آغا خان یونیورسٹی ایگزامینیشن بورڈ

AGA KHAN UNIVERSITY EXAMINATION BOARD

Secondary School Certificate
Examination Syllabus

Chemistry

Grades IX - X

(Based on New National Curriculum 2022-2023)

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Secondary School Certificate
Examination Syllabus

CHEMISTRY
GRADES IX-X

This syllabus will be examined in both
Annual and September Examination sessions from
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Annual Examination 2027 for Grade X

For queries and feedback

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Preface

Established in 2002 through the Pakistan government's ordinance, the Aga Khan University Examination Board (AKU-EB) is country's first private autonomous qualification awarding body for Secondary School Certificate (SSC) and Higher Secondary School Certificate (HSSC). Its vision is to be a model of excellence and innovation in education in Pakistan and the developing world.

AKU-EB achieves its vision by developing examination syllabi which inculcate conceptual thinking and higher order learning and is aligned with the National Curriculum and mapped with provincial curricula and international standards. AKU-EB revises its syllabi periodically to support the needs of students, teachers and society.

The aims of the syllabus review of SSC and HSSC are to:

- Ensure continued compatibility with the goals of the National Curriculum of Pakistan.
- Review the content for inclusion of new knowledge and deletion of obsolete knowledge.
- Review the content for clarity and relevance as per the changing needs of students, teachers and society.
- Enhance and strengthen continuation and progression of content both within and across grades IX - XII (SSC and HSSC).
- Ensure the readiness of students for higher education.

During the syllabus review, the needs of all the stakeholders were identified through a needs-assessment survey. Students and teachers of AKU-EB affiliated schools from across Pakistan participated in the survey. Thereafter, a revision panel, which consisted of examiners, teachers of affiliated and non-affiliated schools, teacher trainers and university academicians, reviewed and revised the syllabus following a planned, meticulous and standardised syllabi review process.

The development of the revised syllabus has been made possible by the creativity and relentless hard work of Curriculum and Examination Development unit and the constant support provided by all the other units of AKU-EB. We are particularly thankful to our Principal Syllabus Reviewers, Syllabus Revision Panellists and all other reviewers for their contribution. We are also thankful to all the students and teachers who took part in the needs-assessment survey and to the principals of AKU-EB affiliated schools who made this endeavour possible by facilitating and encouraging their teachers and students to be a part of the survey and the syllabus revision panel.

With your support and collective hard work, AKU-EB has been able to take the necessary steps to ensure effective implementation of the National Curriculum of Pakistan through this syllabus. We are confident that this syllabus will continue to provide the support that is needed by students to progress to the next level of education, and we wish the very best to our students and teachers in implementing this syllabus.

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Understanding of AKU-EB Syllabi

1. The AKU-EB syllabi guide the students, teachers, parents and other stakeholders regarding the topics that will be taught and examined in each grade (IX, X, XI and XII). In each syllabus document, the content progresses from simple to complex, thereby facilitating a gradual, conceptual learning of the content.

2. The topics of the syllabi are divided into Sub-topics and **student learning outcomes** (**SLOs**). The SLOs define the depth and the breadth at which each topic or sub-topic will be taught, learnt and examined. The syllabi also provide enabling SLOs where needed to scaffold student learning.

3. Each SLO starts with an achievable and assessable **command word** such as describe, relate, evaluate, etc. The purpose of the command words is to direct the attention of teachers and students to specific tasks that the students are expected to undertake during their studies.

4. The SLOs are classified under the following **cognitive levels** of Bloom's Taxonomy: Remember (R), Understand (U), Apply and beyond [Apply (A), Analyse (An), Evaluate (E), Create (C)]. This is to facilitate effective planning for teaching, learning and assessment. In addition, some SLOs are identified as Formative Assessments (FA), where applicable.

5. Where applicable, the **Practical Activities** section is provided to elaborate the assessment in the Practical Examination.

6. The **Examination Specification** is provided, which elucidates the weightage of each topic in the examinations determined based on the content as well as the relevance of the topic.

7. To implement this syllabus, students and teachers can take support from additional material provided by the board to its affiliated schools including **Learning Resource Guides**, **Pacing Guides** and **Model Papers**.

8. The AKU-EB syllabi for Secondary School Certificate (SSC) and Higher Secondary School Certificate (HSSC) are designed to foster not only conceptual understanding but also critical thinking and problem-solving skills. These syllabi ensure students develop the cognitive, affective and psychomotor skills essential for success at the university and beyond.

Subject Rationale of AKU-EB Chemistry

Why study Chemistry?

Chemistry is all about fundamental understanding of the natural world. It is not restricted to schools, books or the science laboratory, it is found everywhere around us. The air we respire, the food in the kitchen, the aroma of perfumes, the fibres in our clothing, the medicines we take, the fertilisers in the soil, the environment we live in, the construction materials in our houses, the petrochemical industries – literally there occur hundreds and thousands of chemical phenomena every day in life which involves chemistry. By studying chemistry, students learn about the composition, properties, and changes of matter, which are crucial for comprehending how substances interact in everyday life. It also teaches practical skills involving the usage of chemicals and sophisticated analytical instruments for the interpretation of chemical phenomena. Chemistry, often called the "central science," bridges other natural sciences, including physics, biology, and geology, creating a cohesive understanding of various phenomena.

What will you learn in AKUEB Chemistry?

The AKU-EB Chemistry Syllabus is designed to provide students with essential theoretical and practical knowledge of real-life Chemistry. It focuses on understanding the different themes of Chemistry including Organic Chemistry, Environmental Chemistry, Inorganic Chemistry, Biochemistry, Analytical Chemistry etc.

The syllabus attempts to develop a logical approach for students to understand different chemical phenomena and solve authentic problems. This is not only academically enriching but also helps to develop 21st century skills in students such as critical thinking and problem-solving skills. Additionally, it also focuses on laboratory skills and safety practices, preparing students for future scientific endeavours.

Furthermore, the use of multiple learning resources included in Learning Resource Guide such as models, pictures, animations and various reference books create interest and provide logical understanding of fundamental concepts of Chemistry. Overall, AKU-EB Chemistry syllabus is not just about memorising reactions and formulas; it’s about developing a scientific mindset and curiosity to explore the world.

Where will it take you?

The study of Chemistry enables an individual to play a vital role in the socio-economic development of our country. In recent years, the impact of Chemistry in our society for prospects has been excellent. It has opened doors for careers in a variety of professions and occupations in academia, government, and industry, and in diverse fields such as environmental sciences, pharmaceuticals, medicine, oceanography, aerospace, engineering and education. More employment opportunities are available as compared to the past and the academic sector is becoming well-equipped with highly qualified staff to transfer valuable knowledge to students. Furthermore, government officials have paid more attention to raise the standard of higher education in our country, which has resulted in significant provision of research opportunities to experience problem solving, information handling, organisation,

interpretation and presentation skills in discovering new scientific knowledge. It teaches practical skills involving the usage of chemicals and sophisticated analytical instruments for the interpretation of chemical phenomena. The results of the research are of immediate benefit to the chemists, other scientists in related disciplines and the industrial sector.

