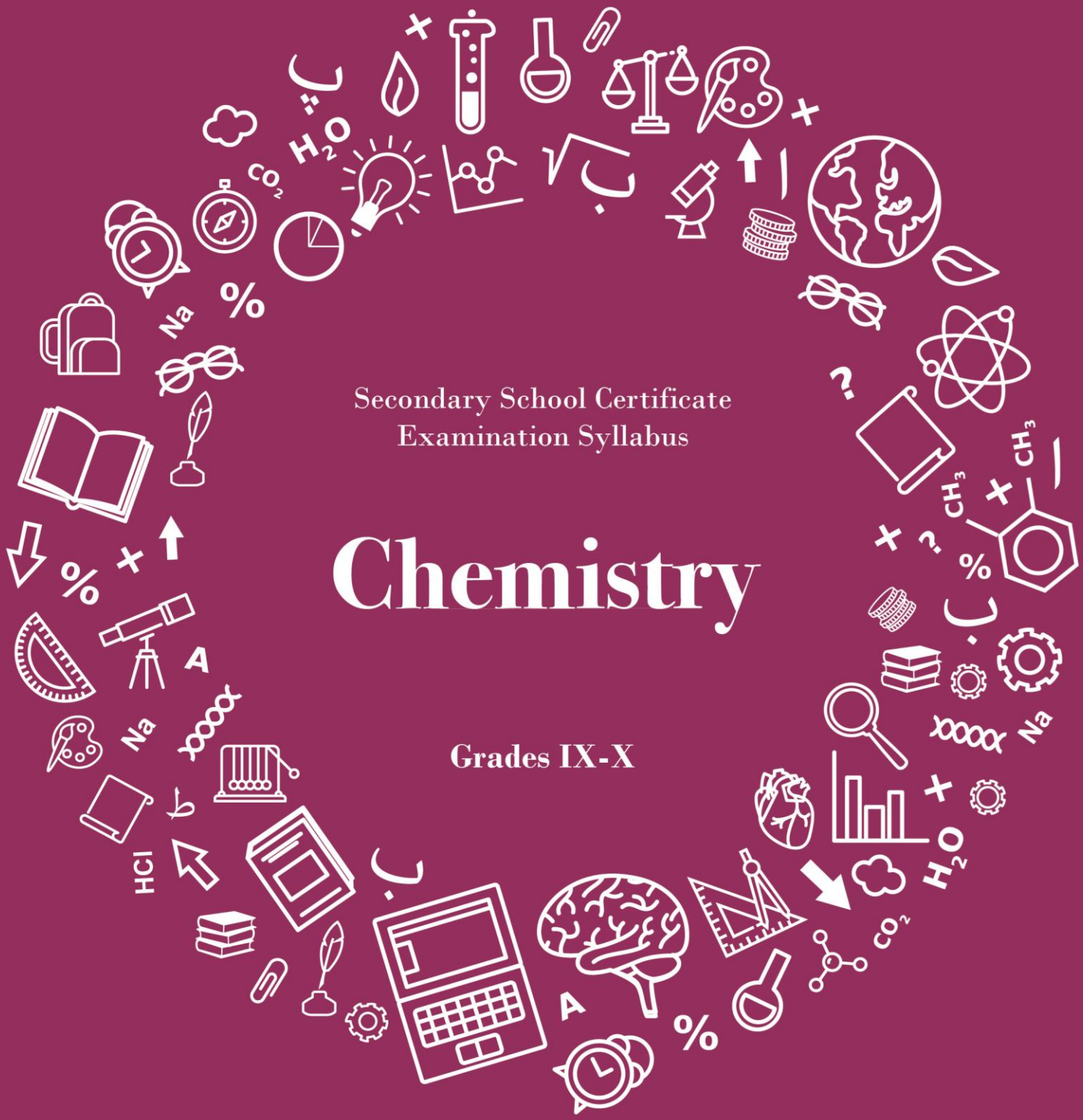
آغا خان یونیورسٹی ایگزامینیشن بورڈ

AGA KHAN UNIVERSITY EXAMINATION BOARD



Secondary School Certificate
Examination Syllabus

Chemistry

Grades IX-X

Published by
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Secondary School Certificate Examination Syllabus

CHEMISTRY

GRADES IX-X

This syllabus will be examined in both Annual and Re-sit Examination sessions from Annual Examinations 2023

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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 (SSC) and higher secondary (HSSC) school certifications. 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 are aligned with National/ trans-provincial curricula and international standards. AKU-EB revises its syllabi periodically to support the needs of students, teachers and examiners.

