. Structure 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. Structure 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. 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. It is the charge that atom would have if the compound were composed of ions. **Additional higher level**: Structure 3.1.7—Discontinuities occur in the trend of increasing first ionization energy across a period. Structure 3.1.8—Transition elements have incomplete d-sublevels that give them characteristic properties. Structure 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.	**Standard level and higher level: 7 hours** **Additional higher level: 4 hours**	2. Apply 3. Formulate, analyse and evaluate End of Unit Test, Practical Test or Individual Project. **Formative:** Worksheets, Quizzes, Lab Activities, Topic Presentations, Case Studies, Group Project, etc **ATL**: Social Self management Research **LPA**: Thinkers Students should be able to relate relationship between heat and temperature and a reaction Knowledgeable Students should be able to describe what happens to energy when bonds are broken and made? Experimental evidence to support theories - emission spectra provide evidence for	for Data based questions and also to refer exceptional cases in the periodic trends http://www2.gsu.edu/~mstnrhx/9870/science.htm http://trailblazing.royalsociety.org/ http://chemcollective.org/activities/type_page/1 **Chemistry extended essay exemplar previous years** http://www2.gsu.edu/~mstnrhx/9870/science.htm http://trailblazing.royalsociety.org/ http://chemcollective.org/activities/type_page/1 IBDP chemistry-Hodder Educaiton

	Structure 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. **Structure 3.2—Functional groups: Classification of organic compounds** Structure 3.2.1—Organic compounds can be represented by different types of formulas. These include empirical, molecular, structural (full and condensed), stereochemical and skeletal. Structure 3.2.2—Functional groups give characteristic physical and chemical properties to a compound. Organic compounds are divided into classes according to the functional groups present in their molecules. Structure 3.2.3—A homologous series is a family of compounds in which successive members differ by a common structural unit, typically CH2. Each homologous series can be described by a general formula. Structure 3.2.4—Successive members of a homologous series show a trend in physical properties. Structure 3.2.5—"IUPAC nomenclature" refers to a set of rules used by the International Union of Pure and Applied Chemistry to apply systematic names to organic and inorganic compounds. Structure 3.2.6—Structural isomers are molecules that have the same molecular formula but different connectivities. **Additional higher level** Structure 3.2.7—Stereoisomers have the same constitution (atom identities, connectivities and	**Standard level and higher level: 9 hours** **Additional higher**	the existence of energy levels. Distinction between empirical, molecular and structural formulas. • 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. **ATL:** Thinking: using concept of reaction mechanisms Social: Discussion in pairs and within class to solve problems, working together to complete research and present it	

Reactivity 2. How much, how fast and how far? Reactivity 2.2—How fast? The rate of chemical change Reactivity 2.3—How far? The extent of chemical change	bond multiplicities) but different spatial arrangements of atoms. Structure 3.2.8—Mass spectrometry (MS) of organic compounds can cause fragmentation of molecules. Structure 3.2.9—Infrared (IR) spectra can be used to identify the type of bond present in a molecule. Structure 3.2.10—Proton nuclear magnetic resonance spectroscopy (1H NMR) gives information on the different chemical environments of hydrogen atoms in a molecule. Structure 3.2.11—Individual signals can be split into clusters of peaks. Structure 3.2.12—Data from different techniques are often combined in structural analysis. **Reactivity 2.2—How fast? The rate of chemical change** Reactivity 2.2.1—The rate of reaction is expressed as the change in concentration of a particular reactant/product per unit time. Reactivity 2.2.2—Species react as a result of collisions of sufficient energy and proper orientation. Reactivity 2.2.3—Factors that influence the rate of a reaction include pressure, concentration, surface area, temperature and the presence of a catalyst. Reactivity 2.2.4—Activation energy, *E*a, is the minimum energy that colliding particles need for a successful collision leading to a reaction. Reactivity 2.2.5—Catalysts increase the rate of reaction by providing an alternative reaction pathway with lower *E*a. **Additional higher level:**	**level: 11 hours** **Standard level and higher level: 9 hours** **Additional higher**	to the class Communication: using subject specific terminology in Chemistry to communicate understanding in a scientific, concise manner, presenting answers and working on the board, showing working clearly, use of maths and units, use of command terms **LPA :** Inquirers Through research online or from text books at times and practical lab work Knowledgeable You must really memorize or learn the reaction pathways Thinkers Using the given background facts you need to apply your learning to solve problems in unfamiliar circumstances	