Moreover, students on acquiring the knowledge of Chemistry are expected to be able to pursue tertiary education in various fields including:

- Engineering
- Medicine
- Pharmacy
- Dentistry
- Nursing
- Veterinary
- Environmental science
- Biotechnology
- Geology
- Biochemistry
- Polymer engineering
- Textile engineering
- Chemical engineering
- Microbiology

How to approach the syllabus?

The AKU-EB syllabus is carefully designed with a reader-friendly approach to ensure that students and teachers can easily comprehend it, making it functional for teaching, learning and assessment purposes. The syllabus includes the following parts:

Subject Rationale	It is an introductory document for students.
Student Learning Outcomes (SLOs)	These guide students about what must be achieved.
Exam Specification	It guides regarding what is expected in the examination.
Practical Activities	These include laboratory activities to be performed during an academic year.
Additional Resources	
Pacing Guide	It ensures smooth transition and curricular continuity of a school's academic year. It also predicts the time and pace of the syllabus implementation.
Resource Guide	It includes teaching and learning resources for students and teachers.
Model Paper	It guides regarding exam pattern, types of questions and marking scheme.
Command Word Guide	It clarifies expectations regarding the cognitive levels and skills that should be acquired by the students, and which are assessed in examinations.

Student Learning Outcomes of AKU-EB SSC Chemistry Syllabus

Part I (Grade IX)

Topics and Sub-topics	Student Learning Outcomes		Cognitive Level[1]		
			R	U	A and beyond
1. Fundamentals of Chemistry	Students should be able to:				
1.1 Chemistry and its Branches	1.1.1	define 'chemistry' and its various branches: a. analytical chemistry, b. astrochemistry, c. biochemistry, d. environmental chemistry, e. geochemistry, f. industrial chemistry, g. inorganic chemistry, h. nuclear chemistry, i. organic chemistry, j. physical chemistry, k. polymer chemistry;	*		
	1.1.2	explain the significance of the branches of chemistry mentioned in SLO 1.1.1;		*	

[1]R = Remember, U = Understand, A = Apply and beyond [Apply (A), Analyse (An), Evaluate (E), Create (C)]

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
1.2	History of Chemistry	1.2.1	describe the contribution of Jabir Ibn Hayyan and Al-Razi in chemistry during the Islamic Golden Age (8th to 14th centuries);		FA[2]	
		1.2.2	define the term 'scientific paradigm';	FA		
		1.2.3	explain the following examples of 'scientific paradigm' in chemistry: a. Phlogiston theory, b. Plum pudding model;		FA	
1.3	Basic Definitions, Comparisons, Valencies, and Chemical Formulae	1.3.1	define the following terms: a. atoms, b. elements, c. compounds, d. mixtures, e. molecules;	*		
		1.3.2	differentiate between: a. atoms and molecules, b. atoms and ions, c. molecules and molecular ions, d. ions and free radicals;		*	
		1.3.3	differentiate among elements, compounds and mixtures;		*	
		1.3.4	classify the chemical species into elements, mixtures, compounds, ions, molecular ions and free radicals;		*	
		1.3.5	define the term 'valency';	*		
		1.3.6	determine valencies of common elements and ions (radicals) independently or in compounds;			A
		1.3.7	determine the formula of a compound based on the valencies of elements and ions (radicals).			A

[2]FA= Formative Assessment, not to be assessed under examination conditions

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
2. Stoichiometry		Students should be able to:				
2.1	Avogadro's Number and Mole	2.1.1	define the following terms: a. gram atomic mass, b. gram molecular mass, c. gram formula mass, d. formula unit, e. mole, f. Avogadro's number;	*		
		2.1.2	relate gram atomic mass, gram molecular mass and gram formula mass to mole and Avogadro's number;		*	
		2.1.3	calculate the following quantities of chemical species: a. number of moles, b. number of particles (atoms, molecules and ions), c. molar mass (atomic/ molecular/ formula), d. mass;			A
2.2	Formulae and Percentage Composition	2.2.1	differentiate between empirical formula and molecular formula;		*	
		2.2.2	calculate the percentage composition by mass of an element in a compound;			A
		2.2.3	calculate the empirical formula using percentages or masses of elements;			A
		2.2.4	calculate the molecular formula using molecular mass and empirical formula;			A
2.3	Chemical Reactions and Calculations	2.3.1	describe the following terms: a. chemical reaction, b. chemical equation;		*	

Topics and Sub-topics		Student Learning Outcomes	Cognitive Level		
			R	U	A and beyond
	2.3.2	illustrate the following types of chemical reactions: a. displacement (single/ double), b. decomposition, c. addition/ synthesis/ combination, d. combustion (complete/ incomplete), e. neutralisation, f. hydrolysis;			A
	2.3.3	evaluate the effectiveness of chemical reactions based on the following characteristics: a. change of state, b. change in colour, c. evolution of gas, d. change in temperature, e. formation of a precipitate, f. occurrence of sound;			E
	2.3.4	construct chemical equations and ionic equations to show reactants forming products, including state symbols;			An
	2.3.5	balance chemical equations by inspection or trial and error method;			An
	2.3.6	solve problems based on stoichiometric relationships of substances in terms of: a. mass, b. number of moles, c. number of molecules, d. mole ratio, e. volume of gases at Room Temperature and Pressure (RTP) (24 L or dm^3 and 24000 mL or cm^3).			A

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
3. Atomic Structure		Students should be able to:				
3.1	Features of an Atom	3.1.1	describe the structure of an atom with reference to the location, relative electric charges and relative masses of proton, electron and neutron;		*	
		3.1.2	define the following terms: a. atomic (proton) number, b. mass (nucleon) number, c. atomic mass, d. atomic mass unit;	*		
		3.1.3	calculate the atomic number, mass number, number of electrons and neutrons of atoms and ions;			A
		3.1.4	draw the atomic structure of the first twenty elements of the periodic table and their ions (cations and anions) using their mass number and atomic number;			A
3.2	Isotopes	3.2.1	define the following terms: a. isotopes, b. average atomic mass, c. relative atomic mass based on C-12 scale, d. radioactive isotopes, e. radioactivity;	*		
		3.2.2	determine the number of protons, neutrons and electrons in different isotopes of H, C, O, Cl and U;			A
		3.2.3	calculate the relative atomic masses of chlorine and boron by using the mass number and natural abundance of their isotopes;			A
		3.2.4	explain the role of isotopes in carbon dating (carbon), power generation (uranium) and medical imaging (iodine, sodium, technetium, thallium, arsenic, cobalt and xenon);		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
3.3	Models to Understand the Structure of an Atom	3.3.1	explain Rutherford's experiment leading to the discovery of the atomic nucleus;		*	
		3.3.2	explain the defects of Rutherford's atomic model;		*	
		3.3.3	describe the main points (postulates) of Bohr's atomic model;		*	
3.4	Shells and Sub-shells	3.4.1	differentiate between shells and sub-shells of an atom;		*	
3.5	Electronic Configuration	3.5.1	deduce the electronic arrangement (in shells) and electronic configuration (of sub-shells) of the first twenty elements and their ions using their atomic number and charges (if any).			E