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

- Ensure continued compatibility with the goals of the trans-provincial curricula 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 examiners.
- Enhance and strengthen continuation and progression of content both within and across grades IX - XII (SCC 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 syllabus is organised into topics and subtopics. Each subtopic is further divided into achievable student learning outcomes (SLOs). The SLOs of the cognitive domain are each assigned a cognitive level on which they have to be achieved. These cognitive levels are 'knowledge', 'understanding' and 'application', the latter also including other higher order skills. This is followed by the Exam Specification which gives clear guidance about the weightage of each topic and how the syllabus will be assessed.

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 Dr Sohail Qureshi for his very useful feedback on revising the syllabus review process, to Dr Naveed Yousuf for his continued guidance and support throughout the syllabus revision process and to Raabia Hirani for leading the syllabi revision. 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 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 best international and trans-provincial standards 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.

Dr Shehzad Jeeva
Chief Executive Officer (CEO), Aga Khan University Examination Board
Associate Professor of Practice, Faculty of Arts and Sciences, Aga Khan University

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 subtopics and **student learning outcomes (SLOs)**. The subtopics and the SLOs define the depth and the breadth at which each 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 in the course of their studies. The examination questions are framed using the same command words or their connotations to elicit evidence of these competencies in students' responses.

4. The topics of the syllabi are grouped into themes derived from the national/ trans-provincial curricula. The connection between various themes and topics is highlighted in the '**concept map**' provided at the beginning of each syllabus. This ensures that students begin to understand the interconnectedness of knowledge, learn conceptually and think critically.

5. The SLOs are classified under three **cognitive levels**: knowledge (K), understanding (U) and application and other higher order skills (A) for effective planning during teaching and learning. Furthermore, it will help to derive multiple choice questions (MCQs), constructed response questions (CRQs) and extended response questions (ERQs) on a rational basis from the subject syllabi.

6. By focusing on the achievement of the SLOs, these syllabi aim to counter the culture of rote memorisation as the preferred method of examination preparation. While suggesting relevant, locally available textbooks for achieving these outcomes, AKU-EB recommends that teachers and students use multiple teaching and learning resources for achieving these outcomes.

7. The syllabi follow a uniform layout for all subjects to make them easier for students and teachers to follow. They act as a bridge between students, teachers and assessment specialists by providing a common framework of student learning outcomes and **exam specifications**.

8. On the whole, the AKU-EB syllabi for Secondary School Certificate (SSC) provide a framework that helps students to acquire conceptual understanding and learn to critically engage with it. This lays a solid foundation for HSSC and beyond.

Subject Rationale of AKU-EB Chemistry

Why study Chemistry?

Chemistry is not anything which is restricted to schools, books or the science laboratory, it is basically found everywhere around us. The air we respire, the food which cooks in the kitchen, the aroma of perfumes we sense or the storing of food in plants – literally there occur hundreds and thousands of chemical phenomena every day in life which involves chemistry. Chemistry is associated with everything we interact with in our daily routine; such as, the flavourings in our food, the fibres in our clothing, lifesaving drugs for curing threatening diseases, fertilisers enriching soil fertility, pesticides for protection of crops, cement, glass and paints for constructing houses to a huge feedstock of petrochemicals for manufacturing various products. Chemistry could be considered as the core of science subjects, which interlinks different branches of science and strengthens awareness of the environmental changes to resolve environmental issues in order to make this planet a better home for all living organisms.

What will you learn in AKU-EB Chemistry?

The AKU-EB Chemistry Syllabus is designed in such a way that it provides essential theoretical and practical knowledge of real life Chemistry to students. It focuses on understanding the different themes of Chemistry that will enable students to comprehend the composition, structure, properties of different materials, their interactions and use in the synthesis of new products. The syllabus attempts to develop a logical approach for students to understand different chemical phenomena and solve problems. Furthermore, the use of multiple learning resources such as models, pictures, animations and various reference books are encouraged during study to create interest and provide logical understanding of fundamental concepts of Chemistry.

Where will it take you?

