Diploma Programme Course Outline		
Name of the DP subject	**Chemistry**	
Level	**Higher** ☐ **Standard** ☐	
YEAR 1		
UNIT	**TOPIC/CONCEPT**	**ASSESSMENT COMPONENTS**
<u>STRUCTURE ONE (1)</u> **Models of the particulate nature of matter** **Structure 1.1—Introduction to the particulate nature of matter**	**Structure 1.1.1** • Distinguish between the properties of elements, compounds and mixtures. **Structure 1.1.2** • Distinguish the different states of matter. • Use state symbols (s,l, g and aq) in chemical equations. **Structure 1.1.3** • Interpret observable changes in physical properties and temperature during changes of state. • Convert between values in the Celsius and Kelvin scales. **Practical Scheme of Work (PSOW)** **Separation techniques/purification methods :** Solvation, filtration, recrystallization,	**Skills in the study of chemistry** **<u>Tools</u>** • **Tool 1**: Experimental techniques • **Tool 2**: Technology • **Tool 3**: Mathematics ***Inquiry Process*** • **Inquiry 1**: Exploring and designing • **Inquiry 2**: Collecting and processing data • **Inquiry 3**: Concluding and evaluating ***Formative Assessment (any of the following):*** • Observation of practical skills and ability to follow steps and show working • Questioning

	evaporation, distillation and paper chromatography	• Discussion of the methodology of the calculations and what working is necessary: class, small group, pair, individual, teacher-led, student-led. • Think, pair, share • Quiz • Worksheets and past paper questions ***Peer and self- assessment*** • Students will be expected to check their own work at times, marking themselves and making corrections. At other times, they will share their answers and working and give and receive feedback from their peers ***Summative assessment*** • Multiple choice questions • Free response/structure questions
Structure 1.2—The nuclear atom	**Structure 1.2.1** • Use the nuclear symbol $^{A}_{Z}X$ to deduce the number of protons, neutrons and electrons in atoms and ions. **Structure 1.2.2** • Perform calculations involving non-integer relative atomic masses and abundance of isotopes from given data. **Additional higher level:**	**Skills in the study of chemistry** **Tools** • **Tool 1**: Experimental techniques • **Tool 2**: Technology • **Tool 3**: Mathematics ***Inquiry Process*** • **Inquiry 1**: Exploring and designing

	Structure 1.2.3 • Interpret mass spectra in terms of identity and relative abundance of isotopes.	• **Inquiry 2**: Collecting and processing data • **Inquiry 3**: Concluding and evaluating ***Formative Assessment (any of the following):*** • Observation of practical skills and ability to follow steps and show working • Questioning • Discussion of the methodology of the calculations and what working is necessary: class, small group, pair, individual, teacher-led, student-led. • Think, pair, share • Quiz • Worksheets and past paper questions ***Peer and self- assessment*** • Students will be expected to check their own work at times, marking themselves and making corrections. At other times, they will share their answers and working and give and receive feedback from their peers ***Summative assessment*** • Multiple choice questions • Free response/structure questions

Structure 1.3—Electron configurations	**Structure 1.3.1** • Qualitatively describe the relationship between colour, wavelength, frequency and energy across the electromagnetic spectrum. • Distinguish between a continuous and a line spectrum. **Structure 1.3.2** • Describe the emission spectrum of the hydrogen atom, including the relationships between the lines and energy transitions to the first, second and third energy levels. **Inquiry 2** In the study of emission spectra from gaseous elements and of light, what qualitative and quantitative data can be collected from instruments such as gas discharge tubes and prisms? **Structure 1.3.3** • Deduce the maximum number of electrons that can occupy each energy level. **Structure 1.3.4** • Recognize the shape and orientation of an s atomic orbital and the three p atomic orbitals**.**	**Skills in the study of chemistry** **<u>Tools</u>** • **Tool 1:** Experimental techniques • **Tool 2:** Technology • **Tool 3:** Mathematics ***Inquiry Process*** • **Inquiry 1:** Exploring and designing • **Inquiry 2:** Collecting and processing data • **Inquiry 3:** Concluding and evaluating ***Formative Assessment (any of the following):*** • Observation of practical skills and ability to follow steps and show working • Questioning • Discussion of the methodology of the calculations and what working is necessary: class, small group, pair, individual, teacher-led, student-led. • Think, pair, share • Quiz • Worksheets and past paper questions ***Peer and self- assessment*** • Students will be expected to check their own work at times,