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
4. Periodic Table and Periodicity		Students should be able to:				
4.1	Periodic Table	4.1.1	state the modern periodic law;	*		
		4.1.2	differentiate between a period and a group in the periodic table;		*	
		4.1.3	determine the group, period and block of an element using its electronic configuration (first twenty elements);			A
		4.1.4	describe the demarcation of the periodic table into s, p, d, and f-blocks;		*	
		4.1.5	determine the location of families on the periodic table based on their characteristics and electronic configuration (representative elements);			A
4.2	Periodic Properties	4.2.1	define the following terms: a. shielding effect, b. electronegativity, c. atomic radii, d. electron affinity, e. ionisation energy (1^{st} and 2^{nd});	*		
		4.2.2	explain the periodic trend of the following within a group and a period of the periodic table: a. shielding effect, b. electronegativity, c. atomic radii, d. electron affinity, e. ionisation energy (1^{st} and 2^{nd});		*	
		4.2.3	compare the chemical reactivity and physical properties (metallic character, physical states, conductivity, density, melting and boiling points) of elements in the same family of elements (representative elements);		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
4.3	Properties of Elements in a Group	4.3.1	determine elements as an alkali metal, an alkaline earth metal, a halogen and a noble gas based on their electronic configuration;			A
		4.3.2	compare the general properties of metals and non-metals in terms of: a. physical states, b. density, c. malleability, d. ductility, e. melting and boiling points, f. conductivity, g. sonority, h. appearance/ lustre, i. hardness/ brittleness, j. nature of oxides (basic, acidic and amphoteric);		*	
		4.3.3	explain the following properties of Group I and II elements; a. occurrence in combined state in nature, b. softness of metals, c. reaction with water, d. reaction with hydrogen, e. reaction with oxygen, f. reaction with dilute acids;		*	
		4.3.4	explain the following properties of Group VII elements: a. existence as diatomic molecules, b. appearance (colour and state), c. displacement reactions with other halogens, d. reaction with metals;		*	

Topics and Sub-topics	Student Learning Outcomes		Cognitive Level		
			R	U	A and beyond
	4.3.5	explain the following properties of Group VIII elements: a. existence as monoatomic gases or free state in nature, b. chemical inertness, c. importance of noble gas electronic configuration in the formation of ions;		*	
	4.3.6	explain the following properties of transition metals: a. relative hardness, b. density, c. melting and boiling points, d. variable oxidation states, e. formation of coloured compounds;		*	
	4.3.7	explain the inertness of noble metals;		FA	
	4.3.8	discuss the commercial importance of silver, gold and platinum.			FA

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
5. Structure of Molecules		Students should be able to:				
5.1	Formation of Chemical Bond	5.1.1	explain duplet and octet rules that help atoms achieve stable electron configurations by forming bonds;		*	
		5.1.2	define a chemical bond and its following types: a. ionic bond, b. covalent bond, c. coordinate covalent bond, d. metallic bond;	*		
		5.1.3	exemplify the formation of: a. cations from an atom of a metallic element, b. anions from an atom of a non-metallic element;		*	
		5.1.4	explain the nature of bonding based on the electronegativity difference of bonded atoms using Linus Pauling scale;		*	
5.2	Ionic Bond	5.2.1	explain the formation of an ionic bond;		*	
		5.2.2	explain the general characteristics of ionic compounds;		*	
		5.2.3	identify a compound as having ionic bond;		*	
		5.2.4	draw electron dot and cross structure of a binary ionic compound, for example, NaCl, MgO, K_2O and $CaCl_2$;			A
5.3	Covalent Bond	5.3.1	explain the formation of a covalent bond between two non-metallic elements;		*	
		5.3.2	exemplify single, double and triple covalent bonds;		*	
		5.3.3	explain the general characteristics of covalent compounds;		*	
		5.3.4	draw electron dot and cross structures for simple covalent molecules including H_2, Cl_2, O_2, N_2, H_2O, CH_4, NH_3, HCl, CO_2, HCN, C_2H_6, C_2H_4, and C_2H_2;			A
		5.3.5	explain polar and non-polar covalent compounds;		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
		5.3.6	differentiate between ionic and covalent compounds based on characteristics and examples;		*	
5.4	Coordinate Covalent Bond	5.4.1	explain the formation of coordinate covalent bond;		*	
		5.4.2	draw electron dot and cross structure of coordinate covalent compounds, for example, ammonium ion, oxonium (hydronium) ion, aluminium tetrachloride anion, adduct (addition product) of ammonia and boron trifluoride;			A
		5.4.3	compare the formation and characteristics of coordinate covalent compounds with covalent compounds;		*	
5.5	Metallic Bond	5.5.1	explain the formation of metallic bonding (electron-sea model);		*	
		5.5.2	explain the contribution of structure of metals and the mobility of their electrons to the following properties: a. malleability, b. ductility, c. melting and boiling points, d. lustre, e. tensile strength, f. electrical and thermal conductivity;		*	
5.6	Intermolecular Forces	5.6.1	explain weak intermolecular forces, including Van der Waals forces (London dispersion forces and dipole-dipole interactions) and hydrogen bonding, with their effect on the melting and boiling points of compounds.		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
6. States of Matter		Students should be able to:				
6.1	Kinetic Molecular Theory and Phase Changes	6.1.1	compare the physical states of matter based on the intermolecular forces present between their molecules;		*	
		6.1.2	explain phase changes (melting, freezing, vaporisation, condensation, sublimation and deposition) due to changes in temperature and pressure affecting the arrangement and motion of particles within a substance;		*	
		6.1.3	explain melting and boiling point of substances used as a criterion to check their purity;		*	
		6.1.4	interpret heating and cooling curves in terms of kinetic theory;			E
6.2	Gaseous State	6.2.1	explain the following properties of gases in terms of kinetic theory: a. diffusion, b. effusion, c. density, d. compressibility;		*	
		6.2.2	relate qualitatively the effect of the following factors to the rate of diffusion: a. molecular mass, b. temperature;		*	
6.3	Laws Related to Gases	6.3.1	relate the changes in pressure and volume of a gas using Boyle's law;		*	
		6.3.2	relate the changes in temperature and volume of a gas using Charles's law;		*	
		6.3.3	relate the changes in number of molecules and volume of a gas using Avogadro's law;		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
6.4	Liquid State	6.4.1	explain the following properties of liquids and the factors that affect them: a. vapour pressure, b. boiling point, c. freezing point, d. density, e. compressibility;		*	
		6.4.2	differentiate between evaporation and boiling;		*	
		6.4.3	discuss the effects of temperature on vapour pressure and the effects of external pressure on the boiling point of liquids;			E
		6.4.4	explain the significance of diffusion rates in the context of medicine;		FA	
6.5	Solid State	6.5.1	explain the following physical properties of solids: a. melting point, b. density, c. compressibility;		*	
		6.5.2	explain the following applications of sublimation such as: a. solid air fresheners, b. dry ice (solid carbon dioxide), c. mothballs (naphthalene), d. 3D printing;		*	
6.6	Types of Solid	6.6.1	define the term ‘allotropes’;	*		
		6.6.2	explain allotropic forms of carbon (diamond, graphite, buckyballs and coal) and sulphur (rhombic, monoclinic and plastic).		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
7. Solutions		Students should be able to:				
7.1	Introduction to Solutions	7.1.1	exemplify the following terms: a. solvent, b. solute, c. solution, d. aqueous/ non-aqueous solution, e. residue, f. filtrate;		*	
7.2	Types of Solution According to Phases	7.2.1	classify different types of solutions according to the following phases: a. gas into gas, b. gas into liquid, c. gas into solid, d. liquid into gas, e. liquid into liquid, f. liquid into solid, g. solid into gas, h. solid into liquid, i. solid into solid;		*	
7.3	Types of Solution According to Concentration	7.3.1 7.3.2	differentiate among saturated, unsaturated and supersaturated solutions; differentiate between dilute and concentrated solutions;		* *	
7.4	Comparison of Solution, Suspension and Colloid	7.4.1	compare the characteristics of solutions, suspensions and colloids with examples;		*	
7.5	Concentration Units and Dilution of Solutions	7.5.1 7.5.2	define the term ‘molarity’; solve problems based on molarity of a solution;	*		A

