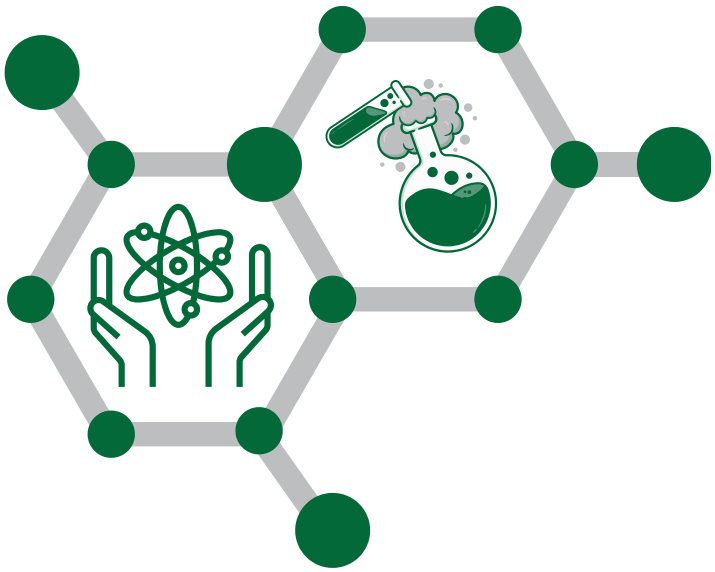
ZIAUDDIN UNIVERSITY
EXAMINATION BOARD

SSC A
Chemistry Syllabus



For exams in 2026 & onwards

INTRODUCTION TO ZUEB

The Ziauddin University Examination Board (ZUEB) is not only an awarding body but also a solution-driven educational organization dedicated to upholding the highest standards of academic excellence. ZUEB believes in Excellence, Integrity, and Innovation in Education. Established with a vision to foster a robust educational environment, ZUEB is committed to nurturing intellectual growth and development that meets international standards in an effective manner. The Ziauddin University Examination Board (ZUEB) was established through Government Gazette No. XLI on June 6th, 2018. Its purpose is to ensure a high quality, maintain global standards, and align the syllabi with national integrity within the examination system of Pakistan. ZUEB manages student appeals, regulates assessments, and reviews policies to maintain high standards.

WHY CHOOSE SSC-A AT ZUEB?

Ziauddin University Examination Board (ZUEB) offers the SSC-A (Secondary School Certificate advance) program, designed for students from international educational backgrounds. This program provides a structured, affordable, and academically strong pathway for learners to align with Pakistan's education system. It allows students to fulfil national curriculum requirements, including Urdu, Islamiyat, Pakistan Studies, or Sindhi, with academic integrity and flexible learning options. ZUEB believes no student should be left behind due to financial limitations or cross-system transitions, and SSC-A serves as a bridge between past efforts and future ambitions. It is the trusted choice for higher education in Pakistan.

SSC-ADVANCE CHEMISTRY

Chemistry in the SSC-Advance qualification at ZUEB is a cornerstone subject for students aspiring to pursue careers in medicine, chemical engineering, pharmacy, environmental sciences, and related fields. It provides the essential foundation for scientific inquiry, experimental skills, and analytical reasoning — abilities that are critical for academic excellence and intellectual growth. This subject not only deepens understanding of matter and its interactions but also equips students with the prerequisites required for success in competitive university entrance examinations across Pakistan.

Aligned with both national educational frameworks and the needs of students from international qualification backgrounds, our SSC-Advance Chemistry creates meaningful connections between global scientific knowledge and local academic standards. Students gain a comprehensive grasp of fundamental concepts in atomic structure, chemical bonding, thermodynamics, organic chemistry, electrochemistry, and environmental chemistry, delivered through a structured, flexible, and supportive learning model.

Whether your goal is to enter a top university in medicine or engineering, pursue research in chemical sciences, or simply build a strong foundation in analytical and practical problem-solving, SSC-Advance Chemistry ensures you are academically prepared and nationally aligned. Explore more on what SSC-A offers: ZUEB SSC-A Official Page.

Syllabus Overview

No.	Content	AO	Exam
1	States of Matter and Methods of Separation	1,2,3	Combination of written exam papers (externally set and marked) and a practical demonstration of skills. **Paper 1:** Multiple Choice Questions, Theoretical Questions and Practical Component. Duration: 2 hours **Paper 2:** Multiple Choice Questions, Theoretical Questions and Practical Component. Duration: 2 hours
2	Atoms and the Periodic Table	1,2,3	
3	Chemical Bonding	1,2,3	
4	Quantitative Chemistry	1,2,3	
5	Chemical Changes	1,2,3	
6	Reversible Reactions and Rate of Reactions	1,2,3	
7	Organic Chemistry	1,2,3	
8	Air and Water Chemistry	1,2,3	

Description Of Assessment Objectives

AO1 – Show knowledge and understanding of:

- scientific concepts and principles
- relevant methods, techniques, and procedures

AO2 – Apply knowledge and understanding to:

- use scientific ideas in various contexts
- perform and explain investigations, techniques, and procedures

AO3 – Analyse and interpret to:

- evaluate information and data
- draw reasoned conclusions and judgements
- suggest improvements to experimental methods