	Structure 1.3.5 • Apply the Aufbau principle, Hund's rule and the Pauli Exclusion Principle to deduce electron configurations for atoms and ions up to Z=36. **Additional higher level:** **Structure 1.3.6** • Explain the trends and discontinuities in first ionization energy (IE) across a period and down a group. • Calculate the value of the first IE from spectral data that gives the wavelength or frequency of the convergence limit**.** **Structure 1.3.7** • Deduce the group of an element from its successive ionization data.	marking themselves and making corrections. At other times, they will share their answers and working and give and receive feedback from their peers ***Summative assessment*** • Multiple choice questions • Free response/structure questions
Structure 1.4—Counting particles by mass: The mole	**Structure 1.4.1** • Convert the amount of substance, n, to the number of specified elementary entities. **Structure 1.4.2** • Determine relative formula masses (M_r) from relative atomic masses (A_r). **Structure 1.4.3** • Solve problems involving the relationships between the number of	**Skills in the study of chemistry** **Tools** • **Tool 1**: Experimental techniques • **Tool 2**: Technology • **Tool 3**: Mathematics ***Inquiry Process*** • **Inquiry 1**: Exploring and designing • **Inquiry 2**: Collecting and processing data

	particles, the amount of substance in moles and the mass in grams**.** **Structure 1.4.4** • Interconvert the percentage composition by mass and the empirical formula. • Determine the molecular formula of a compound from its empirical formula and molar mass**.** **Structure 1.4.5** • Solve problems involving the molar concentration, amount of solute and volume of solution**.** **Structure 1.4.6** • Solve problems involving the mole ratio of reactants and/or products and the volume of gases. **Inquiry 2** How can a calibration curve be used to determine the concentration of a solution? **PSOW** • Obtaining and using experimental data to derive empirical formulas from reactions involving masses. • Prepare standard solutions and serial dilutions	• **Inquiry 3**: Concluding and evaluating ***Formative Assessment (any of the following):*** • Observation of practical skills and ability to follow steps and show working • Questioning • Discussion of the methodology of the calculations and what working is necessary: class, small group, pair, individual, teacher-led, student-led. • Think, pair, share • Quiz • Worksheets and past paper questions ***Peer and self- assessment*** • Students will be expected to check their own work at times, marking themselves and making corrections. At other times, they will share their answers and working and give and receive feedback from their peers ***Summative assessment*** • Multiple choice questions • Free response/structure questions

Structure 1.5—Ideal gases	**Structure 1.5.1** • Recognize the key assumptions in the ideal gas model. **Structure 1.5.2** • Explain the limitations of the ideal gas model. **Structure 1.5.3** • Investigate the relationship between temperature, pressure and volume for a fixed mass of an ideal gas and analyze graphs relating these variables**.** **Structure 1.5.4** • Solve problems relating to the ideal gas equation**.** **Inquiry 2** How can the ideal gas law be used to calculate the molar mass of a gas from experimental data? **PSOW** Obtaining and using experimental values to calculate the molar mass of a gas from the ideal gas equation	**Skills in the study of chemistry** **<u>Tools</u>** • **Tool 1:** Experimental techniques • **Tool 2:** Technology • **Tool 3:** Mathematics ***Inquiry Process*** • **Inquiry 1:** Exploring and designing • **Inquiry 2:** Collecting and processing data • **Inquiry 3:** Concluding and evaluating ***Formative Assessment (any of the following):*** • Observation of practical skills and ability to follow steps and show working • Questioning • Discussion of the methodology of the calculations and what working is necessary: class, small group, pair, individual, teacher-led, student-led. • Think, pair, share • Quiz • Worksheets and past paper questions ***Peer and self- assessment***