The study of Chemistry enables an individual to play a vital role in the socioeconomic development of our country. In recent years, the impact of Chemistry in our society for future 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 in 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

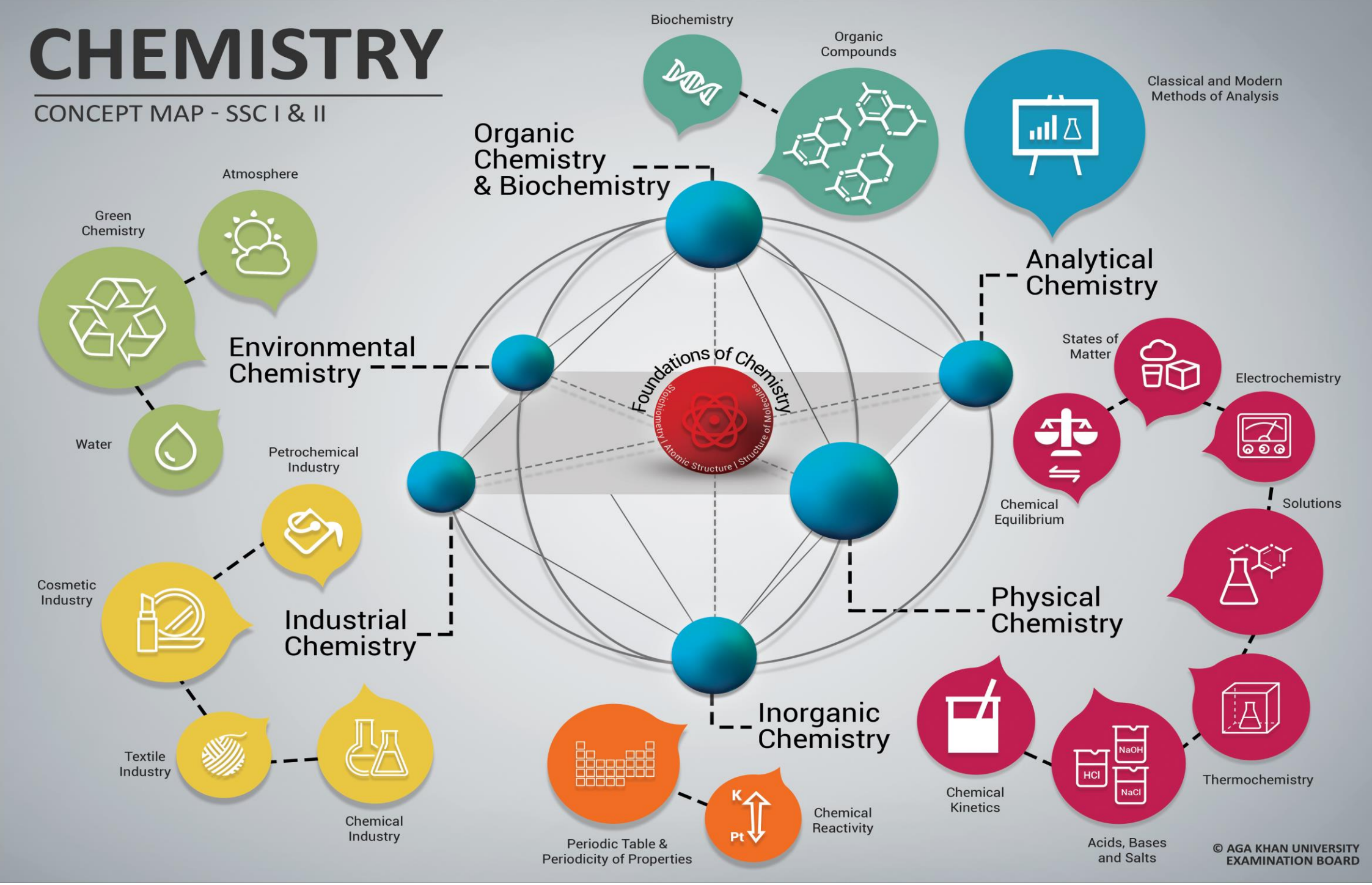
How to approach the syllabus?

The concept map of the syllabus gives an overview of the entire syllabus. The topics and the student learning outcomes (SLOs) guide regarding the details about what has to be achieved. And finally, the exam specification guides regarding what will be expected in the examination.

What is the concept map telling you?

Chemistry is the study of different types of elements and their combinations which give rise to new substances. One such substance is coordination compounds which are found everywhere in nature as well as in industries. These compounds are formed by applying many concepts that are part of this syllabus – literally – for example, Lewis acid-base reactions (Hope you have fun looking for more!).