Weighting of Assessment Objectives

Assesement Objectives	P1 (%)	P2 (%)
A01	30	30
A02	40	40
A03	30	30

States of Matter and Methods of Separation				
Aim: To improve understanding of states of matter and methods of separation.				
	The learner will:	**SLO #**	**Assessment Criteria - The learner can:**	**Cognitive levels**
1	Comprehend the properties and behaviour of states of matter.	1.1.1	**Describe** solids, liquids, and gases in terms of particle arrangement proximity and motion.	AO1
		1.1.2	**Differentiate** among solids, liquids, and gases in terms of (i) volume, (ii) ability to flow, (iii) ability to be compressed, and (iv) relative kinetic energy of particles.	AO2
		1.1.3	**Describe** the physical changes of state of substances as a result in temperature change.	AO1
		1.1.4	**Explain** the kinetic particle model.	AO1
		1.1.5	**Describe** the principle of Brownian motion.	AO1
		1.1.6	**Exemplify** Brownian motion.	AO1
		1.1.7	**Define** diffusion.	AO1
		1.1.8	**Explain** factors that influence the rate of tdiffusion.	AO1
		1.1.9	**Outline** why the rate of diffusion is slow within solids.	AO1
		1.1.10	**Describe** the pressure and temperature of gases with respect to motion of particles.	AO2
		1.1.11	**Carry** out practicals involving investigation of rates of diffusion. 1.Temperature and diffusion e.g., soluble solid added to hot and cold water. 2. Molecular mass and rate of diffusion e.g., hydrogen chloride gas and ammonia. 3. Demonstrations of Brownian motion	AO3
2	Understand methods of purification.	1.2.1	**Identify** appropriate apparatus for the measurement of time, temperature, mass, and volume.	AO1
		1.2.2	**Explain** the processes carried out during paper chromatography.	AO2
		1.2.3	**Outline** how chromatography techniques can be applied to colourless substances using locating agents.	AO2
		1.2.4	**Perform** chromatography experiments: **Investigate** a mixture of water-soluble pigments and calculate Rf value and determine the number of pure substances in a mixture based on results. **Investigate** a mixture of non-water-soluble pigments and the use of an organic solvent to separate the mixture. **Explain** the importance of using a pencil to draw the origin line and solvent front. **Explain** the chemical nature of substances and reasons for using the different solvents. E.g., polar substances only dissolve in polar, and non-polar only dissolve in non-polar solvents.	AO3
		1.2.5	**Identify** substances and **assess** purity of substances based on melting and boiling points.	AO1
		1.2.6	**Conduct** a practical investigation of stearic acid (or alternative substance that has a low melting point) construct a table of results, and plot both heating and cooling curve.	AO3
		1.2.7	**Explain** how impurities affect the melting and boiling points of substances.	AO2
		1.2.8	**Discuss** the need for pure substances in medicines and food additives.	AO2

		1.2.9	**Explain** the term conservation of mass.	AO1
		1.2.10	**Describe** the following methods of purification: i) Filtration ii) Crystallisation iii) Solvent extraction.iv) Simple distillation and Fractional distillation. v)Centrifugation. **Identify** all equipment used from diagrams for methods of purification listed above. **Describe** a suitable method of purification from information provided.	AO3
		1.2.11	**Carry out** each method of separation. Examples include: 1.Separate sand from salt water to obtain pure sand,pure salt and pure water 2.Obtain solid copper sulphate from a copper sulphate solution 3.Separate ethanol from water 4.Separate blood in to its components	AO3
3	Be able to demonstrate a practical awareness of states of matter and methods of separation.	1.3.1	**Investigate** methods of heating and cooling of pure substances and report findings.	AO3
		1.3.2	**Interpret** simple chromatograms.	AO3
		1.3.3	**Interpret** simple chromatograms using Rf values.	AO3
		1.3.4	**Investigate** the effect of impurities on melting and boiling points of substances and report findings.	AO3

Atoms and the Periodic Table				
Aim: To develop an understanding of the structure of the atom and how atoms are arranged in the periodic table.				
	The learner will:	**SLO #**	**Assessment Criteria - The learner can:**	**Cognitive levels**
1	Understand atomic structure, energy levels and concepts of isotopes.	2.1.1	**State** the relative mass and charge of a proton, neutron, and electron.	AO1
		2.1.2	**Define** the terms proton number and nucleon number.	AO1
		2.1.3	**Describe** the significance of the proton number in organizing the periodic table.	AO2
		2.1.4	**Define** the terms relative atomic mass and relative formula mass.	AO1
		2.1.5	**Define** the term isotope.	AO1
		2.1.6	**State** two types of isotopes: radioactive and non-radioactive.	AO2
		2.1.7	**Describe** the importance of isotopes in the field of: i) Medicine, ii) Industry	AO2
		2.1.8	**Evaluate** how isotopes have the same chemical properties due to having the same number of electrons in the outer shell.	AO3
		2.1.9	**Explain** the significance of the noble gas electronic structure and outer shell electrons in terms of chemical reactivity.	AO2
		2.1.10	**Differentiate** between elements, compounds, and mixtures.	AO2
		2.1.11	**Outline** the build-up of electron shells/energy levels.	AO1
2	Understand the periodic table.	2.2.1	**Explain** the following: i. Mendeleev's contribution to the periodic table. ii. Modifications to earlier arrangements in the periodic table. ii. The universal adoption of chemical symbols, many derived from Latin.	AO2
		2.2.2	**Describe** the change in metallic to non-metallic character across a period.	AO2
		2.2.3	**State** the general appearance of Group **I** and **II** elements in the periodic table.	AO1
		2.2.4	**Summarise** the relationship between group number and the number of electrons in the outer shell.	AO2
		2.2.5	**Evaluate** the relationship between period number and the number of electron shells.	AO3
		2.2.6	**Differentiate** between metals and non-metals.	AO2
		2.2.7	Identify trends in the periodic table including: i. Atomic sizes of atoms across the period and down the group. ii.Metallic and non-metallic character across the period. iii.Physical states of matter across the period and down the group.	AO2
		2.2.8	**Describe** the trends in physical and chemical properties of group 1 metals in terms of: (i) melting and boiling points, (ii) density, (iii) reactivity, (iv) colour of oxides formed, (v) formation of hydroxides after reacting with water, and (vi) other properties of metals.	AO2
		2.2.9	**Describe** and **explain** the importance of appropriate storage of group 1 metals.	AO1
		2.2.10	**Explain** changes of reactivity of group 1 in terms of ease of loss of outer electron due to weaker force of attraction between the nuclei and outer electron.	AO2
		2.2.11	**Outline** how halogens are considered as diatomic molecules.	AO1