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UNIT	**TOPIC/CONCEPT**	
<u>STRUCTURE 2-</u> **Models of bonding and structure** **Structure 2.1—The ionic model**	**Structure 2.1.1** • Predict the charge of an ion from the electron configuration of the atom. **Structure 2.1.2** • Deduce the formula and name of an ionic compound from its component ions, including polyatomic ions. • Interconvert names and formulas of binary ionic compounds. **Structure 2.1.3** • Explain the physical properties of ionic compounds to include volatility, electrical conductivity and solubility.	**Skills in the study of chemistry** **<u>Tools</u>** • **Tool 1**: Experimental techniques • **Tool 2**: Technology • **Tool 3**: Mathematics ***Inquiry Process*** • **Inquiry 1**: Exploring and designing • **Inquiry 2**: Collecting and processing data • **Inquiry 3**: Concluding and evaluating ***Formative Assessment (any of the following):***

	Inquiry 2—What experimental data demonstrate the physical properties of ionic compounds? **PSOW** Investigate compounds based on their bond type.	• Observation of practical skills and ability to follow steps and show working • Questioning • Discussion of the methodology of the calculations and what working is necessary: class, small group, pair, individual, teacher-led, student-led. • Think, pair, share • Quiz • Worksheets and past paper questions ***Peer and self- assessment*** • Students will be expected to check their own work at times, marking themselves and making corrections. At other times, they will share their answers and working and give and receive feedback from their peers ***Summative assessment*** • Multiple choice questions • Free response/structure questions

Structure 2.2—The covalent model	**Structure 2.2.1** • Deduce the Lewis formula of molecules and ions for up to four electron pairs on each atom. **Structure 2.2.2** • Explain the relationship between the number of bonds, bond length and bond strength. **Structure 2.2.3** • Identify coordination bonds in compounds. **Structure 2.2.4** • Predict the electron domain geometry and the molecular geometry for species with up to four electron domains. **Structure 2.2.5** • Deduce the polar nature of a covalent bond from electronegativity values. **Structure 2.2.6** • Deduce the net dipole moment of a molecule or ion by considering bond polarity and molecular geometry. **Structure 2.2.7** • Describe the structures and explain the properties of silicon, silicon dioxide and carbon's allotropes: diamond, graphite, fullerenes and graphene. **Structure 2.2.8** • Deduce the types of intermolecular force present from the structural features of covalent molecules.	**Skills in the study of chemistry** **Tools** • **Tool 1**: Experimental techniques • **Tool 2**: Technology • **Tool 3**: Mathematics ***Inquiry Process*** • **Inquiry 1**: Exploring and designing • **Inquiry 2**: Collecting and processing data • **Inquiry 3**: Concluding and evaluating ***Formative Assessment (any of the following):*** • Observation of practical skills and ability to follow steps and show working • Questioning • Discussion of the methodology of the calculations and what working is necessary: class, small group, pair, individual, teacher-led, student-led. • Think, pair, share • Quiz • Worksheets and past paper questions ***Peer and self- assessment***

	Structure 2.2.9 • Explain the physical properties of covalent substances to include volatility, electrical conductivity and solubility in terms of their structure. **Structure 2.2.10** • Explain, calculate and interpret the retardation factor values, *R*F. **Additional higher level:** **Structure 2.2.11** • Deduce resonance structures of molecules and ions. **Structure 2.2.12** • Discuss the structure of benzene from physical and chemical evidence. **Structure 2.2.13** • Visually represent Lewis formulas for species with five and six electron domains around the central atom. • Deduce the electron domain geometry and the molecular geometry for these species using the VSEPR model. **Structure 2.2.14** • Apply formal charge to determine a preferred Lewis formula from different Lewis formulas for a species. **Structure 2.2.15** • Deduce the presence of sigma bonds and pi bonds in molecules and ions. **Structure 2.2.16**	• Students will be expected to check their own work at times, marking themselves and making corrections. At other times, they will share their answers and working and give and receive feedback from their peers ***Summative assessment*** • Multiple choice questions • Free response/structure questions