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
		7.5.3	define the term 'percentage' as a unit of concentration;	*		
		7.5.4	calculate the percentage composition of different solutions (% m/m, % m/v, % v/m, % v/v);			A
		7.5.5	solve problems based on dilution of solutions from concentrated solutions of known molarity;			A
7.6	Factors Affecting Solubility	7.6.1	define the term 'solubility';	*		
		7.6.2	explain the factors that affect solubility, i.e., temperature, pressure and nature of solute and solvent;		*	
		7.6.3	predict the solubility of one substance into another using the rule of 'like dissolves like';			E
		7.6.4	interpret the effect of temperature on the solubility of different salts (for example, KNO_3, KCl, Li_2SO_4, $Ce_2(SO_4)_3$ and NaCl) in water by referring to absorption, release, or no change in heat, based on the solubility versus temperature graphs;			E
7.7	Methods for Separating Mixtures and Purification Techniques	7.7.1	explain the following methods of separation and purification: a. evaporation, b. decantation, c. filtration, d. crystallisation, e. distillation, f. fractional distillation;		*	
		7.7.2	define the following terms: a. chromatography, b. stationary phase, c. mobile phase, d. chromatogram, e. locating agent, f. retention factor (R_f);	*		

Topics and Sub-topics	Student Learning Outcomes		Cognitive Level		
			R	U	A and beyond
	7.7.3	apply the paper chromatography technique for separating mixtures and isolating compounds;			A
	7.7.4	interpret chromatograms using the R_f equation and spotting (locating) agents to recognise components in a mixture;			E
	7.7.5	predict techniques for separating and purifying everyday mixtures.			E

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
8. Electrochemistry		Students should be able to:				
8.1	Oxidation and Reduction (Redox) Reactions	8.1.1	differentiate between oxidation and reduction in terms of loss or gain of oxygen, hydrogen or electrons;		*	
8.2	Oxidation States and Rules for Assigning Oxidation States	8.2.1	define oxidation state;	*		
		8.2.2	explain the common rules used for assigning oxidation numbers to free elements, ions, molecules and atoms;		*	
		8.2.3	calculate the oxidation number of an atom in a compound and polyatomic ion;			A
8.3	Oxidising and Reducing Agents	8.3.1	describe oxidising and reducing agents in a redox reaction;		*	
		8.3.2	deduce oxidising and reducing agents in a redox reaction;			E
8.4	Electrochemical Cells	8.4.1	define the following terms: a. electrolyte, b. weak electrolyte, c. non-electrolyte, d. electrolysis;	*		
		8.4.2	describe an electrochemical cell and its two types;		*	
		8.4.3	distinguish between Galvanic (voltaic) cell and electrolytic cell based on their parts, working and examples;		*	
		8.4.4	deduce the direction of movement of cations and anions towards respective electrodes in an electrolytic cell;			E
		8.4.5	infer the electrical conductivity of solutions based on the dissociation of substances into ions;			An
		8.4.6	identify the reactivity of elements using the reactivity series;		*	
		8.4.7	illustrate metal displacement reactions in an aqueous medium;			A
		8.4.8	determine the half-cell in which oxidation occurs and the half-cell in which reduction occurs in a voltaic cell;			A

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
		8.4.9	deduce the direction of the flow of electrons in a voltaic cell;			E
		8.4.10	explain the production of electrical energy in a dry cell;		*	
8.5	Electrochemical Industries	8.5.1	explain the manufacturing of sodium metal from fused NaCl in Down cell;		*	
		8.5.2	explain the manufacturing of sodium hydroxide from aqueous solution of NaCl in Nelson cell;		*	
8.6	Corrosion and its Prevention	8.6.1	define the term 'corrosion';	*		
		8.6.2	describe the rusting of iron as an example of corrosion;		*	
		8.6.3	explain the following methods used to prevent corrosion: a. barrier coatings (using paint and galvanising), b. electroplating (using tin and chromium), c. sacrificial protection (using magnesium blocks).		*	

Part II (Grade X)

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
9. Chemical Equilibrium		Students should be able to:				
9.1	Reversible Reactions and Dynamic Equilibrium	9.1.1	define chemical equilibrium as a dynamic state in a reversible reaction;	*		
		9.1.2	describe the macroscopic characteristics of: a. forward and reverse reactions, b. dynamic equilibrium;		*	
		9.1.3	explain the necessary conditions for equilibrium and the ways through which equilibrium can be recognised;		*	
		9.1.4	construct balanced chemical equations to represent both forward and reverse reactions;			An
9.2	Thermal Reactions	9.2.1	explain the connection of a system (open, closed and isolated) with its surroundings in terms of energy transfer;		*	
		9.2.2	differentiate between exothermic and endothermic reactions with examples;		*	
		9.2.3	define the term, 'enthalpy change';	*		
		9.2.4	explain the activation energy required for a catalysed and uncatalysed reaction pathway, including the effect of catalysts on reaction rates;		*	
		9.2.5	illustrate an energy profile diagram for exothermic and endothermic reactions;			A

[1]R = Remember, U = Understand, A = Apply and beyond [Apply (A), Analyse (An), Evaluate (E), Create (C)]

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
9.3	Law of Mass Action and Le Chatelier's Principle	9.3.1	state the law of mass action;	*		
		9.3.2	derive the equilibrium constant expression of a reaction and its unit;			A
		9.3.3	predict the direction and extent of reversible reactions using reaction quotient Q_C and equilibrium constant K_C;			E
		9.3.4	predict the direction of a reversible reaction using molar concentration of reactants and products through the calculation of Q_C;			E
		9.3.5	state Le Chatelier's principle;	*		
		9.3.6	deduce the effect of catalyst, temperature, pressure and concentration on a reversible reaction at equilibrium.			E