	Reactivity 2.2.6—Many reactions occur in a series of elementary steps. The slowest step determines the rate of the reaction. Reactivity 2.2.7—Energy profiles can be used to show the activation energy and transition state of the rate-determining step in a multistep reaction. Reactivity 2.2.8—The molecularity of an elementary step is the number of reacting particles taking part in that step. Reactivity 2.2.9—Rate equations depend on the mechanism of the reaction and can only be determined experimentally Reactivity 2.2.10—The order of a reaction with respect to a reactant is the exponent to which the concentration of the reactant is raised in the rate equation. The order with respect to a reactant can describe the number of particles taking part in the ratedetermining step. The overall reaction order is the sum of the orders with respect to each reactant. Reactivity 2.2.11—The rate constant, *k*, is temperature dependent and its units are determined from the overall order of the reaction. Reactivity 2.2.12—The Arrhenius equation uses the temperature dependence of the rate constant to determine the activation energy. Reactivity 2.2.13—The Arrhenius factor, *A*, takes into account the frequency of collisions with proper orientations.	**level: 6 hours**		
	Reactivity 2.3—How far? The extent of chemical change Reactivity 2.3.1—A state of dynamic equilibrium is	**Standard level and higher level: 5 hours**		

	reached in a closed system when the rates of forward and backward reactions are equal. Reactivity 2.3.2—The equilibrium law describes how the equilibrium constant, K, can be determined from the stoichiometry of a reaction. Reactivity 2.3.3—The magnitude of the equilibrium constant indicates the extent of a reaction at equilibrium and is temperature dependent.Reactivity 2.3.4—Le Châtelier's principle enables the prediction of the qualitative effects of changes in concentration, temperature and pressure to a system at equilibrium. **Additional higher level:** Reactivity 2.3.5—The reaction quotient, Q, is calculated using the equilibrium expression with nonequilibrium concentrations of reactants and products. Reactivity 2.3.6—The equilibrium law is the basis for quantifying the composition of an equilibrium mixture. Reactivity 2.3.7—The equilibrium constant and Gibbs energy change, ΔG, can both be used to measure the position of an equilibrium reaction.	**Additional higher level: 4 hours**		
Reactivity 3. What are the mechanisms of chemical change? Reactivity 3.1—Proton transfer	**Reactivity 3.1—Proton transfer reactions** Reactivity 3.1.1—Brønsted–Lowry acid is a proton donor	**Standard level 20 hours and higher level: 30 hours**	**Summative Assessment** Summative task based on objectives 1,2,3 1.Demonstrate knowledge and understanding	

reactions Reactivity 3.2—Electron transfer reactions Reactivity 3.3—Electron sharing reactions Reactivity 3.4—Electron-pair sharing reactions	and a Brønsted–Lowry base is a proton acceptor. Reactivity 3.1.2—A pair of species differing by a single proton is called a conjugate acid–base pair. Reactivity 3.1.3—Some species can act as both Brønsted–Lowry acids and bases. Reactivity 3.1.4—The pH scale can be used to describe the [H+] of a solution: pH = –log10[H+]; [H+] = 10–pH Reactivity 3.1.5—The ion product constant of water, *K*w, shows an inverse relationship between [H+] and [OH–]. *K*w = [H+] [OH–] Reactivity 3.1.6—Strong and weak acids and bases differ in the extent of ionization. Reactivity 3.1.7—Acids react with bases in neutralization reactions. Reactivity 3.1.8—pH curves for neutralization reactions involving strong acids and bases have characteristic shapes and features. **Additional higher level**: 9 hours Reactivity 3.1.9—The pOH scale describes the [OH–] of a solution. pOH = –log10[OH–]; [OH–] = 10–pOH Reactivity 3.1.10—The strengths of weak acids and bases are described by their *K*a, *K*b, p*K*a or p*K*b values. Reactivity 3.1.11—For a conjugate acid–base pair, the relationship *K*a × *K*b = *K*w can be derived from the expressions for *K*a and *K*b. Reactivity 3.1.12—The pH of a salt solution depends on the relative strengths of the parent acid and base. Reactivity 3.1.13—pH curves of different combinations of strong and weak monoprotic acids and bases have characteristic shapes and features.	**Standard level and higher level: 8 hours** **Additional higher level: 9 hours**	2. Apply 3. Formulate, analyse and evaluate End of Unit Test, Practical Test or Individual Project. **Formative assessment** Observation of practical skills and ability to follow steps and showing titration of acid base Questioning Discussion of the methodology of the calculations and what working is necessary: class, small group, pair, individual, teacher-led, student-led (highlight which ones) Presentations: individual, paired, group(highlight which ones) Think, pair, share **ATL** Communication Self management Communication: using subject specific terminology in Chemistry to communicate understanding in a scientific, concise manner,	IBDP Chemistry course books and revision books published by different publishers, students have one and others are available in school library Recomended Textbook: Ch. Tlbot, R.Harwood, Ch. Coates: **CHEMISTRY (2ndEd)** Hodder education Sergey Bulikin: **CHEMISTRY FOR IB DIPLOMA COURSE PREPARATION**, Oxford University Press Jacqueline PARIS: **Chemistry for the IB Diploma Workbook with CD-ROM**, Cambridge University Press, 2017 IB DP Online question bank is