In the coordination compound of SSC Chemistry syllabus, the central atom (or ion) is the Foundation of Chemistry. This foundation is made stronger and stable by the donor atoms, i.e. the major themes of Chemistry. Each theme has its own importance, like an individual atom, molecule or ion with a specific property, but, when these are joined together, their properties change. Hence, the themes are interdependent, i.e. each theme builds upon the other, helping to understand the cycling of material in the world and the changes the matter undergoes. Each atom or theme tells, in the dialogue bubbles surrounding them, the key concepts that will be studied in it. The volume, i.e. size, of these bubbles represents the weightage of each concept in the syllabus.


CHEMISTRY
CONCEPT MAP - SSC I & II
Biochemistry
Organic Compounds
Classical and Modern Methods of Analysis
Organic Chemistry & Biochemistry
Analytical Chemistry
Atmosphere
Green Chemistry
Environmental Chemistry
Water
Foundations of Chemistry
Stoichiometry | Atomic Structure | Structure of Molecules
States of Matter
Electrochemistry
Chemical Equilibrium
Solutions
Petrochemical Industry
Cosmetic Industry
Industrial Chemistry
Physical Chemistry
Textile Industry
Chemical Industry
Inorganic Chemistry
Periodic Table & Periodicity of Properties
K
Pt
Chemical Reactivity
Chemical Kinetics
NaOH
HCl
NaCl
Thermochemistry
Acids, Bases and Salts
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Student Learning Outcomes of AKU-EB SSC Chemistry Syllabus

Part I (Grade IX)

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level[1]		
				K	U	A
1. Fundamentals of Chemistry		Students should be able to:				
1.1	Chemistry and its Branches	1.1.1	define chemistry and its various branches (organic, inorganic, physical, analytical, nuclear, biochemistry, industrial and environmental);	*		
		1.1.2	discuss the significance of the branches of chemistry mentioned in SLO 1.1.1;		*	
1.2	Basic Definitions and Comparison of Essential Terminologies	1.2.1	define the terms: a. atoms b. elements c. compounds d. mixtures e. molecules;	*		
		1.2.2	differentiate among elements, compounds and mixtures;		*	
		1.2.3	differentiate between: a. atoms and molecules b. atoms and ions c. molecules and molecular ions d. ions and free radicals;		*	

[1] K = Knowledge, U = Understanding, A= Application and other higher-order cognitive skills

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
		Students should be able to:				
		1.2.4	define the terms: a. atomic number b. mass number c. isotopes d. atomic mass e. atomic mass unit;	*		
		1.2.5	calculate the relative atomic masses of chlorine and boron by using mass number and natural abundance of their isotopes;			*
		1.2.6	define the term 'relative atomic mass' based on C-12 scale;	*		
		1.2.7	define the terms 'molecular mass' and 'formula mass' of a substance;	*		
		1.2.8	classify the chemical species into elements, mixtures, compounds, ions, molecular ions and free radicals;		*	
		1.2.9	define the term 'valency';	*		
		1.2.10	recognise valencies of common elements and ions (radicals) independently or in compounds;		*	
		1.2.11	determine the formula of a compound based on the valencies of elements and ions (radicals);			*
1.3	Avogadro's Number and Mole	1.3.1	define the terms: a. gram atomic mass b. gram molecular mass c. gram formula mass d. formula unit e. mole f. Avogadro's number;	*		
		1.3.2	relate gram atomic mass, gram molecular mass and gram formula mass to mole and Avogadro's number;		*	
		1.3.3	calculate the number of moles, atoms and molecules of substances;			*

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
		Students should be able to:				
1.4	Empirical and Molecular Formulae	1.4.1	define the terms 'empirical formula' and 'molecular formula';	*		
		1.4.2	calculate empirical formula using the percentages of elements;			*
		1.4.3	calculate the molecular formula using molecular mass and empirical formula;			*
1.5	Chemical Reactions and Calculations	1.5.1	define the terms 'chemical reaction' and 'chemical equation';	*		
		1.5.2	describe the formation and characteristics of chemical equations;		*	
		1.5.3	exemplify the following types of chemical reactions: a. displacement a. decomposition b. addition/ synthesis/ combination c. combustion d. double displacement e. neutralisation f. hydrolysis;		*	
		1.5.4	construct balanced chemical equations for chemical reactions;			*
		1.5.5	balance the chemical equations by inspection or trial and error method;			*
		1.5.6	calculate the following based on balanced chemical equation of combustion analysis: a. mass b. number of moles c. number of molecules d. mole ratio.			*