		2.2.12	**Describe** the trends in the physical properties of the group VII elements (Halogens) in terms of: (i) colour of appearance, (ii) melting and boiling points, (iii) states of matter, and (iv) reactivity.	AO2
		2.2.13	**State** the uses of group VII elements.	AO1
		2.2.14	**Predict** the properties of elements in group VII as; i) oxidising agents ii) electronegative elements	AO3
		2.2.15	**Explain** the changes of reactivity of group VII in terms of ease of gaining of additional electrons due to stronger force of attraction between the nuclei and outer electrons.	AO2
		2.2.16	**Describe** the noble gases as being unreactive, monatomic gases and **explain** this in terms of electronic structure.	AO2
		2.2.17	**List** the uses of noble gases and explain why their chemical inertness makes them suitable for creating an inert atmosphere.	AO2
		2.2.18	**Describe** the properties of transition elements in terms of: (i) high melting and boiling points, (ii) high densities, (iii) forming coloured compounds, (iv) acting as catalysts, (v) variable oxidation states, and (vi) other metal properties.	AO
		2.2.19	**Describe** the uses of transition metals.	AO1
		2.2.20	**Perform** various tests to demonstrate metallic versus non metallic properties including: 1. Adding range of metals to acids and observe results. 2. Testing relative conductivity of metals / non-metals in a simple series circuit. 3. Magnetic properties of iron versus other metals and non-metals. 5. Making various metal-coloured compounds such as hydrated copper sulphate (blue), potassium permanganate (purple), iron oxide (brown) and other suitable examples.	AO1
3	Be able to demonstrate practical awareness of the structure of atoms.	2.3.1	**Calculate** the number of protons, neutrons and electrons of an element using the periodic table.	AO2
		2.3.2	**Investigate** how lithium, sodium and potassium reacts with water.	AO3
		2.3.3	**Investigate** and **predict** properties of other group 1 metals.	AO3
		2.3.4	**Identify** trends in the groups of the periodic from specified provided.	AO2

Chemical Bonding				
Aim: To enhance understanding of bonding between atoms.				
	The learner will:	**SLO #**	**Assessment Criteria - The learner can:**	**Cognitive levels**
1	Understand structure and bonding.	3.1.1	**Explain** that the bulk properties of substances are related to the type of bonding present. In terms of: 1. Bond strength of intermolecular forces 2. Bonding arrangement 3. Recall that individual atoms do not have these properties.	AO2
		3.1.2	**Explain** the formation of ions through the loss or gain of electrons.	AO1
		3.1.3	**Describe** ionic bonding as the electrostatic force of attraction between oppositely charged positive and negative ions.	AO2
		3.1.4	**Outline** the formation of ionic bonds between metallic and non-metallic elements.	AO1
		3.1.5	**Outline** the formation of ionic bonds between groups I and VII elements.	AO1
		3.1.6	**Outline** the formation of ionic bonds between groups II and VI elements.	AO2
		3.1.7	**Describe** the lattice structure of ionic compounds.	AO1
		3.1.8	**Evaluate** the importance of balancing the ions when determining chemical formula of ionic compounds.	AO2
		3.1.9	**Describe** covalent bonding in terms of sharing of electrons.	AO1
		3.1.10	**Describe** the formation of simple covalent bonds in molecules such as; (i) hydrogen gas, (ii) chlorine gas,(iii) water, (iv) ammonia gas, (v) hydrogen chloride, and (vi) methane gas	AO2
		3.1.11	**Define** the term ‘lone pair of electrons’	AO1
		3.1.12	**Outline** how bonding allows atoms to achieve a stable noble gas electron configuration.	AO1
		3.1.13	**Describe** the arrangement of electrons for complex covalent molecules giving relevant examples.	AO2
		3.1.14	**List** examples of complex covalent compounds.	AO1
		3.1.15	**Describe** the terms; single, double and triple covalent bonds with examples.	AO1
		3.1.16	**Exemplify** single, double, and triple covalent bonds.	AO2
		3.1.17	**Explain** the term valency.	AO1
		3.1.18	**Define** the term ‘macromolecular structure’.	AO1
		3.1.19	**Describe** giant covalent structures, giving examples such as diamond, graphite, fullerenes, and graphene.	AO2

		3.1.20	**Differentiate** between the physical properties of ionic and covalent substances in terms of: (i) volatility, (ii) electrical conductivity, (iii) solubility, and (iv) melting and boiling points.	AO2
		3.1.21	**Define** the term 'metallic bonding' in terms of a lattice of positive ions floating in a sea of delocalised electrons.	AO1
		3.1.22	**Describe** the properties of metals.	AO2
2	Be able to demonstrate practical awareness of the purpose of chemical bonding.	3.2.1	**Draw** dot and cross diagrams to show electron transfer in the formation of ionically bonded substances.	AO2
		3.2.2	**Draw** diagrams representing covalent bonds using a single line (e.g., H–H, Cl-Cl etc).	AO2
		3.2.3	**Deduce** the uses of diamond, graphite, fullerenes, and graphene with reference to their structure.	AO3
		3.2.4	**Compare** diamond and silicon (IV) dioxide in terms of structure and properties.	AO3
		3.2.5	**Deduce** whether an unknown substance is a metal, non-metal, ionic, simple covalent, or giant covalent from given information about its properties.	AO3

Quantitative Chemistry				
Aim: To enhance understanding of quantitative chemistry.				
	The learner will:	**SLO #**	**Assessment Criteria - The learner can:**	**Cognitive levels**
1	Understand chemical formula.	4.1.1	**Differentiate** between: i. metals and non-metals ii. ionic compounds and covalent compounds.	AO2
		4.1.2	**Define** the following terms: i. reactants ii. products iii. by products	AO1
		4.1.3	**State** the following states of matter symbols: (i) s, (ii) l, (iii) g, (iv) aq, (v) ppt	AO1
		4.1.4	**Define** the term 'spectator ions'.	AO1
2	Be able to demonstrate practical awareness of chemical formulae.	4.2.1	**Write** the chemical formula for elements and simple compounds.	AO1
		4.2.2	**Deduce** the formula of ionic compounds using valency of elements present.	AO2
		4.2.3	**Deduce** the formula of compounds from diagrams.	AO2
		4.2.4	**Construct** the word, chemical and balanced chemical equations form information provided.	AO3
		4.2.5	**Construct** balanced ionic chemical equations.	AO3
3	Understand chemical calculations.	4.3.1	**Describe** the terms 'mole' and the 'Avogadro's constant'.	AO2
		4.3.2	**Describe** titration as a method for determining the unknown concentration of a solution.	AO2
		4.3.3	**Describe** the terms 'percentage yield' and 'percentage purity'.	AO2
4	Be able to demonstrate practical awareness of chemical calculations.	4.4.1	**Deduce** relative atomic mass and relative formula mass of various chemical compounds.	AO2
		4.4.2	Use moles to calculate stoichiometric reacting masses, applying the following: • Moles (mol) = mass (g) ÷ relative atomic/molar mass (Ar or Mr) • Moles (mol) = concentration (mol/dm^3) × volume (dm^3) • Moles (mol) = volume of gas (dm^3) ÷ 24 (dm^3 mol^{-1}) at room temperature and pressure • Concentration (mol/dm^3) = mass (g) ÷ volume (dm^3)	AO3
		4.4.3	**Calculate** the theoretical yield of a product from a given amount of reactant.	AO3