	Reactivity 3.1.14—Acid–base indicators are weak acids, where the components of the conjugate acid–base pair have different colours. The pH of the end point of an indicator, where it changes colour, approximately corresponds to its p*K*a value. Reactivity 3.1.15—An appropriate indicator for a titration has an end point range that coincides with the pH at the equivalence point. Reactivity 3.1.16—A buffer solution is one that resists change in pH on the addition of small amounts of acid or alkali. Reactivity 3.1.17—The pH of a buffer solution depends on both: the p*K*a or p*K*b of its acid or base the ratio of the concentration of acid or base to the concentration of the conjugate base or acid. **Reactivity 3.2—Electron transfer reactions** Standard level and higher level: 10 hours Reactivity 3.2.1—Oxidation and reduction can be described in terms of electron transfer, change in oxidation state, oxygen gain/loss or hydrogen loss/gain. Reactivity 3.2.2—Half-equations separate the processes of oxidation and reduction, showing the loss or gain of electrons. Reactivity 3.2.3—The relative ease of oxidation and reduction of an element in a group can be predicted from its position in the periodic table. The reactions between metals and aqueous metal ions demonstrate the relative ease of oxidation of different metals. Reactivity 3.2.4—Acids react with reactive metals to release hydrogen. Reactivity 3.2.5—Oxidation occurs at the anode and	**Standard level and higher level: 10 hours**	presenting answers. **LPA:** Knowledgeable and Inquirers	used for producing quizzes, mock exams and homework. Simulations (Phet, etc),Data logging, databases, and spreadsheets are in use in class Vernier software and hardware are used for experimental work (such as Graphical Analysis Software, pH Sensor, temperature probe, Voltage probe, Spectrometry). Tutorial videos: MSJChem - Tutorial videos for IB Chemistry - Home

	reduction occurs at the cathode in electrochemical cells. Reactivity 3.2.6—A primary (voltaic) cell is an electrochemical cell that converts energy from spontaneous redox reactions to electrical energy. Reactivity 3.2.7—Secondary (rechargeable) cells involve redox reactions that can be reversed using electrical energy. Reactivity 3.2.8—An electrolytic cell is an electrochemical cell that converts electrical energy to chemical energy by bringing about non-spontaneous reactions. Reactivity 3.2.9—Functional groups in organic compounds may undergo oxidation. Reactivity 3.2.10—Functional groups in organic compounds may undergo reduction. Reactivity 3.2.11—Reduction of unsaturated compounds by the addition of hydrogen lowers the degree of unsaturation. **Additional higher level:** Reactivity 3.2.12—The hydrogen half-cell H+(aq) + e− ⇌12 H2(g) is assigned a standard electrode potential of zero by convention. It is used in the measurement of standard electrode potential, $E^\ominus$. Reactivity 3.2.13—Standard cell potential, $E^\ominus$ cell, can be calculated from standard electrode potentials. $E^\ominus$ cell has a positive value for a spontaneous reaction. Reactivity 3.2.14—The equation $\Delta G^\ominus = -nFE^\ominus$ cell shows the relationship between standard change in Gibbs energy and standard cell potential for a reaction. Reactivity 3.2.15—During electrolysis of aqueous solutions, competing reactions can occur at the	**Additional higher level: 5 hours**		