	• Analyze the hybridization and bond formation in molecules and ions. • Identify the relationships between Lewis formulas, electron domains, molecular geometry and type of hybridization. • Predict the geometry around an atom from its hybridization, and vice versa. **Inquiry 2**—What experimental data demonstrate the physical properties of covalent substances? **PSOW** Investigate compounds based on their bond type	
Structure 2.3—The metallic model	**Structure 2.3.1** • Explain the electrical conductivity, thermal conductivity and malleability of metals. **Structure 2.3.2** • Explain trends in melting points of s and p block metals. **Additional higher level:** **Structure 2.3.3**	**Skills in the study of chemistry** **Tools** • **Tool 1**: Experimental techniques • **Tool 2**: Technology • **Tool 3**: Mathematics ***Inquiry Process*** • **Inquiry 1**: Exploring and designing • **Inquiry 2**: Collecting and processing data • **Inquiry 3**: Concluding and evaluating

	• Explain the high melting point and electrical conductivity of transition elements**.** **Inquiry 2** What experimental data demonstrate the physical properties of metals, and trends in these properties, in the periodic table? **Computer Simulations** Computer simulation to show examples of metallic bonding.	***Formative Assessment (any of the following):*** • Observation of practical skills and ability to follow steps and show working • Questioning • Discussion of the methodology of the calculations and what working is necessary: class, small group, pair, individual, teacher-led, student-led. • Think, pair, share • Quiz • Worksheets and past paper questions ***Peer and self- assessment*** • Students will be expected to check their own work at times, marking themselves and making corrections. At other times, they will share their answers and working and give and receive feedback from their peers ***Summative assessment*** • Multiple choice questions • Free response/structure questions

Structure 2.4—From models to materials	**Structure 2.4.1** • Use bonding models to explain the properties of a material. **Structure 2.4.2** • Determine the position of a compound in the bonding triangle from electronegativity data. • Predict the properties of a compound based on its position in the bonding triangle. **Structure 2.4.3** • Explain the properties of alloys in terms of non-directional bonding **Structure 2.4.4** • Describe the common properties of plastics in terms of their structure. **Structure 2.4.5** • Represent the repeating unit of an addition polymer from given monomer structures. **Additional higher level:** **Structure 2.4.6** • Represent the repeating unit of polyamides and polyesters from given monomer structures.	**Skills in the study of chemistry** **<u>Tools</u>** • **Tool 1**: Experimental techniques • **Tool 2**: Technology • **Tool 3**: Mathematics ***Inquiry Process*** • **Inquiry 1**: Exploring and designing • **Inquiry 2**: Collecting and processing data • **Inquiry 3**: Concluding and evaluating ***Formative Assessment (any of the following):*** • Observation of practical skills and ability to follow steps and show working • Questioning • Discussion of the methodology of the calculations and what working is necessary: class, small group, pair, individual, teacher-led, student-led. • Think, pair, share • Quiz • Worksheets and past paper questions ***Peer and self- assessment*** • Students will be expected to check their own work at times,

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UNIT	**TOPIC/CONCEPT**	**ASSESSMENT COMPONENTS**
STRUCTURE THREE (3)- Classification of matter **Structure 3.1—The periodic table: Classification of elements**	**Structure 3.1.1** • Identify the positions of metals, metalloids and non-metals in the periodic table. **Structure 3.1.2** • Deduce the electron configuration of an atom up to *Z*=36 from the element's position in the periodic table and vice versa. **Structure 3.1.3** • Explain the periodicity of atomic radius, ionic radius, ionization energy, electron affinity and electronegativity. **Structure 3.1.4**	**Skills in the study of chemistry** **Tools** • **Tool 1**: Experimental techniques • **Tool 2**: Technology • **Tool 3**: Mathematics ***Inquiry Process*** • **Inquiry 1**: Exploring and designing • **Inquiry 2**: Collecting and processing data • **Inquiry 3**: Concluding and evaluating ***Formative Assessment (any of the following):***