		4.4.4	**Deduce** which reactant is limiting or in excess by comparing the number of moles of each reactant considering the stoichiometry of the equation.	AO3
		4.4.5	**Calculate** the percentage by mass of an element in a compound.	AO3
		4.4.6	**Calculate:** • Percentage yield • Percentage purity • Empirical formula • Molecular formula	AO3
		4.4.7	**Calculate** the concentration of a solution from experimental or given data.	AO3

Chemical Changes				
Aim: To enhance the understanding of chemical changes.				
	The learner will:	**SLO #**	**Assessment Criteria - The learner can:**	**Cognitive levels**
1	Understand chemical changes.	5.1.1	**Exemplify** physical and chemical changes.	AO1
		5.1.2	**Define** physical and chemical changes and **illustrate** with examples.	AO2
		5.1.3	**Describe** the terms exothermic and endothermic in terms of: 1. Net energy gain and loss from a reaction. 2. Change in surrounding temperature	AO2
		5.1.4	**State** various finite fuels including coal, oil, gas, hydrogen, and uranium.	AO1
		5.1.5	**Describe** the processes involved in release of energy from fuels	AO2
		5.1.6	**Evaluate** differences in energy output by per kg of fuel.	AO3
		5.1.7	**Describe** various polluting products produced by energy production.	AO2
		5.1.8	**Describe** the production of electrical energy from simple cells.	AO2
		5.1.9	**Explain** differences between electrochemical cells(Galvanic cell) and electrolytic cells.	AO2
		5.1.10	**Relate** differences in voltage of electrochemical cells according to the differences of the reactivity series.	AO2
		5.1.11	**Describe** how hydrogen is used in fuel cells and used in the production of electricity.	AO2
		5.1.12	**Evaluate** the use of hydrogen as a fuel compared to other fuels.	AO3
2	Be able to demonstrate practical awareness of chemical changes.	5.2.1	**Draw**, **label** and **interpret** energy level diagrams.	AO2
		5.2.2	**Calculate** the energy absorbed and released from reactions using bond energy values.	AO3
		5.2.3	**Deduce** a reaction as exothermic or endothermic from the given data.	AO3
		5.2.4	**Investigate** fuels using calorimetry to measure energy released.	AO3
		5.2.5	**Draw** and **label** simple electrochemical cells.	AO1
		5.2.6	**Investigate** metal combinations and voltage output.	AO3

		5.2.7	**Create** a model of a fuel cell.	AO3
		5.2.8	**Construct** balanced chemical half-equations for acidic and alkaline electrolytes in fuel cells.	AO3
3	Understand acid and bases.	5.3.1	**Explain** the following terms i.neutral, ii.acid, iii.base, and iv.alkali.	AO1
		5.3.2	**Define** acids and bases, in terms of proton transfer.	AO1
		5.3.3	**Compare** the differences between strong and weak acids in terms of: i. Hydrogen ion concentration and pH. ii. Ability of acid substance to dissociate to form hydrogen ions. iii. Examples of laboratory acids and chemical formula, Hydrochloric acid HCl, Sulphuric acid H_2SO_4, Nitric acid HNO_3. **Compare** the differences between strong and weak alkali in terms of: i. Hydroxide ion concentration. ii. Ability of an alkali substance to dissociate to form hydroxide ions. iii. Examples of laboratory alkalis and chemical formula, Sodium hydroxide NaOH, Calcium hydroxide $Ca(OH)_2$, Aluminium hydroxide $Al(OH)_3$.	AO3
		5.3.4	**Describe** indicators used to identify acids and alkalis, specifically: (i) litmus, (ii) methyl orange, (iii) phenolphthalein, and (iv) universal indicator.	AO2
		5.3.5	**Perform** a range of chemical tests on variety of substances using the full range of indictors stated in 5.3.4(i)-(iv) demonstrating the ability to interpret the chemical nature of unknown chemicals based on observations.	AO3
		5.3.6	**Describe** properties of acids.	AO1
		5.3.7	**Evaluate** the importance of using bases to assist in regulating pH of soils.	AO3
		5.3.8	**List** examples of oxides as: (i) acidic, (ii) basic, (iii) neutral, and (iv) amphoteric.	AO1
		5.3.9	**Classify** oxides as acidic, basic, neutral, and amphoteric with examples.	AO2
4	Be able to demonstrat practical awareness of acids and bases.	5.4.1	**Deduce** the acidity / alkalinity of a substance based on given information.	AO3
		5.4.2	**Apply** the following general equations in given examples: (i) Metal + acid -> salt + hydrogen (ii) metal oxide + acid -> salt + water (iii) metal carbonate + acid -> salt + water + carbon dioxide (iv) metal hydroxides + acid -> salt + water (v) aqueous ammonia + acid -> salt	AO3
		5.4.3	**Construct** word,chemical and balanced chemical equations of reactions including states of matter symbols for acid-base reactions.	AO3
		5.4.4	**Construct** ionic equations for acid-base reactions.	AO3
		5.4.5	**Conduct** a range of metal, metal oxide, metal carbonate and metal hydroxide reactions using range of laboratory acids.	AO3
5	Understand the process of making salts.	5.5.1	**Describe** methods of preparation, separation, and purification of (i) salts from metal, (ii) a soluble base, and (iii) an insoluble base.	AO2
		5.5.2	**Conduct** experiments to make metal salts from metals, metal oxides, metal carbonates and metal hydroxides reacted with laboratory acids e.g., copper oxide + sulphuric acid to make solid copper sulphate.	AO3
		5.5.3	**Describe** the preparation of insoluble salts by precipitation reactions.	AO2