	anode and cathode, including the oxidation and reduction of water. Reactivity 3.2.16—Electroplating involves the electrolytic coating of an object with a metallic thin layer. **Reactivity 3.3—Electron sharing reactions** Reactivity 3.3.1—A radical is a molecular entity that has an unpaired electron. Radicals are highly Reactive Reactivity 3.3.2—Radicals are produced by homolytic fission, e.g. of halogens, in the presence of ultraviolet (UV) light or heat. Reactivity 3.3.3—Radicals take part in substitution reactions with alkanes, producing a mixture of products. **Reactivity 3.4—Electron-pair sharing reactions** Reactivity 3.4.1—A nucleophile is a reactant that forms a bond to its reaction partner (the electrophile) by donating both bonding electrons. Reactivity 3.4.2—In a nucleophilic substitution reaction, a nucleophile donates an electron pair to form a new bond, as another bond breaks producing a leaving group. Reactivity 3.4.3—Heterolytic fission is the breakage of a covalent bond when both bonding electrons remain with one of the two fragments formed. Reactivity 3.4.4—An electrophile is a reactant that forms a bond to its reaction partner (the nucleophile) by accepting both bonding electrons from that reaction partner. Reactivity 3.4.5—Alkenes are susceptible to electrophilic attack because of the high electron	**Standard level and higher level: 2 hours** **Standard level and higher level: 4 hours**		

	density of the carbon–carbon double bond. These reactions lead to electrophilic addition. **Additional higher level:** Reactivity 3.4.6—A Lewis acid is an electron-pair acceptor and a Lewis base is an electron-pair donor. Reactivity 3.4.7—When a Lewis base reacts with a Lewis acid, a coordination bond is formed. Nucleophiles are Lewis bases and electrophiles are Lewis acids. Reactivity 3.4.8—Coordination bonds are formed when ligands donate an electron pair to transition element cations, forming complex ions. Reactivity 3.4.9—Nucleophilic substitution reactions include the reactions between halogenoalkanes and nucleophiles. Reactivity 3.4.10—The rate of the substitution reactions is influenced by the identity of the leaving group. Reactivity 3.4.11—Alkenes readily undergo electrophilic addition reactions. Reactivity 3.4.12—The relative stability of carbocations in the addition reactions between hydrogen halides and unsymmetrical alkenes can be used to explain the reaction mechanism. Reactivity 3.4.13—Electrophilic substitution reactions include the reactions of benzene with electrophile**s.**	**Additional higher level: 7 hours**		

2. The group 4 project

As the IB guides say, “The group 4 project is a collaborative activity where students from different group 4 subjects work together on a scientific or technological topic, allowing for concepts and perceptions from across the disciplines to be shared in line with aim 10—that is, to ‘encourage an understanding of the relationships between scientific disciplines and the overarching nature of the scientific method.’” Describe how you will organize this activity. Indicate the timeline and subjects involved, if applicable.

he Group 4 Project will include students studying Biology and Chemistry.

Timing: The group work is an assignment to be done throughout the end of the first year DP study – May, June, and terminating at the beginning of the second year DP study – September, October.
Timeline: (10 hrs)
(2 hrs): Planning stage – After selecting a focused topic, the activities to be carried out must be clearly defined before moving to action phase (6 hrs): Action stage – investigation of topic
(2 hrs): Evaluation Stage – Powerpoints, videos, scale models etc. will be presented in class

3. IB practical work and the internal assessment requirement to be completed during the course

As you know, students should undergo practical work related to the syllabus.

- Physics, chemistry and biology: 40 hours (at standard level) or 60 hours (at higher level)
- Computer science: 40 hours (at standard level) or 40 hours (at higher level)
- Design technology: 60 hours (at standard level) or 96 hours (at higher level)
- Sport, exercise and health science: 40 hours (at standard level) or 60 hours (at higher level)

Use the table below to indicate the name of the experiment you would propose for the different topics in the syllabus.

An example is given. Add as many rows as necessary.

Syllabus unit	Subtopic	Possible demonstrations and practicals	Links to tools in “Skills in the study of chemistry”	Links to inquiry process in “Skills in the study of chemistry”
Structure 1. Models of the particulate nature of matter	1.1—Introduction to the particulate nature of matter	Practical 1: Simple separation techniques circus. Solvation, filtration, evaporation, distillation, reflux and paper chromatography should be covered. Use a variety of homogeneous (e.g. ethanol and water) and heterogeneous mixtures (e.g. tea leaves and water)	Show awareness of the purpose and practice of: 1. distillation and reflux 2. paper or thin layer chromatography 3. separation of mixtures.	
		Practical 2: Changes of state—melting and freezing stearic acid	Understand how to accurately measure the following to an appropriate level of precision. 1. Temperature	Collect and record sufficient relevant quantitative data. Interpret diagrams, graphs and charts.