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
2. Atomic Structure		Students should be able to:				
2.1	Features of an Atom	2.1.1	describe the structure of an atom including the location and electric charges of proton, electron and neutron;		*	
		2.1.2	calculate the mass (nucleon) number, number of electrons, protons and neutrons of atoms and ions;			*
		2.1.3	draw the atomic structure of the first twenty elements of the periodic table and their ions using their mass number and atomic number;			*
2.2	Isotopes	2.2.1	determine the number of protons, neutrons and electrons in different isotopes of H, C, O, Cl and U;			*
		2.2.2	draw the atomic structures of different isotopes of H, C, O, and Cl using their mass number and atomic number;			*
		2.2.3	discuss the importance of isotopes in various fields of life;		*	
2.3	Models to Understand the Structure of an Atom	2.3.1	describe Rutherford's experiment leading to the discovery of atomic nucleus;		*	
		2.3.2	discuss the defects of Rutherford's atomic model;		*	
		2.3.3	describe the main points (postulates) of Bohr's atomic model;		*	
2.4	Shells and Sub-shells	2.4.1	differentiate between shells and sub-shells of an atom;		*	
2.5	Electronic Configuration	2.5.1	determine the electronic arrangement (K, L, M) and electronic configuration (s, p) of the first twenty elements and their ions using their atomic number.			*

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
3. Periodic Table and Periodicity		Students should be able to:				
3.1	Periodic Table	3.1.1	state the modern periodic law;	*		
		3.1.2	differentiate between a period and a group in the periodic table;		*	
		3.1.3	deduce the groups and periods of elements on the basis of electronic configuration;			*
		3.1.4	describe the shape of the periodic table (s, p, d, f blocks);		*	
		3.1.5	determine the location of families on the periodic table based on their characteristics and electronic configuration;			*
		3.1.6	discuss the physical and chemical properties of: a. group I b. group II c. group VII d. group VIII;		*	
3.2	Periodic Properties	3.2.1	compare the chemical and physical properties (metallic character, physical states, conductivity, density, melting and boiling points) of elements in the same family of elements;		*	
		3.2.2	define the terms with reference to elements: a. shielding effect b. electronegativity c. atomic radii d. electron affinity e. ionisation energy;	*		
		3.2.3	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.		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
4. Structure of Molecules		Students should be able to:				
4.1	Formation of Chemical Bond	4.1.1	determine the number of valence electrons in an atom using the periodic table and electronic configuration;			*
		4.1.2	discuss the importance of noble gas electronic configuration in the formation of an ion;		*	
		4.1.3	state octet and duplet rules;	*		
		4.1.4	describe the ways in which chemical bonds are formed;		*	
		4.1.5	describe the formation of: a. cations from an atom of a metallic element; b. anions from an atom of a non-metallic element;		*	
4.2	Ionic Bond	4.2.1	describe the formation of an ionic bond;		*	
		4.2.2	identify a compound as having ionic bond;		*	
		4.2.3	draw electron dot and cross structure of an ionic compound, for example NaCl, MgO, K_2O and $CaCl_2$;			*
		4.2.4	describe the characteristics of ionic compounds;		*	
4.3	Covalent Bond	4.3.1	describe the formation of a covalent bond between two non-metallic elements;		*	
		4.3.2	exemplify single, double and triple covalent bonds;		*	
		4.3.3	draw electron dot and cross structures for simple covalent molecules containing single, double and triple bonds;			*
		4.3.4	describe the characteristics of covalent compounds;		*	
		4.3.5	exemplify polar and non-polar covalent compounds;		*	
		4.3.6	describe the properties of polar and non-polar covalent compounds;		*	
		4.3.7	differentiate between ionic and covalent compounds with examples;		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
		Students should be able to:				
4.4	Coordinate Covalent Bond	4.4.1	describe the formation of coordinate covalent bond by donation of an electron pair from one element to the other element;		*	
		4.4.2	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;			*
		4.4.3	compare the formation and characteristics of coordinate covalent compounds with covalent compounds;		*	
4.5	Metallic Bond	4.5.1	describe the formation of metallic bonding;		*	
		4.5.2	describe the physical properties of metals, i.e. malleability, ductility, melting and boiling points, lustre, tensile strength, electrical and thermal conductivity based on the structure of metals and mobility of electrons;		*	
4.6	Intermolecular Forces	4.6.1	explain weak forces of interactions such as dispersion forces, dipole-dipole interaction and hydrogen bonding with their significance.		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
5. States of Matter		Students should be able to:				
5.1	Physical States of Matter	5.1.1	compare the physical states of matter with regard to intermolecular forces present between their molecules;		*	
5.2	Gaseous State	5.2.1	explain the properties of gases: a. diffusion b. effusion c. condensation d. density e. compressibility;		*	
5.3	Laws Related to Gases	5.3.1	discuss the pressure and volume changes in a gas using Boyle's law;		*	
		5.3.2	discuss the temperature and volume changes in a gas using Charles's law;		*	
5.4	Liquid State	5.4.1	explain the properties of liquids and the factors that affect them: a. evaporation b. vapour pressure c. boiling point d. freezing point e. diffusion f. density g. compressibility;		*	
		5.4.2	explain the effect of temperature and external pressure on vapour pressure and boiling point of liquids;		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
		Students should be able to:				
5.5	Solid State	5.5.1	describe the physical properties of solids: a. melting point b. sublimation c. density d. compressibility;		*	
		5.5.2	exemplify amorphous and crystalline solids;		*	
5.6	Types of Solid	5.6.1	define the term 'allotropes';	*		
		5.6.2	explain allotropic forms of carbon and sulphur.		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
6. Solutions		Students should be able to:				
6.1	Introduction to Solutions	6.1.1	exemplify solution, aqueous solution, solute and solvent;		*	
6.2	Types of Solution According to Phases	6.2.1	classify different types of solutions according to phases, i.e. gas into gas, gas into liquid, gas into solid, liquid into gas, liquid into liquid, liquid into solid, solid into liquid, solid into solid, solid into gas;		*	
		6.2.2	define the term 'alloy';	*		
		6.2.3	describe the composition of different alloys (brass, bronze, nichrome);		*	
6.3	Types of Solution According to Concentration	6.3.1	differentiate among saturated, unsaturated and supersaturated solutions;		*	
		6.3.2	differentiate between dilute and concentrated solutions;		*	
6.4	Concentration Units and Dilution of Solutions	6.4.1	define concentration of solution in terms of proportion or ratio of solute to solvent/ solution;	*		
		6.4.2	define the term 'molarity';	*		
		6.4.3	solve problems based on molarity of a solution;			*
		6.4.4	define the term 'percentage' as unit of concentration;	*		
		6.4.5	calculate percentage composition of different solutions (% m/m, % m/v, % v/m, % v/v);			*
		6.4.6	solve problems based on dilution of solutions from concentrated solutions of known molarity;			*