		5.5.4	**Describe** methods and observation for the following chemical tests: (i) test for oxygen, and (ii) test for carbon dioxide, (iii) test for water, and (iv) test for sulphur dioxide, (v) test for ammonia, and (vi) test for chlorine.	AO2
		5.5.5	**Describe** the tests for cations using the following: (i) precipitation reactions, and (ii) flame tests.	AO2
		5.5.6	**Describe** the test for anions, specifically: (i) testing for halides using precipitation, (ii) testing for carbonates by analysis of carbon dioxide formed, (iii) testing for nitrates by identifying ammonia using litmus, (iv) testing for sulphate by identifying sulphur dioxide using potassium manganate (VII).	AO2
		5.5.7	**Carry out** each method described in 5.5.6(i)-(iv) using appendix for tests and positive results required.	AO3
6	Be able to demonstrate practical awareness of the process for making salts.	5.6.1	**Deduce** a suitable method of making a salt from information provided.	AO3
		5.6.2	**Carry out** a titration to make potassium sulphate.	AO2
		5.6.3	**Deduce** the unknown substances by qualitative analysis based on the given information.	AO3
		5.6.4	**Carry out** the following chemical tests: (i) test for oxygen, and (ii) test for carbon dioxide, (iii) test for water, and (iv) test for sulphur dioxide, (v) test for ammonia, and (vi) test for chlorine.	AO3
7	Understand metals and reactivity.	5.7.1	**Define** the term 'alloy'.	AO1
		5.7.2	**State** the constituent metals of the following alloys: (i) brass, (ii) bronze, (iii) solder, and (iv) stainless steel.	AO2
		5.7.3	**Describe** the properties and uses of the following alloys (i) brass, (ii) bronze, (iii) solder, and (iv) stainless steel.	AO2
		5.7.4	**Recognise** alloys from the given information (diagrams).	AO1
		5.7.5	**Describe** metals that are above hydrogen in the reactivity series.	AO2
		5.7.6	**State** metals that react with (i) water, (ii) steam, and (iii) acids.	AO1
		5.7.7	**Describe** metal reactivity in terms of displacement reactions.	AO2
		5.7.8	**Perform** a range of metal + acid reactions and **construct** a reactivity series based on observations on vigorousness of reaction.	AO3
		5.7.9	**Describe** reactivity of metals in terms of valency and ability to lose electrons.	AO2
		5.7.10	**Describe** the use of carbon as a reducing agent for some metal oxides.	AO1
		5.7.11	**Evaluate** the difference between freshly made aluminium and old aluminium.	AO3
		5.7.12	**Define** the term 'thermal decomposition'.	AO1
		5.7.13	**Describe** the impact of heat on hydroxides and nitrates.	AO2
		5.7.14	**Outline** the relationship of thermal decomposition with reactivity series of metals.	AO1

		5.7.15	**Construct** the correct word, chemical and balanced chemical formula for the thermal decomposition of (i) hydroxides, and (ii) nitrates	AO3
8	Be able to demonstrate practical awareness of metals and reactivity.	5.8.1	**Investigate** metals placed in a reactivity series in terms of reactions with water, steam, and acids.	AO3
		5.8.2	**Deduce** reactivity of metals based on given information.	AO3
9	Understand electrochemistry.	5.9.1	**Define** the term electrolysis.	AO1
		5.9.2	**Define** the terms cation and anion.	AO1
		5.9.3	**State** the word, chemical and balanced chemical equation for electrolysis reactions.	AO2
		5.9.4	**Explain** products at electrodes in terms of reactivity referring to 'discharge series'.	AO2
		5.9.5	**Summarise** electrolysis in terms of electron transfer.	AO2
		5.9.6	**Explain** electrolysis in the context of purifying copper, including the type of electrolyte used and electrodes used.	AO2
		5.9.7	**Describe** the process of electrolysis in electroplating.	AO2
		5.9.8	**Describe** the uses of electroplating in terms of: (i) protection against corrosion, and (ii) improving of appearance of metals.	AO2
		5.9.9	**Conduct** an electroplating experiment on conductive material e.g., using copper sulphate solution and an iron nail.	AO3
		5.9.10	**Describe** the purpose of purifying aluminium from bauxite including the type of electrolyte and electrodes used.	AO2
		5.9.11	**Define** the term conductor and insulator in terms of energy transfer within a material.	AO1
		5.9.12	**Describe** the use of thick steel-cored aluminium wires for high voltage electrical cables in terms of electron transfer and resistance.	AO2
		5.9.13	**Outline** the role of copper in electrical wiring.	AO1
		5.9.14	**Discuss** the use of plastics and ceramics as insulators.	AO2
		5.9.15	**Describe** the tests for identifying substances, specifically: (i) halides in concentrated solutions and (ii) hydroxides	AO2
10	Be able to demonstrate practical awareness of electrochemistry.	5.10.1	**Identify** and **label** components of an electrolysis cell.	AO1
		5.10.2	**Deduce t**he products at electrodes of a molten ionic compound and ionic compounds in solution.	AO2
		5.10.3	**Carry out** observations of products formed at electrodes and identify substances based on these observations, specifically: (i) halides in concentrated solutions, (ii) electrolysis of brine to manufacture chlorine, (iii) hydroxide, and (iv) sodium hydroxide.	AO3
		5.10.4	**Construct** half equations for reactions occurring at both electrodes	AO2