	1.2—The nuclear atom	Practical 3: Understanding isotopes—pasta isotopese. Udsifferent proportions of different types of pasta and their mass to calculate the relative atomic mass of the element Pa		
	1.3—Electron configurations	Practical 4: Investigating and explaining line spectra using a gas spectrum tube and metal ion flame tests		Identify and record relevant qualitative observations.
	1.4—Counting particles by mass: The mole	Practical 5: Jars containing 1 mole of various elements and molecules. Discuss different appearances in the masses		
		Practical 6: Finding the mass and surface area of a mole of sand grains Students use sand balances and perhaps graph paper to come up with an estimate. Discuss assumptions	Use approximation and estimation.	
		Practical 7: Determining Avogadro's constant through electrolysis of copper sulfate solution	Understand how to accurately measure the following to an appropriate level of precision. 1. Mass Use and interpret scientific notation (e.g. 3.5 × 10^6). Calculate and interpret percentage error and percentage uncertainty.	
		Demo 1: Hofmann voltameter—Electrolysis of H2SO4. This can also be done on a microscale if a Hofmann voltameter is not available		

		Practical 8: Mole ratio in copper oxide using reduction of the oxide with methane or a simpler alternative: mole ratio in magnesium oxide using combustion of magnesium	Understand how to accurately measure the following to an appropriate level of precision. 1. Mass Carry out calculations involving decimals, fractions, percentages, ratios, reciprocals and exponents.	
		Practical 9: Finding the water of crystallization of $CuSO_4.xH_2O$	Show awareness of the purpose and practice of: 1. drying to constant mass. Compare and quote values to the nearest order of magnitude.	
		Practical 10: Preparing a standard solution of sodium carbonate using a mass balance and volumetric flask	Show awareness of the purpose and practice of: 1. preparing a standard solution. Understand how to accurately measure the following to appropriate level of precision. 2. Mass 3. Volume Express measurement and processed uncertainties— absolute, fractional (relative), percentage—to an appropriate number of significant figures or level of precision.	

			Record uncertainties in measurements as a range (±) to an appropriate level of precision. Propagate uncertainties in processed data, in calculations involving addition, subtraction, multiplication, division and (HL only) exponents.	
		Practical 11: Standardizing a solution of hydrochloric acid through an acid–base titration. Potential for microscale approach. There is also an online simulation approach if equipment is not available	Show awareness of the purpose and practice of: 1. acid–base and redox titration. Understand how to accurately measure the following to an appropriate level of precision. 2. Volume	
		Practical 12: CaCO3 content in different eggshells through a back-titration with sodium hydroxide	Show awareness of the purpose and practice of: 1. acid–base and redox titration. Understand how to accurately measure the following to an appropriate level of precision. 2. Volume Carry out calculations involving decimals, fractions, percentages, ratios, reciprocals and exponents.	

	1.5—Ideal gases	Practical 13: Volume of 1 mole of H2 gas at room temperature and pressure by reacting magnesium with hydrochloric acid	Express measurement and processed uncertainties—absolute, fractional (relative), percentage—to an appropriate number of significant figures or level of precision.	Appreciate when and how to: 1. maintain constant environmental conditions of systems.
		Practical 14: Mr of a butane gas at room temperature and pressure		Compare the outcomes of an investigation to the accepted scientific context. Identify and discuss sources and impacts of random and systematic errors.
		Practical 15: Determining the M_r of CO_2 through the thermal decomposition of $CuCO_3$		
		Practical 16: Determining the gas constant, R, through the reaction of Mg with hydrochloric acid		Identify and discuss sources and impacts of random and systematic errors. Evaluate the implications of methodological weaknesses, limitations and assumptions on conclusions. Explain realistic and relevant improvements to an investigation.
Structure 2. Models of bonding and structure	2.1—The ionic model	Demo 2: Reaction of sodium and chlorine		
		Practical 17: Investigating and explaining the physical properties of ionic compounds to include volatility, electrical conductivity and solubility. Use, e.g., $CuSO_4$ or NaCl		