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
10. Acids, Bases and Salts		Students should be able to:				
10.1	Concepts of Acids and Bases	10.1.1	exemplify Arrhenius acids and bases;		*	
		10.1.2	illustrate dissociation equations for acids or bases in aqueous solution;			A
		10.1.3	state Brønsted-Lowry theory;	*		
		10.1.4	classify substances as acids or bases or as proton donors or proton acceptors using Brønsted-Lowry theory;		*	
		10.1.5	explain the limitations of Arrhenius and Brønsted-Lowry theory;		*	
		10.1.6	state Lewis concepts of acids and bases;	*		
		10.1.7	classify substances as Lewis acids or bases;		*	
		10.1.8	describe the amphoteric nature of water using the equation of its self-ionisation;		*	
10.2	Properties of Acids and Bases	10.2.1	explain the physical properties of acids and bases;		*	
		10.2.2	differentiate between alkalis and bases;		*	
		10.2.3	illustrate the chemical properties of: a. acids (reaction with bases, active metals, metal oxides metal carbonates and metal bicarbonates), b. bases (reaction with ammonium salts);			A
10.3	Strengths and Applications of Acids and Bases	10.3.1	explain the acidity of bases and the basicity of acids;		*	
		10.3.2	exemplify strong and weak acids and bases;		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
		10.3.3	exemplify the uses of acids and bases in the following areas: a. household settings (cleaning, personal care and cooking), b. industries (chemical manufacturing, mining and water treatment), c. artistic endeavours (glass etching and metal etching);		*	
10.4	pH and pOH	10.4.1	describe pH and pOH using mathematical equations;		*	
		10.4.2	illustrate the use of pH paper and a pH meter in measuring the pH of body fluids, beverages, personal care products, household items and fruit juices;			A
		10.4.3	determine a solution as neutral, acidic or basic based on hydrogen ion or hydroxide ion concentration using pH and pOH scale;			A
		10.4.4	calculate the pH and pOH of solutions using the concentrations of hydrogen or hydroxide ions;			A
10.5	Acid-Base Titration	10.5.1	construct balanced chemical equations of a neutralisation reaction;			An
		10.5.2	illustrate the role of indicators such as phenolphthalein, methyl orange, and litmus paper in detecting the endpoint during an acid-base titration;			A
		10.5.3	differentiate between the endpoint and equivalence point in an acid-base titration;		*	
		10.5.4	solve problems based on acid-base titrations;			A

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
10.6	Salts	10.6.1	define the term 'salt';	*		
		10.6.2	explain the properties of salts;		*	
		10.6.3	exemplify the different types of salts, i.e., acidic, basic, normal (based on replaceable H^+ and OH^- ions), double, mixed and complex;		*	
		10.6.4	predict the solubility of different salts based on the general solubility rules for common ionic compounds;			E
		10.6.5	illustrate the preparation, separation and purification of soluble salts by the reaction of an acid with: a. an alkali (titration), b. excess metal, c. excess insoluble base, d. excess insoluble carbonate;			A
		10.6.6	illustrate the preparation of insoluble salts by precipitation;			A
		10.6.7	explain the applications of salts in everyday activities and industries, including food preservation and flavouring, textile manufacturing, paper production, metallurgy, water treatment, fertiliser production, animal feed supplementation, remediation of salty soils, and de-icing and road maintenance.		FA[2]	

[2]FA= Formative Assessment, not to be assessed under examination conditions

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
11. Organic Chemistry		Students should be able to:				
11.1	Organic Compounds	11.1.1	explain the general characteristics of organic compounds;		*	
		11.1.2	explain the diversity and magnitude of organic compounds;		*	
		11.1.3	identify sources of organic compounds;		*	
		11.1.4	identify the uses of organic compounds in daily life;		FA	
11.2	Classification of Organic Compounds	11.2.1	classify organic compounds into acyclic and cyclic compounds with examples;		*	
		11.2.2	describe the homologous series and its characteristics;		*	
		11.2.3	define the term 'functional group';	*		
		11.2.4	classify various organic compounds into alkanes, alkenes, alkynes, alkyl halides, alcohols, amines, ethers, aldehydes, ketones, carboxylic acids, acid amides, esters and nitro compounds based on their functional groups;		*	
		11.2.5	determine a molecule's functional group (mentioned in SLO 11.2.4) using structural, condensed and skeletal formulae and systematic names of compounds up to seven carbon atoms;			A
		11.2.6	draw structural, condensed, skeletal and molecular formulae for organic compounds up to seven carbon atoms including: a. alkanes, b. alkenes, c. alkynes, d. alcohols, e. carboxylic acids;			A

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
		11.2.7	determine carboxylic acids, phenols, aldehydes and ketones using the following chemical tests: a. sodium bicarbonate ($NaHCO_3$) test, b. ferric chloride ($FeCl_3$) test, c. Tollen's test (silver mirror test), d. Fehling's test, e. sodium nitroprusside test;			A
11.3	Alkyl Group	11.3.1	illustrate the formation of alkyl groups by the removal of hydrogen atom from their corresponding alkanes up to five carbon atoms;			A
11.4	Isomerism	11.4.1	define the terms 'isomerism' and 'structural isomerism';	*		
		11.4.2	describe the following types of structural isomerism with examples: a. chain isomerism, b. positional isomerism, c. functional group isomerism;		*	
		11.4.3	draw possible structures of the chain isomers of alkanes up to five carbon atoms;			A
11.5	Nomenclature	11.5.1	explain the systematic nomenclature of organic compounds according to IUPAC rules;		*	
		11.5.2	apply the IUPAC system in naming the following compounds up to seven carbon atoms: a. alkanes, b. alkenes, c. alkynes, d. alcohols, e. carboxylic acids.			A