11	Understand the process of metal extraction.	5.11.1	**Describe** bauxite as an ore of aluminium.	AO1
		5.11.2	**Explain** metal extraction in terms of its position on the reactivity series.	AO2
		5.11.3	**Describe** the process of extraction of zinc from zinc blende.	AO2
		5.11.4	**Describe** hematite as an ore of iron.	AO2
		5.11.5	**Explain** the chemical reactions that occur in the blast furnace during the extraction of iron from hematite.	AO2
		5.11.6	**State** the raw materials used in the process of producing iron in a blast furnace.	AO1
		5.11.7	**Describe** the process of conversion of iron into steel.	AO2
		5.11.8	**Outline** the role of basic oxides and oxygen in steel making.	AO1
		5.11.9	**Describe** the changing of properties of iron by addition of additives.	AO2
		5.11.10	**Explain** the difference between iron extraction in blast furnace and steel making processes.	AO2
		5.11.11	**List** the uses of (i) aluminium, (ii) mild steel, (iii) stainless steel, and (iv) copper.	AO1
		5.11.12	**Describe** uses of these metals related to their properties: (i) aluminium, (ii) mild steel, (iii) stainless steel, and (iv) copper.	AO2
		5.11.13	**Evaluate** the advantages and disadvantages of recycling metals.	AO3
		5.11.14	**Explain** the uses of zinc; i) galvanising and ii) for alloy making.	AO2

Reversible Reactions and Rate of Reactions				
Aim: To enhance understanding of reversible reactions and rate of reactions.				
	The learner will:	**SLO #**	**Assessment Criteria - The learner can:**	**Cognitive levels**
1	Understand the rate of reactions.	6.1.1	**Identify** and **explain** suitable methods to calculate rate of reactions based on: (i) calculating mass loss of reactants in a given time, (ii) calculating volume of product in a given time, and (iii) calculating the time taken in a precipitation reaction.	AO2
		6.1.2	**Summarise** appropriate methods and name equipments for: (i) calculating mass loss of reactants in a given time, (ii) calculating volume of product in a given time, and (iii) calculating the time taken in a precipitation reaction.	AO2
		6.1.3	**Evaluate** suitable methods for calculating rate of reactions based on information provided.	AO3
		6.1.4	**Interpret** changes from data and graphs regarding rates of reactions.	AO2
		6.1.5	**Discuss** the impact of the following factors that affect the rate of reaction: (i) surface area,(ii) temperature, (iii) catalyst, and (iv) concentration.	AO2
		6.1.6	**Conduct** and **report** practical investigations on reaction rates, including: 1.Measuring volume of carbon dioxide produced over a period of time using metal carbonate + acid. 2.Measuring mass decrease over a period of time e.g., metal carbonate + acid. 3.Using difference sizes of reactants e.g., lumps versus powder.	AO3
		6.1.7	**Describe** the role of light in photochemical reactions and give examples where light provides the energy to break or form chemical bonds.	AO2
		6.1.8	**State** the word equation, chemical formulae and the balanced equation for photosynthesis.	AO1
		6.1.9	**Describe** the role of silver salts in photography.	AO1
		6.1.10	**State** the word, chemical and balanced chemical equation for the redox reactions in photography using silver salts.	AO2
2	Demonstrate practical understanding related to reaction rates.	6.2.1	**Investigate** the use of dependent, independent and control variables based on given information.	AO2
		6.2.2	**Interpret** data and graphs when describing rate of reactions, in terms of (i) chance of successful collisions between reacting particles, and (ii) kinetic energy and activation energy.	AO2
		6.2.3	**Determine** the rate of reaction from data and graphs based on given information.	AO3
3	Understand reversible reactions.	6.3.1	**Evaluate** the conditions which must be present when chemical reactions are reversible.	AO2
		6.3.2	**Recognize** a reversible reaction using ⇌ symbol.	AO1
		6.3.3	**Describe** reversible reactions in terms of changing conditions including: (i) hydrous and anhydrous copper sulphate due to presence of water, (ii) carbon dioxide as gas and carbon dioxide in solution due to change in pressure, and (iii) use of cobalt chloride to test presence of water vapour.	AO2

		6.3.4	**Define** the term 'water crystallisation'.	AO1
		6.3.5	**Compare** the appearance of hydrous and anhydrous copper sulphate.	AO2
		6.3.6	**Perform** an experiment to observe the hydrated and anhydrous versions of copper sulphate.	AO2
		6.3.7	**Define** the term 'closed system'.	AO1
		6.3.8	**State** what is meant by the term 'equilibrium', specifically: when it occurs in a closed system, (i) when concentrations of reactants and products are fixed, and (ii) during forward and reverse reaction taking place at the same rate.	AO2
		6.3.9	**Define** the term 'shifting equilibrium'.	AO1
		6.3.10	**Describe** changes of equilibrium under the following conditions: (i) changes in concentration of reactants / products, (ii) changes in temperature, and (iii) during the use of a catalyst, (iv) when there are changes in pressure.	AO2
		6.3.11	**Describe** the following: (i) Haber process, and (ii) Contact process.	AO2
		6.3.12	**Determine** changes of equilibrium based on given information.	AO3
		6.3.13	**Explain** the term oxidation and reduction in terms of: (i) gain or loss of electrons, (ii) gain or loss of oxygen, (iii) gain or loss of hydrogen.	AO1
		6.3.14	**Evaluate** the importance of oxidation states.	AO2
		6.3.15	**Define** the terms oxidising agents and reducing agents.	AO1
		6.3.16	**Construct** the chemical and balanced chemical half reactions for redox reactions.	AO3
		6.3.17	**Recognise** redox reactions by changes in oxidation state and by colour changes using potassium manganate (VII) and potassium iodide.	AO1
4	Demonstrate understanding of key processes within the chemical industry.	6.4.1	**Explain** the use of nitrogen, phosphorous and potassium containing fertilisers.`	AO2
		6.4.2	**Describe** the displacement of ammonia from its salts.	AO2
		6.4.3	**List** the sources of hydrogen and nitrogen that are used to manufacture ammonia.	AO1
		6.4.4	**Explain** the essential conditions and chemical used in the Haber process including: (i) temperature, (ii) pressure, and (iii) use of iron as a catalyst.	AO2
		6.4.5	**List** sources of sulphur.	AO1
		6.4.6	**Evaluate** changes in the equilibrium of the Haber process and its impact on yield and rate of reaction.	AO3