	• Describe and explain the reactions of group 1 metals with water, and of group 17 elements with halide ions **Structure 3.1.5** • Deduce equations for the reactions with water of the oxides of group 1 and group 2 metals, carbon and sulfur. **Structure 3.1.6** • Deduce the oxidation states of an atom in an ion or a compound. • Explain why the oxidation state of an element is zero. **Additional higher level:** **Structure 3.1.7** • Explain how these discontinuities provide evidence for the existence of energy sublevels. **Structure 3.1.8** • Recognize properties, including: variable oxidation state, high melting points, magnetic properties, catalytic properties, formation of coloured compounds and formation of complex ions with ligands. **Structure 3.1.9** • Deduce the electron configurations of ions of the first-row transition elements **Structure 3.1.10** • Apply the colour wheel to deduce the wavelengths and frequencies of light absorbed and/or observed. **Inquiry 2**	• Observation of practical skills and ability to follow steps and show working • Questioning • Discussion of the methodology of the calculations and what working is necessary: class, small group, pair, individual, teacher-led, student-led. • Think, pair, share • Quiz • Worksheets and past paper questions ***Peer and self- assessment*** • Students will be expected to check their own work at times, marking themselves and making corrections. At other times, they will share their answers and working and give and receive feedback from their peers ***Summative assessment*** • Multiple choice questions • Free response/structure questions

	How can colorimetry or spectrophotometry be used to calculate the concentration of a solution of coloured ions? **PSOW** Investigate the colours of a range of complex ions of elements such as chromium, iron, cobalt, nickel and copper via spectrophotometry**.**	
Structure 3.2—Functional groups: Classification of organic compounds	**Structure 3.2.1** • Identify different formulas and interconvert molecular, skeletal and structural formulas. • Construct 3D models (real or virtual) of organic molecules**.** **Structure 3.2.2** • Identify the following functional groups by name and structure: halogeno, hydroxyl, carbonyl, carboxyl, alkoxy, amino, amido, ester, phenyl. **Structure 3.2.3** • Identify the following homologous series: alkanes, alkenes, alkynes, halogenoalkanes, alcohols, aldehydes, ketones, carboxylic acids, ethers, amines, amides and esters. **Structure 3.2.4** • Describe and explain the trend in melting and boiling points of members of a homologous series. **Structure 3.2.5**	**Skills in the study of chemistry** ***Tools*** • **Tool 1:** Experimental techniques • **Tool 2:** Technology • **Tool 3:** Mathematics ***Inquiry Process*** • **Inquiry 1:** Exploring and designing • **Inquiry 2:** Collecting and processing data • **Inquiry 3:** Concluding and evaluating ***Formative Assessment (any of the following):*** • Observation of practical skills and ability to follow steps and show working • Questioning • Discussion of the methodology of the calculations and what

	• Apply IUPAC nomenclature to saturated or mono-unsaturated compounds that have up to six carbon atoms in the parent chain and contain one type of the following functional groups: halogeno, hydroxyl, carbonyl, and carboxyl. **Structure 3.2.6** • Recognize isomers, including branched, straight-chain, position and functional group isomers. **Additional higher level:** **Structure 3.2.7** • Describe and explain the features that give rise to cis-trans isomerism; recognize it in non-cyclic alkenes and C3 and C4 cycloalkanes. • Draw stereochemical formulas showing the tetrahedral arrangement around a chiral carbon. • Describe and explain a chiral carbon atom giving rise to stereoisomers with different optical properties. • Recognize a pair of enantiomers as non-superimposable mirror images from 3D modelling (real or virtual). **Structure 3.2.8**	working is necessary: class, small group, pair, individual, teacher-led, student-led. • Think, pair, share • Quiz • Worksheets and past paper questions ***Peer and self- assessment*** • Students will be expected to check their own work at times, marking themselves and making corrections. At other times, they will share their answers and working and give and receive feedback from their peers ***Summative assessment*** • Multiple choice questions • Free response/structure questions

	• Deduce information about the structural features of a compound from specific MS fragmentation patterns. **Structure 3.2.9** • Interpret the functional group region of an IR spectrum, using a table of characteristic frequencies (wavenumber/cm^{-1}). **Structure 3.2.10** • Interpret ^{1}H NMR spectra to deduce the structures of organic molecules from the number of signals, the chemical shifts, and the relative areas under signals (integration traces). **Structure 3.2.11** • Interpret ^{1}H NMR spectra from splitting patterns showing singlet, doublets, triplets and quartets to deduce greater structural detail**.** **Structure 3.2.12** • Interpret a variety of data, including analytical spectra, to determine the structure of a molecule.	
UNIT	**TOPIC/CONCEPT**	**ASSESSMENT COMPONENTS**