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
12. Hydrocarbons		Students should be able to:				
12.1	Saturated and Unsaturated Hydrocarbons	12.1.1	define the term 'hydrocarbons';	*		
		12.1.2	distinguish between saturated and unsaturated hydrocarbons (including tests with iodine, bromine and potassium permanganate);		*	
12.2	Uses of Hydrocarbons	12.2.1	explain the uses of hydrocarbons as: a. fuel, b. feedstock in industry;		*	
12.3	Alkanes	12.3.1	describe the tetrahedral structure of alkanes with reference to the four bonds of each carbon atom;		*	
		12.3.2	illustrate the preparation of alkanes through the following methods: a. cracking of larger hydrocarbons, b. hydrogenation of alkenes and alkynes, c. reduction of alkyl halides;			A
		12.3.3	explain the physical properties (physical state, melting and boiling points, density, odour and solubility) of alkanes;		*	
		12.3.4	describe the complete and incomplete combustion of alkanes;		*	
12.4	Alkenes	12.4.1	describe the plane and angles formed by carbon atoms in alkenes;		*	
		12.4.2	explain the physical properties (physical state, melting and boiling points, density, odour and solubility) of alkenes;		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
		12.4.3	illustrate the preparation of alkenes through the following methods: a. cracking of large alkane molecules using a high temperature and a catalyst, b. dehydration of alcohols, c. dehydrohalogenation of alkyl halides;			A
		12.4.4	illustrate the addition reactions of alkenes with: a. hydrogen in the presence of a nickel catalyst, b. steam in the presence of an acid catalyst;			A
12.5	Alkynes	12.5.1	explain the physical properties (physical state, melting and boiling points, density, odour and solubility) of alkynes;		*	
		12.5.2	explain the use of ethyne as fuel for welding and in artificial ripening of fruits;		*	
		12.5.3	illustrate the preparation of alkynes through the following methods: a. dehydrohalogenations of 1,2-dihalides, b. dehalogenations of tetrahalides;			A
12.6	Reactions of Hydrocarbons	12.6.1	illustrate halogenations of alkanes, alkenes and alkynes up to three carbon atoms;			A
		12.6.2	illustrate oxidation (with $KMnO_4$) of ethene and ethyne;			A
		12.6.3	differentiate between ethene and ethyne using silver nitrate test.		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
13. Natural and Synthetic Polymers		Students should be able to:				
13.1	Types of Polymers and Polymerisation	13.1.1	define the following terms: a. monomers, b. polymers, c. polymerisation;	*		
		13.1.2	differentiate between natural and synthetic polymers;		*	
		13.1.3	differentiate between addition and condensation polymerisation;		*	
13.2	Synthetic Polymers	13.2.1	identify the repeating unit of an addition polymer from its given structure, specifically focusing on polyethylene (polyethene) and polyvinyl chloride (PVC);		*	
		13.2.2	elaborate the environmental impact of plastics, emphasising challenges related to their disposal in landfill sites;		*	
13.3	Carbohydrates	13.3.1	define the term ‘carbohydrates’;	*		
		13.3.2	classify carbohydrates into monosaccharides, oligosaccharides and polysaccharides with examples;		*	
		13.3.3	compare the solubility of starch and glucose in water;		*	
		13.3.4	illustrate the medicinal use of dextrose;			A
13.4	Proteins and Enzymes	13.4.1	define the term ‘proteins’;	*		
		13.4.2	describe peptide linkage between amino acids in a polypeptide chain;		*	
		13.4.3	explain the primary, secondary and tertiary structural features of protein molecule;		*	
		13.4.4	explain enzymes as biological catalysts including definition, functions, factors affecting enzyme activity and examples related to human body;		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
		13.4.5	exemplify the commercial uses of enzymes in the following industries: a. food, b. detergent, c. pharmaceutical;		*	
13.5	Lipids	13.5.1 13.5.2 13.5.3	define the term 'lipids'; compare the structures of fats and oil; explain hydrogenation of vegetable oil;	*	 * *	
13.6	Nucleic Acids	13.6.1 13.6.2 13.6.3	define the term 'nucleic acids'; describe the basic structural features of deoxyribonucleic acid (DNA) and ribonucleic acid (RNA); explain the importance of nucleic acids;	*	 * *	
13.7	Vitamins	13.7.1 13.7.2 13.7.3	describe 'vitamins' and their significance in biological functions; classify vitamins based on solubility; discuss the sources, functions and deficiency diseases of vitamin A, B complex, C, D, E and K;		* * 	 E
13.8	Sources and Uses	13.8.1 13.8.2 13.8.3	identify the sources of carbohydrates, proteins and lipids; explain the importance of carbohydrates, proteins and lipids for humans; explain the significance of agricultural and nutritional sciences.		* * *	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
14. Environmental Chemistry I: Atmosphere		Students should be able to:				
14.1	Environmental Spheres	14.1.1	define the term 'environmental chemistry';	FA		
		14.1.2	differentiate among environmental spheres (lithosphere, hydrosphere, biosphere and atmosphere);		*	
14.2	Layers of Atmosphere	14.2.1	state the composition of clean air;	*		
		14.2.2	describe the different layers of the atmosphere;		*	
		14.2.3	differentiate between stratosphere and troposphere;		*	
14.3	Air Pollutants, Their Effects and Control	14.3.1	classify major air pollutants into primary and secondary categories based on their sources and formation mechanism;		*	
		14.3.2	discuss the sources and effects of air pollutants (carbon dioxide, carbon monoxide, particulates, methane, oxides of nitrogen and sulphur dioxide) on the environment and human health;			E
		14.3.3	explain the formation of oxides of nitrogen in car engines and the role of catalytic converters in reducing them;		*	
		14.3.4	recommend strategies to control air pollution;			E
14.4	Environmental Issues (Acid Rain, Ozone Depletion and Global Warming), Their Effects and Control	14.4.1	describe acid rain;		*	
		14.4.2	relate the effects of acid rain to the properties of acids;		*	
		14.4.3	explain ozone formation;		*	
		14.4.4	explain ozone depletion and its effects;		*	
		14.4.5	define the term 'greenhouse effect';	*		
		14.4.6	explain the contribution of greenhouse gases, such as carbon dioxide and methane, to global warming;		*	
		14.4.7	discuss the effects of global warming;			E
		14.4.8	suggest strategies to reduce the effects of global warming and acid rain.			E

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
15. Environmental Chemistry II: Water		Students should be able to:				
15.1	Properties of Water	15.1.1	explain the composition and physical properties of water;		*	
		15.1.2	analyse water's anomalous behaviour and its significance;			An
		15.1.3	distinguish between distilled water and tap water with their applications in practical chemistry;		*	
		15.1.4	explain the unique properties of water that make it a universal solvent;		*	
		15.1.5	explain the significance of naturally occurring substances in water; a. dissolved oxygen, b. essential minerals;		*	
15.2	Softness and Hardness of Water	15.2.1	differentiate among soft, temporary and permanent hard water;		*	
		15.2.2	apply methods to eliminate temporary and permanent hardness of water;			A
		15.2.3	explain the decrease in soap effectiveness caused by hard water;		*	
15.3	Water Pollution and Treatment	15.3.1	identify water pollutants originating from agricultural, industrial, and household wastes;		*	
		15.3.2	discuss the effects of agricultural, industrial and household wastes on life;			E
		15.3.3	compare the processes of raw water treatment and sewage treatment;		*	
		15.3.4	explain the use of chlorine in maintaining the cleanliness of swimming pool;		*	
15.4	Water Borne Diseases	15.4.1	discuss the causes, symptoms and preventive measures of various types of water-borne diseases, i.e., diarrhoea, cholera, dysentery, cryptosporidiosis, fluorosis, jaundice, hepatitis, typhoid and hookworm infection.			E