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
		Students should be able to:				
6.5	Factors Affecting Solubility	6.5.1	define the term ‘solubility’;	*		
		6.5.2	explain the factors which affect solubility, i.e. temperature, pressure and nature of solute and solvent;		*	
		6.5.3	determine the effect of temperature (referring to absorption, release or no change in heat) on solubility of different salts, for example, KNO_3, KCl, Li_2SO_4, $Ce_2(SO_4)_3$ and NaCl in water;			*
		6.5.4	predict the solubility of one substance into another using the rule of ‘like dissolves like’;			*
6.6	Methods for Separating Mixtures	6.6.1	define the term ‘crystallisation’;	*		
		6.6.2	describe the process of crystallisation;		*	
		6.6.3	exemplify the use of crystallisation for purifying impure substances;		*	
		6.6.4	define the term ‘chromatography’;	*		
		6.6.5	apply chromatography as a separation technique and for the isolation of compounds from a mixture;			*
6.7	Comparison of Solution, Suspension and Colloid	6.7.1	differentiate among solution, suspension and colloid with examples.		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
7. Electrochemistry		Students should be able to:				
7.1	Oxidation and Reduction Reactions	7.1.1	define oxidation and reduction in terms of loss or gain of oxygen, hydrogen or electrons;	*		
7.2	Oxidation States and Rules for Assigning Oxidation States	7.2.1	define oxidation state;	*		
		7.2.2	state the common rules used for assigning oxidation numbers to free elements, ions (simple and complex), molecules and atoms;	*		
		7.2.3	deduce the oxidation number of an atom of any element in a compound;			*
7.3	Oxidising and Reducing Agents	7.3.1	define oxidising and reducing agents in a redox reaction;	*		
		7.3.2	determine oxidising and reducing agents in a redox reaction;			*
7.4	Electrochemical Cells	7.4.1	define electrolyte, weak electrolyte, non-electrolyte and electrolysis;	*		
		7.4.2	define an electrochemical cell and its two types (Galvanic or voltaic cell and electrolytic cell);	*		
		7.4.3	describe the nature of electrochemical processes;		*	
		7.4.4	identify the components of an electrolytic cell;		*	
		7.4.5	deduce the direction of movement of cations and anions towards respective electrodes in an electrolytic cell;			*
		7.4.6	infer the solutions that conduct electricity in a given set of solutions with reference to the dissociation of substances into ions;			*
		7.4.7	identify the reactivity of elements using the reactivity series;		*	
		7.4.8	describe metal displacement reactions in an aqueous medium;		*	
		7.4.9	discuss the uses of an electrolytic cell in daily life;		*	
		7.4.10	identify the components and direction of flow of electrons in a Daniel cell;		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
		Students should be able to:				
		7.4.11	describe the production of electrical energy in a dry cell;		*	
		7.4.12	determine the half-cell in which oxidation occurs and the half-cell in which reduction occurs in given voltaic cells;			*
		7.4.13	differentiate between electrolytic and voltaic (Galvanic) cells;		*	
7.5	Electrochemical Industries	7.5.1	describe the manufacturing of sodium metal from fused NaCl;		*	
		7.5.2	describe the manufacturing of sodium hydroxide from aqueous solution of NaCl;		*	
7.6	Corrosion and its Prevention	7.6.1	define the term ‘corrosion’;	*		
		7.6.2	describe the rusting of iron as an example of corrosion;		*	
		7.6.3	explain the methods used to prevent corrosion;		*	
		7.6.4	explain electroplating of metals on iron and steel using examples of silver, zinc, tin and chromium plating.		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
8. Chemical Reactivity		Students should be able to:				
8.1	Differences Between Metals and Non-Metals	8.1.1	differentiate between metals and non-metals based on physical and chemical properties;		*	
8.2	Metals	8.2.1	identify elements as an alkali metal or an alkaline earth metal;		*	
		8.2.2	explain the occurrence of alkali and alkaline earth metals in combined state in nature;		*	
		8.2.3	differentiate between ionisation energies of alkali and alkaline earth metals;		*	
		8.2.4	describe the physical and chemical properties of sodium, calcium and magnesium with respect to their position on the periodic table;		*	
		8.2.5	discuss the uses of sodium, magnesium and calcium in daily life;		*	
		8.2.6	differentiate between soft and hard metals (sodium, iron);		*	
		8.2.7	describe the inertness of noble metals;		*	
		8.2.8	describe the commercial importance of silver, gold and platinum;		*	
8.3	Non-Metals	8.3.1	discuss reactions of halogens with group I and II elements and their compounds;		*	
		8.3.2	identify non-metals which are found in free state in nature.		*	