REACTIVITY ONE (1) **What drives chemical reactions?** **Reactivity 1.1—Measuring enthalpy changes**	**Reactivity 1.1.1** • Understand the difference between heat and temperature**.** **Reactivity 1.1.2** • Understand the temperature change (decrease or increase) that accompanies endothermic and exothermic reactions, respectively**.** **Reactivity 1.1.3** • Sketch and interpret energy profiles for endothermic and exothermic reactions **Reactivity 1.1.4** • Apply the equations $Q = mc\Delta T$ and $\Delta H = -\frac{Q}{n}$ in the calculation of the enthalpy change of a reaction. **Inquiry 2** What observations would you expect to make during an endothermic and an exothermic reactions? **Inquiry 1, 2, 3** How can the enthalpy change for combustion reactions, such as for alcohols or food, be investigated experimentally? **Inquiry 3** Why do calorimetry experiments typically measure a smaller change in temperature than is expected from theoretical values?	**Skills in the study of chemistry** ***Tools*** • **Tool 1:** Experimental techniques • **Tool 2:** Technology • **Tool 3:** Mathematics ***Inquiry Process*** • **Inquiry 1:** Exploring and designing • **Inquiry 2:** Collecting and processing data • **Inquiry 3:** Concluding and evaluating ***Formative Assessment (any of the following):*** • Observation of practical skills and ability to follow steps and show working • Questioning • Discussion of the methodology of the calculations and what working is necessary: class, small group, pair, individual, teacher-led, student-led. • Think, pair, share • Quiz • Worksheets and past paper questions ***Peer and self- assessment***

	PSOW Determine the enthalpy change of simple reactions in aqueous solutions Determine the enthalpy of melting ice Calculate the energy content of food	• Students will be expected to check their own work at times, marking themselves and making corrections. At other times, they will share their answers and working and give and receive feedback from their peers ***Summative assessment*** • Multiple choice questions • Free response/structure questions
Reactivity 1.2—Energy cycles in reactions	**Reactivity 1.2.1** • Calculate the enthalpy change of a reaction from given average bond enthalpy data. **Reactivity 1.2.2** • Apply Hess's law to calculate enthalpy changes in multistep reactions. Additional higher level: **Reactivity 1.2.3** • Deduce equations and solutions to problems involving these terms. **Reactivity 1.2.4** Calculate enthalpy changes of a reaction using $\Delta H^{\ominus}$f data or $\Delta H^{\ominus}$c data: $\Delta H^{\ominus} = \Sigma(\Delta H_f^{\ominus}\text{products}) - \Sigma(\Delta H_f^{\ominus}\text{reactants})$ $\Delta H^{\ominus} = \Sigma(\Delta H_c^{\ominus}\text{reactants}) - \Sigma(\Delta H_c^{\ominus}\text{products})$	**Skills in the study of chemistry** ***Tools*** • **Tool 1:** Experimental techniques • **Tool 2:** Technology • **Tool 3:** Mathematics ***Inquiry Process*** • **Inquiry 1:** Exploring and designing • **Inquiry 2:** Collecting and processing data • **Inquiry 3:** Concluding and evaluating ***Formative Assessment (any of the following):*** • Observation of practical skills and ability to follow steps and show working

	Reactivity 1.2.5 • Interpret and determine values from a Born–Haber cycle for compounds composed of univalent and divalent ions.	• Questioning • Discussion of the methodology of the calculations and what working is necessary: class, small group, pair, individual, teacher-led, student-led. • Think, pair, share • Quiz • Worksheets and past paper questions ***Peer and self- assessment*** • Students will be expected to check their own work at times, marking themselves and making corrections. At other times, they will share their answers and working and give and receive feedback from their peers ***Summative assessment*** • Multiple choice questions • Free response/structure questions