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
16. Chemical Industries		Students should be able to:				
16.1	Industries and Basic Metallurgical Operations	16.1.1	relate the study of chemistry to careers in industry;		*	
		16.1.2	explain the following metallurgical operations: a. crushing and grinding of the ore, b. concentration of the ore, c. extraction of the metal, d. purification and refining of the metal;		*	
		16.1.3	assess extraction methods based on the position of metals in the reactivity series such as: a. electrolysis for the most reactive metals, b. reduction by carbon or hydrogen for moderately reactive metals, c. natural occurrence or heating for least reactive metals;			E
16.2	Extraction of Metals	16.2.1	describe the extraction of iron from hematite ore in the blast furnace;		*	
		16.2.2	differentiate between iron and steel;		*	
		16.2.3	explain the process of extracting aluminium from purified bauxite (aluminium oxide) through electrolysis;		*	
		16.2.4	describe the extraction and refining of copper;		*	
16.3	Manufacturing of Mineral Acids and Sodium Carbonate	16.3.1	illustrate the production of sulphuric acid through the Contact process including a flowchart diagram;			A
		16.3.2	illustrate the production of nitric acid through the Ostwald process including a flowchart diagram;			A
		16.3.3	illustrate the basic reactions involved in the manufacturing of sodium carbonate through the Solvay process including a flowchart diagram;			A

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
16.4	Ammonia and its Uses	16.4.1	illustrate the production of ammonia through the Haber process including a flowchart diagram;			A
		16.4.2	illustrate the manufacturing of urea including a flowchart diagram;			A
		16.4.3	explain the use of urea, ammonium salts and nitrates in making fertilisers;		*	
		16.4.4	differentiate between synthetic fertilisers and natural fertilisers based on their advantages and disadvantages;		*	
16.5	Petroleum Industry	16.5.1	describe the composition, formation and properties of: a. petroleum, b. natural gas;		*	
		16.5.2	explain the process of fractional distillation of petroleum;		*	
		16.5.3	analyse the separation of fractions based on the following properties: a. carbon chain length, b. volatility, c. boiling point range, d. density;			An
		16.5.4	identify the uses of the following fractions of petroleum in daily life: a. refinery gas fraction, b. gasoline/ petrol fraction, c. naphtha fraction, d. kerosene/ paraffin fraction, e. diesel oil/ gas oil fraction, f. fuel oil fraction, g. lubricating oil fraction, h. bitumen fraction;		FA	

Topics and Sub-topics	Student Learning Outcomes		Cognitive Level		
			R	U	A and beyond
	16.5.5	discuss the need for different methods and materials to put out (extinguish) different types of fire (wood, oil, electric).			E

Practical Activities of AKU-EB SSC Chemistry Syllabus

Student Learning Outcomes

Content Covered	Actions Performed	Attitude Developed
• Separation Techniques • Measurement Techniques • Reaction Demonstrations • pH Analysis • Volumetric Analysis • Salt Analysis • Functional Group Identification • Water Treatment	• Follow the safety precautions provided in the Lab guidelines. • Collect the required apparatus for the experiments. • Handle the apparatus/ equipment/ chemicals appropriately. • Perform the experiments with the help of the given methods/ steps. • Modify the steps to perform a similar experiment in real-life settings. • Take reading with precision.	• Ensure safety of yourself, others around you and your surroundings. • Demonstrate a scientific mindset by asking questions and planning further investigations. • Display ethical dealings and practices while performing experiments. • Show willingness to solve problems and challenges. • Show self-reliance and cooperation when working independently and in a group setting respectively. • Revise judgements and change behaviour considering new evidence.

Topic Wise Practical Activities

Part I (Grade IX)

S No.	Topic-Wise Practical Activity	Equipment	Chemical
	Topic 1: Fundamentals of Chemistry		
1.	Employ appropriate physical methods to separate a mixture of iron filings, sand and alum.	China dish, funnel, magnet, watch glass, fitter paper, funnel stand, Bunsen burner or spirit lamp, glass rod, beaker, match box, tripod stand	Fe (iron filings), alum, sand and water
	Topic 2: Stoichiometry		
2.	Demonstrate that compounds can be the products of a decomposition reaction.	Test tubes, mortar pestle, safety goggles, match box, Bunsen burner or spirit lamp, test tube holder, one holed stopper with glass tube and rubber tubing or bent tube	Calcium carbonate and lime water (solution of calcium hydroxide)
	Topic 6: States of Matter		
3.	Measure the boiling point of ethyl alcohol.	Beaker, iron stand, clamp, glass rod thermometer, fusion tube, tripod stand, capillary tube, wire gauze, matchbox, Bunsen burner or spirit lamp	Sample of ethyl alcohol and water
4.	Measure the melting point of wax.	Beaker, iron stand, clamp, glass rod thermometer, capillary tube, tripod stand, wire gauze, match box, Bunsen burner or spirit lamp, thread	Sample of wax and water

S. No.	Topic-Wise Practical Activity	Equipment	Chemical
5.	Demonstrate sublimation using solid ammonium chloride.	Test tube, cotton, test tube holder, match box, Bunsen burner or spirit lamp	Ammonium chloride
	Topic 7: Solutions		
6.	Prepare 250 cm^3/ 1 litre of 0.1 M oxalic acid solution.	Beaker, glass rod, spatula, balance (physical/ digital), funnel, pipette, filter paper/ watch glass (for weighing), weight box, volumetric flask 250 cm^3/ 1 litre)	Oxalic acid, distilled water
7.	Prepare 100 cm^3 of 0.01 M Na_2CO_3 solution from the given 0.1 M solution.	Beaker, volumetric flask, stirrer, graduated cylinder or pipette	Distilled water, 0.1 M Na_2CO_3 solution
8.	Demonstrate that temperature affects solubility.	Beaker, glass rod, Bunsen burner or spirit lamp, tripod stand, wire gauze, match box	Sucrose and water
9.	Prepare crystals of copper sulphate.	Beaker, tripod stand, wire gauze, filter paper, china dish, funnel, filter stand, stirrer, match box, Bunsen burner or spirit lamp	Impure copper sulphate and distilled water
10.	Perform paper chromatography to separate the components of the given ink mixture.	Whatman filter paper No. 1, glass cylinder with a glass support, rubber bung, capillary tubes, lead pencil	Developing solvents (water – alcohol mixture/ n-butanol, ethanol and ammonia) and mixture of inks (blue, green, red)

S. No.	Topic-Wise Practical Activity	Equipment	Chemical
	Topic 8: Electrochemistry		
11.	Demonstrate the conductivity of different solutions.	Beakers, wires, battery, electrodes, bulb, crocodile clips, bulb holder, stirrer	Distilled water, sugar, NaCl, vinegar, HCl, NaOH and $CuSO_4$ solution
12.	Demonstrate the electroplating of copper metal on iron strip using copper sulphate solution.	Iron and copper strips, beaker, battery, wires, bulb, bulb holder, crocodile clips	Copper sulphate solution

Part II (Grade X)