		Demo 3: Migration of ions using KMnO4 to demonstrate the existence of ions		
		Demo 4: Electrolysis of lead bromide or electrolysis of zinc chloride (safer alternative still to be done in a fume hood) to demonstrate the existence of ions		
		Practical 18: Determining the temperature of a Bunsen flame using the melting points of salts. Ensure that you include NaCl (801) and NaF (993)		
	2.2—The covalent model	Practical 19: Investigating the differences in properties of ionic and covalent compounds		
		Practical 20: Effect of adding ethanol to water on the solubility of a salt		
		Practical 21: Exploring surface tension, volatility, viscosity and cohesion of various compounds		Formulate research questions and hypotheses. State and explain predictions using scientific understanding.
	2.3—The metallic model	Practical 22: Visualizing the metallic model using a bubble raft		
	2.4—From models to materials	Practical 23: Making an alloy by heating together lead and tin		
		Practical 24: Making polymers—nylon through the reaction between decanedioyl dichloride and 1,6-diaminohexane		
Structure 3. Classification of matter	3.1—Periodic table: Classification of elements	Demo 5: Properties of group 1 (alkali) metals and their reactions with water		

		Demo 6: Reactions of the halogens with iron wool		
		Practical 25: Displacement reactions of halogens with their halide ions *Can also be used in Reactivity 3.2*		
		Practical 26: Testing the pH of oxides to explore acid–base character		
		Practical 27: Exploring paramagnetism in transition metal compounds		
		Practical 28: Using colorimetry to determine the formula of transition metal complex ions		
		Practical 29: Exploring ligand exchange reactions in transition metal complexes		
	3.2—Functional groups: Classification of organic compounds	Practical 30: Comparing properties of alkanes and alkenes		
		Demo 7: Comparing oxidation of alcohols. https://edu.rsc.org/experiments/a-microscale-oxidation-of-alcohols/553.article		
Reactivity 1. What drives chemical reactions?	1.1—Measuring enthalpy changes	Demo 8: Endothermic reaction of barium hydroxide and ammonium chloride in a solid– solid reaction		
		Practical 31: Exploring simple exothermic and endothermic reactions		

		Practical 32: Determining the enthalpy change of combustion of a fuel using calorimetry	Show awareness of the purpose and practice of: 1. calorimetry.	Appreciate when and how to: 1. insulate against heat loss or gain.
		Practical 33: Determining the enthalpy change of the reaction between zinc and copper sulfate	Show awareness of the purpose and practice of: 1. calorimetry. Extrapolate and interpolate graphs.	Appreciate when and how to: 1. insulate against heat loss or gain.
	1.2—Energy cycles in reactions	Practical 34: Using Hess's law to determine the enthalpy change of hydration of magnesium sulfate	Show awareness of the purpose and practice of: 1. calorimetry.	Appreciate when and how to: 1. insulate against heat loss or gain.
	1.3—Energy from fuels	Demo 9: Identifying the products of combustion through burning a solid hydrocarbon		
		Demo 10: Building a hydrogen fuel cell		
	1.4—Entropy and spontaneity (Additional higher level)			
Reactivity 2. How much, how fast and	2.1—How much? The amount of chemical change	Practical 35: Calculating percentage yield using the combustion of magnesium in air		

how far?	2.2—How fast? The rate of chemical change	Practical 36: Exploring methods for monitoring the rates of a reaction For example: 1. Measuring the change in volume of a gas produced over time (e.g. Mg + HCl) 2. Measuring the change in mass of gas lost over time (e.g. marble chips + acid) 3. Measuring the change in colour intensity over time (colorimetry)—crystal violet reaction 4. Measuring the change in conductivity over time (e.g. using the reaction of potassium bromate and potassium iodide)	Understand how to accurately measure the following to an appropriate level of precision. 1. Mass 2. Volume 3. Time Show awareness of the purpose and practice of: 4. colorimetry or spectrophotometry.	
		Demo 11: Iodine clock reaction		
		Practical 37: Investigating the effects of changing conditions on the rate of the reaction between sodium thiosulfate and hydrochloric acid		
		Demo 12: Catalysis—“Elephant’s toothpaste”o—mdpeocsition of hydrogen peroxide		
		Demo 13: Oxidation of potassium sodium tartrate by hydrogen peroxide using a cobalt salt as a catalyst		
		Practical 38: Determining the rate equation and the reaction mechanism for the iodination of propanone	Show awareness of the purpose and practice of: 1. colorimetry or spectrophotometry.	