		6.4.7	**Describe** uses of sulphur and sulphur dioxide.	AO2
		6.4.8	**Outline** the properties and applications of dilute and concentrated sulfuric acid.	AO1
		6.4.9	**Explain** the manufacturing of sulfuric acid by the Contact Process.	AO2
		6.4.10	**Describe** the essential conditions and reactions of the Contact process, in terms of (i) temperature, (ii) pressure, and (iii) use of Vanadium (V) oxide as a catalyst.	AO2
		6.4.11	**Describe** the manufacture of lime in terms of thermal decomposition.	AO2
		6.4.12	**State** the uses of (i) lime, (ii) slaked lime, and (iii) calcium carbonate.	AO1

Organic Chemistry				
Aim: To enhance understanding of organic chemistry.				
	The learner will:	**SLO #**	**Assessment Criteria - The learner can:**	**Cognitive levels**
1	Understand organic chemistry and petrochemicals.	7.1.1	**Describe** the term homologous series in terms of a group of similar compounds with similar chemical properties due to the presence of the same functional group.	AO2
		7.1.2	**Describe** the general characteristics of a homologous series.	AO1
		7.1.3	**Explain** that compounds in a homologous series have the same general formula.	AO1
		7.1.4	**State** the structures of methane, ethane, ethanol, and ethanoic acid	AO1
		7.1.5	**Define** the term 'hydrocarbon'.	AO1
		7.1.6	**Draw** and **identify** the structural formulae of alkanes up to six carbon atoms (methane to hexane).	AO2
		7.1.7	**Define** the term 'isomers'	AO1
		7.1.8	**Describe** structural isomers from given information.	AO2
		7.1.9	**Outline** the characteristics of the following fuels: (i) coal, (ii) natural gas, and (iii) petroleum (crude oil).	AO1
		7.1.10	**Describe** the types of fuels obtained from petroleum.	AO1
		7.1.11	**Describe** the properties of molecules within a fraction.	AO
		7.1.12	**Describe** the products of complete combustion of a hydrocarbon fuel as carbon dioxide and water.	AO2
		7.1.13	**Explain** how petroleum is separated into fractions by fractional distillation.	AO2
		7.1.14	**Identify** the uses of the fractions obtained from fractional distillation.	AO1
2	Understand alkanes and alkenes.	7.2.1	**Discuss** the properties of alkanes.	AO2
		7.2.2	**Describe** the bonding of alkanes.	AO2
		7.2.3	**Summarise** the reaction of alkanes with chlorine.	AO1
		7.2.4	**Explain** the manufacturing process of: (i) alkenes, and (ii) hydrogen by cracking.	AO2
		7.2.5	**State** and **illustrate** the structural formulae of alkenes up to six carbon atoms.	AO1
		7.2.6	**Differentiate** between saturated and unsaturated hydrocarbons in terms of: (i) presence of double C bond, and (ii) reactions with aqueous bromine.	AO2
		7.2.7	**Explain** the addition reactions of alkenes with bromine, steam and hydrogen.	AO2
		7.2.8	**Evaluate** the formation of ethanol by fermentation and by the addition of steam to ethane.	AO2

		7.2.9	**Describe** the uses of ethanol.	AO1
		7.2.10	**State** and **draw** the structural formulae of alcohols up to four carbon atoms.	AO2
		7.2.11	**Explain** the method of preparing ethanoic acid.	AO2
		7.2.12	**Explain** the properties of ethanoic acid in terms of: (i) strength of acid, and (ii) its reaction with ethanol.	AO2
		7.2.13	**State** and **draw** the structural formulae of carboxylic acids up to four carbon atoms.	AO1
		7.2.14	**State** and **draw** the structural formulae of esters up to four carbon atoms.	AO1
3	Understand polymers.	7.3.1	**Define** the following terms: (i) macromolecule, (ii) monomer, (iii) polymer, and (iv) polymerisation.	AO1
		7.3.2	**State** some of the uses of plastics and man-made fibres.	AO1
		7.3.3	**Identify** the structure of a polymer formed from a given alkene.	AO1
		7.3.4	**Analyse** the problems of pollution caused by non-biodegradable plastics.	AO3
		7.3.5	**Identify** the structure of a monomer from a given addition polymer.	AO1
		7.3.6	**Identify** the structure of monomers and addition polymers.	AO1
		7.3.7	**Summarise** the characteristic features of amide and ester linkages.	AO1
		7.3.8	**Define** the following terms: (i) polyamide, and (ii) polyester.	AO1
		7.3.9	**Explain** condensation polymerisation.	AO2
		7.3.10	**Describe** the formation of nylon and terylene.	AO2
		7.3.11	**Differentiate** between addition polymers and condensation polymers.	AO2
4	Understand biological molecules.	7.4.1	**Describe** DNA as a polymer of four different nucleotide monomers, in which adjacent nucleotides in a single strand are joined by phosphodiester bonds and the two strands are held together by hydrogen bonds.	AO2
		7.4.2	**Discuss** proteins and carbohydrates as constituents of food.	AO1
		7.4.3	**Define** the term ‘macromolecule’.	AO1
		7.4.4	**State** the general chemical structure of a protein.	AO1
		7.4.5	**Describe** the process of hydrolysis reactions when breaking down proteins to amino acids.	AO2
		7.4.6	**Describe** the process of condensation reactions when building proteins from amino acids.	AO2
		7.4.7	**Evaluate** the significance of the amide linkage (peptide bond) formed between the amine group and carboxyl group of amino acids.	AO2
		7.4.8	**Describe** the hydrolysis of starch and cellulose.	AO2
		7.4.9	**Describe** the formation of complex carbohydrates by polymerisation of simple sugars.	AO1

		7.4.10	**Describe** how chromatography can be used to identify the products of hydrolysis of carbohydrates and proteins.	AO2
		7.4.11	**Describe** enzymes as proteins that act as biological catalysts	AO2
		7.4.12	**Describe** the fermentation of simple sugars.	AO2
		7.4.13	**Compare** the two methods of producing ethanol.	AO2