Part II (Grade X)

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
9. Chemical Equilibrium		Students should be able to:				
9.1	Reversible Reactions and Dynamic Equilibrium	9.1.1	define chemical equilibrium in terms of a reversible reaction;	*		
		9.1.2	define the term 'dynamic equilibrium';	*		
		9.1.3	show both forward and reverse reactions using chemical equations;			*
		9.1.4	describe the macroscopic characteristics of: a. forward and reverse reactions b. dynamic equilibrium;		*	
9.2	Law of Mass Action and Thermal Reactions	9.2.1	state the law of mass action;	*		
		9.2.2	differentiate between exothermic and endothermic reactions with examples;		*	
		9.2.3	draw an energy profile diagram for exothermic and endothermic reactions;			*
9.3	Equilibrium Constant Expression and Le Chatelier's Principle	9.3.1	derive an expression for the equilibrium constant and its units;			*
		9.3.2	determine the equilibrium constant expression of a reaction and its unit;			*
		9.3.3	predict the direction and extent of reversible reactions using reaction quotient Q_C and equilibrium constant K_C;			*
		9.3.4	predict the direction of a reversible reaction using molar concentration of reactants and products through the calculation of Q_C;			*
		9.3.5	describe the necessary conditions for equilibrium and the ways through which equilibrium can be recognised;		*	
		9.3.6	state Le Chatelier's principle;	*		
		9.3.7	determine the effect of catalyst, temperature, pressure and concentration on a reversible reaction at equilibrium.			*