	2.3 How far? The extent of chemical change	Demo 14 (a series of reversible reactions): The "Blue bottle" experiment by transforming methylthioninium chloride from blue to colourless and back again by mixing it with glucose Heating hydrated copper sulfate to remove the water of crystallization Liquid bromine in a sealed jar to demonstrate the equilibrium between a liquid and gaseous state		
		Demo 15: Modelling equilibrium using water and dyes		
		Demo 16: Modelling Le Chatelier's principle using two coloured cobalt species		
		Practical 39: Determining the equilibrium constant, Kc, on a microscale for the reaction between silver(I) and iron(II) ions		
		Practical 40: Determining the equilibrium constant, Kc, for the formation of iron(III) thiocyanate complex ion using a spectrophotometer or colorimetry	Show awareness of the purpose and practice of: 1. colorimetry or spectrophotometry.	
Reactivity 3. What are the mechanisms of chemical change?	3.1—Proton transfer reactions	Demo 17: Visualizing the pH scale using rainbow fizz		
		Practical 41: Creating a pH scale using a 10- fold dilution of hydrochloric acid and sodium hydroxide		
		Practical 42: Determining the acid dissociation constant (Ka) of ethanoic acid using a pH probe		

		Practical 43: Determining the acid dissociation constant (Ka) and pKa of a weak acid uaslfing a h -titration		
		Practical 44: Obtaining pH curves for acid– base titrations using a pH probe		Appreciate when and how to: 1. calibrate measuring apparatus.
		Practical 45: Investigating indicators—choosing the appropriate indicator for an acid–base titration		
		Practical 46: Making buffers and determining their buffer capacity		
	3.2—Electron transfer reactions	Demo 18: The "screaming jelly baby"—highly exothermic reaction involving the oxidizing agent potassium chlorate(V)		
		Practical 47: Simple redox half-equations on a microscale		
		Demo 19: The thermite reaction—redox reaction between aluminium and iron(III) oxide		
		Practical 48: Investigating and explaining reactions involving metals with aqueous solutions of metal ions		
		Practical 49: Displacement reactions of halogens with their halide ions *Can also be used in Reactivity 3.1*		

		Practical 50: Investigating the cell potential of voltaic cellsnoa microscale	Show awareness of the purpose and practice of: 1. electrochemical cells.	
			Understand how to accurately measure the following to an appropriate level of precision. 1. Electric current and voltage	
		Practical 51: Electroplating copper onto an iron spoon using copper(II) sulfate as an electrolyte		
		Demo 20: Colourful electrolysis of brine (sodium chloride) solution		
		Practical 52: Electrolysis of copper(II) sulfate solution		
		Practical 53: Electrolysis of water		
		Practical 54: Investigating the oxidation of alcohols, including the use of distillation and reflux. This can also be done on a microscale		
	3.3—Electron sharing reactions			
	3.4—Electron-pair sharing reactions	Demo 21: Hydrogenation of propene on a microscale		
		Demo 22: Testing for unsaturation with bromine in alkenes		

		Practical 55: Hydrolysis of 2-bromo-2-methylpropane to determine the order of reaction and its mechanism		
		Practical 56: Investigating the relative rate of the nucleophilic substitution reactions of primary, secondary and tertiary halogenoalkanes using silver nitrate		
		Practical 57: Investigating the relative rate of the nucleophilic substitution reactions of chloro-, bromo- and iodo-halogenoalkanes using silver nitrate		
		Practical 58: Nitration of methyl benzoate	Show awareness of the purpose and practice of: 1. recrystallization.	

4. Laboratory facilities

Describe the laboratory and indicate whether it is presently equipped to facilitate the practical work that you have indicated in the chart above. If it is not, indicate the timeline to achieve this objective and describe the safety measures that are applicable.

Laboratory gives IB DP school students everything they need in order to grow during the years of study. Laboratory facilities are sufficient for experiments identified. Laboratory includes benches established with sinks and necessary equipments. The lab is equipped with electronic balance, eye protection, eye wash station, fire extinguisher and breaker, water bath.

5. Other resources

Indicate what other resources the school has to support the implementation of the subject and what plans there are to improve them, if needed.