Air and Water Chemistry				
Aim: To enhance understanding of air and water chemistry.				
	The learner will:	**SLO #**	**Assessment Criteria - The learner can:**	**Cognitive levels**
1	Understand the physical and chemical properties of air and water.	8.1.1	**Describe** the chemical tests to check the purity of water.	AO2
		8.1.2	**Define** the term potable water.	AO1
		8.1.3	**Discuss** the treatment of water in terms of filtration and chlorination.	AO2
		8.1.4	**Describe** domestic and industrial uses of water.	AO2
		8.1.5	**Describe** the sources of water.	AO2
		8.1.6	**Describe** the problems of an inadequate supply of water.	AO2
		8.1.7	**Explain** the changes in composition of air from early Earth's atmosphere to present day.	AO2
		8.1.8	**State** the relative composition of gases in the atmosphere.	AO1
		8.1.9	**Explain** the process of separating nitrogen and oxygen from liquid air by fractional distillation.	AO2
		8.1.10	**Describe** uses of nitrogen and oxygen.	AO1
		8.1.11	**Summarise** the sources of various air pollutants including: (i) carbon monoxide, (ii) lead compounds, (iii) nitrogen oxides, (iv) carbon dioxide, (v) methane, and (vi) sulphur dioxides.	AO2
		8.1.12	**Discuss** the negative effects of air pollutants including: (i) global warming, (ii) acid rain, (iii) respiratory conditions, (iv) formation of ground level ozone, (v) brain damage, (vi) reduced oxygen carrying capacity of blood, (vii) damage to environments.	AO3
		8.1.13	**Describe** strategies to prevent and reduce impacts of air pollutants: i) Use of pollutant scrubbers, (ii) use of catalytic converters, (iii) flue gas desulphurisation, (iv) governmental agreements, (v) changes in human behaviour, (vi) use of renewables / alternative sources of energy production.	AO3
		8.1.14	**Explain** the various stages of the carbon cycle.	AO2
		8.1.15	**Explain** the conditions needed for rusting to occur.	AO2
		8.1.16	**Describe** various methods of rust prevention including: (i) addition of coatings such as paint and grease, and (ii) galvanising.	AO2
		8.1.17	**Evaluate** the process of sacrificial protection in terms of reactivity.	AO3

Mathematical Requirements

Candidates may use calculators for all sections.

Candidates should be able to:

1. Work out problems involving addition, subtraction, multiplication, and division.
2. Calculate percentages with accuracy.
3. Determine percentage increase or decrease.
4. Apply different formulas to find missing values.
5. Convert between various units of measurement.
6. Judge suitable orders of magnitude and sense of scale.
7. Estimate values by identifying patterns or trends.
8. Represent data using standard form.
9. Give answers using the proper number of significant figures.
10. Record results in line with measuring equipment precision (e.g., 1.1 cm≥ for a burette).
11. Work out energy efficiency.
12. Understand and use ratios effectively.

Safety in the laboratory

The following safety rules must be followed at all times in the laboratory.

1. Safety goggles must be worn in the lab at all times. Glasses and contact lenses are not acceptable substitutes for eye protection.
2. Never eat or drink in the lab. Food can absorb or pick up toxic chemicals.
3. Never inhale fumes or vapours. Use fume hoods for hazardous or irritating chemicals.
4. Never taste any chemical. Some chemicals are highly corrosive and poisonous even in very small quantities.
5. Never perform an unauthorized experiment and never work in the lab without an instructor present. An accident may happen even when mixing simple chemicals.
6. Never remove anything (chemicals, glassware, etc.) from the lab. It is illegal.
7. All containers are labelled to identify their contents.
8. Never put anything back into a reagent bottle. Once a reagent has passed the mouth of its container, it has passed the point of no return. Always take as little of a chemical as possible. Use only clean, dry spatulas for removing chemicals from bottles. Properly dispose of excess chemicals.
9. Leave chemicals in their proper place. Do not carry original containers of chemicals to your benchtop.
10. Avoid touching hot objects. Burns are a common accident in the chemistry lab. Be careful when using hot plates and objects which have been heated on them. Use beaker tongs to remove hot containers from hot plates.
11. Rinse spills off skin immediately. Rinse off any chemicals spilled on the skin immediately with large amounts of water.
12. Clean up broken glassware immediately. Place it in the labelled container and obtain replacement glassware from the instructor.
13. Properly dispose of waste chemicals. Certain liquids can be poured into the sink and flushed with water while others are poured into designated waste containers. Most solid wastes are placed in designated crocks. Your instructor will provide disposal instructions for each lab.
14. Notify your instructor immediately of all accidents.
15. Learn to locate and operate (if applicable), the fire extinguishers, eye-wash fountain, fire blanket, and fire exit.

Appendix Tests

Flame test colours for ions

Metal ion	Flame test colour
Lithium (Li+)	Red
Sodium (Na+)	Yellow
Potassium (K+)	Lilac
Copper (Cu^{2+})	Blue-green
Calcium (Ca^{2+})	Orange-red
Barium (Ba^{2+})	Green

Testing for Halides

Halide ion	Precipitate colour
Chloride (Cl^-)	White
Bromide (Br^-)	Cream
Iodide (I^-)	Yellow

Testing for cations

Metal ion	Precipitate colour (metal hydroxide added)
Aluminium Al^{3+}	White
Calcium Ca^{2+}	White
Copper Cu^{2+}	Blue
Iron (II) Fe^{2+}	Green
Iron (III) Fe^{3+}	Brown
Zinc Zn^{2+}	White
Chromium Cr^{3+}	Red

Testing for anions

Anion	Test	Result
Nitrate NO_3^-	Add sodium hydroxide solution, aluminium foil and heat.	Ammonia gas produced, can be tested by using red litmus that will turn to blue.
Sulphate SO_2^{2-}	Add to aqueous barium nitrate.	White precipitate formed.
Sulphite SO_3^{2-}	Add dilute hydrochloric acid, warm gently.	Sulphur dioxide produced will turn acidified aqueous potassium manganate (VII) from purple to colourless.