S. No.	Topic-Wise Practical Activity	Equipment	Chemical
	Topic 9: Chemical Equilibrium		
1.	Demonstrate the effect of heat (temperature) on chemical equilibrium system using copper(II) sulphate or cobalt(II) chloride.	Bunsen burner or hot plate, test tubes, test tube holder, test tube rack, thermometer, googles	Copper(II) sulphate pentahydrate or cobalt(II) chloride hexahydrate and distilled water
	Topic 10: Acids, Bases and Salts		
2.	Measure the pH of different solutions using pH paper to detect their acidic, neutral, or basic nature.	Beakers, pH paper, pH scale, watch glass, stirrer	Baking soda, HCl, soap solution, curd, garden soil, table salt, caustic soda, vinegar, lemon juice, apple juice, orange juice and oxalic acid
3.	Standardise the given solution of sodium hydroxide volumetrically.	Burette, iron stand, funnel, clamp, pipette, beakers, conical flasks, dropper	Sodium hydroxide solution, standard solution of hydrochloric acid, phenolphthalein
4.	Measure the exact molarity of a solution of oxalic acid volumetrically.	Burette, iron stand, funnel, clamp, pipette, beakers, conical flasks, dropper	Standard solution of NaOH, oxalic acid solution, phenolphthalein
5.	Perform the silver nitrate test to detect chloride (Cl^-), bromide (Br^-), and iodide (I^-) ions in sodium chloride (NaCl), sodium bromide (NaBr), and sodium iodide (NaI) solutions, respectively.	Test-tube, test-tube stand, stirrer	NaI, NaBr, NaCl and $AgNO_3$, and NH_4OH
6.	Perform a flame test to detect the presence of calcium, strontium, barium, and copper ions by observing characteristic flame colours.	Platinum wire/ glass rod, match box, watch glass, Bunsen burner or spirit lamp	Salt of each ion: calcium, strontium, barium, and copper and concentrated HCl

S. No.	Topic-Wise Practical Activity	Equipment	Chemical
	Topic 11: Organic Chemistry		
7.	Perform the sodium nitroprusside test to detect the presence of ketones.	Test tubes, test tube holder, test tube stand, Bunsen burner or spirit lamp, match box, dropper, water bath	Fructose solution, distilled water, sodium nitroprusside solid and sodium hydroxide solution
8.	Perform Fehling's and Tollen's tests to detect the presence of aldehydes.	Test tubes, test tube holder, test tube stand, Bunsen burner or spirit lamp, match box, water bath, dropper	Formaldehyde, Tollen's reagent, Fehling's solution and glucose solution
9.	Perform the sodium carbonate test (C.T. = limewater test) to detect the presence of carboxylic acids.	Test tubes, test tube holder, test tube stand, delivery tube, dropper	Limewater, carboxylic acid, solid sodium carbonate and distilled water
10.	Perform the ferric chloride test to detect the presence of phenol.	Test tubes, test tube holder, test tube stand, dropper	Phenol solution, freshly prepared ferric chloride solution and distilled water
	Topic 12: Hydrocarbons		
11.	Perform the potassium permanganate ($KMnO_4$) test to differentiate between saturated and unsaturated organic compounds.	Test tubes, test tube holder, test tube stand, dropper	Cinnamic acid solution, ghee, vegetable oil and $KMnO_4$ solution
	Topic 15: Environmental Chemistry II: Water		
12.	Demonstrate the softening of permanent and temporary hard water.	Beaker, test tubes, china dish, funnel, iron stand, filter paper, Bunsen burner or spirit lamp	Water sample (beakers containing two types of hard water), lime water, small soap bar, sodium carbonate solution and sodium zeolite

Scheme of Assessment

Grade IX

Table 1: Exam Specification

Topic No.	Topics	Marks Distribution			Total Marks
		MCQs	CRQs	ERQs	
1.	Fundamentals of Chemistry	5	Total 3 Marks (1 CRQ)		8
2.	Stoichiometry	5		6 Marks Choose any ONE from TWO	16
5.	Structure of Molecules	5			
3.	Atomic Structure	5	Total 3 Marks (1 CRQ)		8
4.	Periodic Table and Periodicity	5	Total 4 Marks (1 CRQ)		9
6.	States of Matter	5	Total 3 Marks (1 CRQ)		8
7.	Solutions	5		6 Marks Choose any one from TWO	16
8.	Electrochemistry	5			
	Total	**40**	**13**	**12**	**65**
	Practical				**10**
	Total				**75**

Note: The cognitive distribution of marks for Chemistry SSC are as follows
Remember: 10 to 15 %
Understand: 55 to 60 %
Apply and beyond: 20 to 30 %

Grade X

Table 2: Exam Specification

Topic No.	Topics	Marks Distribution			Total Marks
		MCQs	CRQs	ERQs	
9.	Chemical Equilibrium	5	Total 4 Marks (1 CRQ)		9
10.	Acid, Bases and Salts	5		6 Marks Choose any ONE from TWO	16
12.	Hydrocarbons	5			
11.	Organic Chemistry	5	Total 3 Marks (1 CRQ)		8
13.	Natural and Synthetic Polymers	5	Total 3 Marks (1 CRQ)		8
15.	Environmental Chemistry II: Water	5	Total 3 Marks (1 CRQ)		8
14.	Environmental Chemistry I: Atmosphere	5		6 Marks Choose any ONE from TWO	16
16.	Chemical Industries	5			
	Total	**40**	**13**	**12**	**65**
	Practical				**10**
	Total				**75**

Note: The cognitive distribution of marks for Chemistry SSC are as follows
Remember: 10 to 15 %
Understand: 55 to 60 %
Apply and beyond: 20 to 30 %

Examination Structure and Practical Requirements for Grades IX and X

Theory:

- Multiple Choice Question (MCQ) requires candidates to choose one best/ correct answer from four options for each question. Each MCQ carries ONE mark.
- Constructed Response Question (CRQ) requires students to respond with a short text (few phrases/ sentences), calculations or diagrams.
- Extended Response Question (ERQ) requires students to answer in a more descriptive form. The answer should be in paragraph form, with diagrams where needed, and address all parts of the question.
- Table 1 and 2 contain the mark distribution for each topic.
- There will be two examinations, one at the end of grade IX and one at the end of grade X.
- In each grade, the theory paper will be for 3 hours and will consist of two parts: Paper I and Paper II.
- Paper I theory will consist of 40 compulsory, multiple choice items. These questions will involve four responses options. The answer sheet for Paper I will be provided separately.
- Paper II theory will carry 25 marks and consist of Constructed Response Questions (CRQs) and Extended Response Questions (ERQs). Each extended response question will be presented in an either/ or form.
- The booklet for Paper II will serve as an answer script.

Practical:

- In each grade, practical examination (Paper III) will be conducted separate from the theory paper and will consist of 10 marks.
- Practical examination (Paper III) will be based on the list of practical activities given in the examination syllabus. Schools may design their own practical manuals based on these activities for teaching and learning purpose.
- Practical journal/ portfolio should be developed by students and endorsed by a figure of authority, such as a teacher or principal, and submitted at the time of the practical examination (Paper III).
- It is essential for each school to equip its laboratories with chemicals, instruments, apparatus, specimens etc. according to the requirements of the practical activities. Each school will be responsible for ensuring that each student is provided the opportunity to do the practical activities.

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