There are a variety of Chemistry resources available for student use, both in the library and in the Science department, which include online resources such as Turnitin, IB online question bank. The School Library and the Science Department has a varied and very well-stocked range of DP CHemistry and other textbooks. The school plans to buy subscriptions to a variety of science journals including New Scientist.Students are encouraged to use a range of course books in the library but an IB Diploma specific course book is purchased – one per student at the start of the course: Chemistry for the IB Diploma by Hodder Education. The School library and the Science Department has a range of additional Chemistry resources suitable for students at this level, and is in the process of reassessing these and extending the collection. These can act as extension material, university preparation and research material suitable for students to prepare their Extended Essays, and IA's. The Science department has a list of websites which will be used to support learning. MSJChem - Tutorial videos for IB Chemistry - Home

IB-Specific Resources:

1. C. Brown & M. Ford, Chemistry – developed specifically for the IB Diploma (2009). Pearson Education Limited
2. T. Lister & J. Renshaw, Understanding Chemistry for AL (1999). Nelson Thornes
3. R. Petrucci & W. Harwood, General Chemistry. Pearson Education
4. M. Clugston & R. Flemming, Advanced Chemistry, Oxford University Press
5. J. Murray, Fundamentals of Organic Chemistry (1998), Brooks/Cole Publishing Company
6. ICT research
7. IB Question Bank

Additional Teacher Resources: www.chemcollective.org

6. Links to TOK

You are expected to explore links between the topics of your subject and TOK. As an example of how you would do this, choose one topic from your course outline that would allow your students to make links with TOK. Describe how you would plan the lesson.

Topic	Link with TOK (including description of lesson plan)

Introduction to the particulate nature of matter and chemical change	Priestley´s and Lavoisier´s discovery of oxygen overturned the phlogiston theory of combustions and it is example of a **paradigm shift.** **Topic of lesson:** Burning and rusting as a the most common chemical change that occurs History of the various discoveries or theories are leading the humankind to the knowledge. The Flogiston theory proposed by j.Becher and G.Stahl in 17th century was theory of combustion and rusting and main hypothesis was that all materials can burn if they contain substabce known as «phlogiston». The theory has considerable influence upon the progress of chemistry. Although the theory made qualitative sense and helped explain burning and rusting, it suffered from a quantitative defect. The theory was disproved by the work of French chemist Lavoisier and English chemist Priestley. **TOK question:** How does scientific knowledge progress? Why theorems are important even if turns out to be wrong? The students will explore the history behind the theory and analyse the work of Lavoisier and Priestley to understand the way of proving the theories wrong.

7. Approaches to learning

Every IB course should contribute to the development of students' approaches to learning skills. As an example of how you would do this, choose one topic from your outline that would allow your students to specifically develop one or more of these skill categories (thinking, communication, social, self-management or research).

Topic	Contribution to the development of students' approaches to learning skills (including one or more skill category)
ATOMIC STRUCTURE Electron configuration	**The lesson topic:** Recognizing the shapes of orbitals Students find information about different shapes of orbitals , sketch the shape of each one and determine the position around the atom´s nucleus. They work in groups and afterwards they make a presentation of their research in the poster. **ATL skills : -** Information literacy skills **-** Critical thinking skills **-** Collaboration skills

8. International mindedness

Every IB course should contribute to the development of international-mindedness in students. As an example of how you would do this, choose one topic from your outline that would allow your students to analyse it from different cultural perspectives. Briefly explain the reason for your choice and what resources you will use to achieve this goal.

Topic	Contribution to the development of international mindedness (including resources you will use)

Equilibrium (SL)	Students will learn about the Haber process and the production of ammonia. Students will research uses of ammonia and consider global implications for the production of fertiliser and ammunition powder, with a particular focus on implications during World War II. Students discuss why the Nobel Prize was awarded for this discovery, and consider the ethics of this decision from different global perspectives. Students will research Nobel Prize winners in recent years to examine the types of chemistry that have been awarded a prize and the international collaboration that has allowed for the discovery awarded. Through this process, they will consider the value of different perspectives in the discovery of new scientific ideas.

9. Development of the IB learner profile

Through the course it is also expected that students will develop the attributes of the IB learner profile. As an example of how you would do this, choose one topic from your course outline and explain how the contents and related skills would pursue the development of any attribute(s) of the IB learner profile that you will identify.

Topic	Contribution to the development of the attribute(s) of the IB learner profile
Reactions of alkanes, alkenes, alcohols, halo alkanes, esters, soaps; reaction pathways.	Studying chemical properties of organic substance is interesting and develops students’ natural curiosity and skills of observation. Doing experiments, analysing and generalising, students exercise critical skills and are taught to make reasoned decisions. The students become not only **knowledgeable** but **principled** and **caring**. Collaborating with others they learn to predict the processes.