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
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	state Brønsted-Lowry theory;	*		
		10.1.3	classify substances as acids or bases or as proton donors or proton acceptors using Brønsted-Lowry theory;		*	
		10.1.4	discuss the limitations of Arrhenius and Brønsted-Lowry theory;		*	
		10.1.5	state Lewis concepts of acids and bases;	*		
		10.1.6	classify substances as Lewis acids or bases;		*	
		10.1.7	describe the amphoteric nature of water using the equation of its self-ionisation;		*	
10.2	Properties of Acids and Bases	10.2.1	describe the physical properties of acids and bases;		*	
		10.2.2	describe the chemical properties of: a. acids (reactions with bases, active metals, metal oxides, metal carbonates, metal bicarbonates and metal hydroxides) b. bases (reactions with non-metallic oxides, acids, solutions of metal salts and ammonium salts);		*	
10.3	Strengths of Acids and Bases	10.3.1	exemplify acidity of bases and basicity of acids;		*	
		10.3.2	exemplify strong and weak acids and bases;		*	
10.4	Applications of Acids and Bases	10.4.1	describe the uses of acids and bases in home and industries;		*	
		10.4.2	describe the process of glass and metal etching in art and industry;		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
		Students should be able to:				
10.5	pH Scale	10.5.1	define pH;	*		
		10.5.2	discuss the use of pH paper and pH meter in measuring the pH of body fluids, secretions and fruit juices;		*	
		10.5.3	classify a solution as neutral, acidic or basic based on hydrogen ion or hydroxide ion concentration;		*	
		10.5.4	calculate the pH and pOH of solutions by using hydrogen or hydroxide ion concentration;			*
10.6	Acid Base Titration	10.6.1	solve problems based on acid-base titrations;			*
		10.6.2	write and balance equations of a neutralisation reaction;			*
10.7	Salts	10.7.1	define the term 'salts';	*		
		10.7.2	describe the properties of salts;		*	
		10.7.3	describe the methods of preparing soluble and insoluble salts;		*	
		10.7.4	exemplify the different types of salts, i.e. acidic, basic, normal, double, mixed and complex.		*	
		10.7.5	discuss the uses of salts in daily life and industries.		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
11. Organic Chemistry		Students should be able to:				
11.1	Organic Compounds	11.1.1	discuss general characteristics of organic compounds;		*	
		11.1.2	explain the diversity and magnitude of organic compounds;		*	
		11.1.3	list sources of organic compounds;	*		
		11.1.4	recognise the uses of organic compounds in daily life;		*	
11.2	Classification of Organic Compounds	11.2.1	classify organic compounds into acyclic and cyclic compounds with examples;		*	
		11.2.2	identify straight chain hydrocarbons up to ten carbon atoms on the basis of their structural, condensed and molecular formulae;		*	
11.3	Alkanes and Alkyl Groups	11.3.1	list the names of straight chain alkanes up to decane;	*		
		11.3.2	illustrate the formation of alkyl groups by the removal of hydrogen atom from their corresponding alkanes (up to five carbon atoms);			*
11.4	Homologous Series and Isomerism	11.4.1	describe the homologous series and its characteristics;		*	
		11.4.2	define the term ‘isomerism’ and its types, i.e. ‘structural isomerism’ and ‘sterioisomerism’;	*		
		11.4.3	describe chain isomerism as a type of structural isomerism;		*	
		11.4.4	draw possible structures of the chain isomers of given alkanes up to five carbon atoms;			*

Topics and Sub-topics		Student Learning Outcomes	Cognitive Level		
			K	U	A
	Students should be able to:				
11.5 Functional Groups	11.5.1	define the term ‘functional group’;	*		
	11.5.2	classify various organic compounds i.e. alkane, alkene, alkyne, alkyl halide, alcohol, amine, ether, aldehyde, ketone, carboxylic acid, acid amide, ester and nitro compounds on the basis of their functional groups,;		*	
	11.5.3	identify a molecule's functional group using structural formula and systematic names of compounds up to five carbon atoms;		*	
	11.5.4	determine carboxylic acids, phenols, amines, aldehydes and ketones using different chemical tests.			*

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
12. Hydrocarbons		Students should be able to:				
12.1	Nomenclature	12.1.1	discuss the need for a systematic method of naming chemical compounds;		*	
		12.1.2	apply IUPAC system in naming compounds (alkanes, alkenes and alkynes) up to seven carbon atoms;			*
12.2	Saturated and Unsaturated Hydrocarbons	12.2.1	define the term 'hydrocarbons';	*		
		12.2.2	distinguish between saturated and unsaturated hydrocarbons (including test with iodine, bromine and potassium permanganate);		*	
		12.2.3	differentiate between alkynes and alkenes with reference to unsaturation;		*	
12.3	Structural and Electronic Formulae	12.3.1	draw structural and electronic (dot and cross) formulae of alkanes, alkenes and alkynes up to five carbon atoms;			*
12.4	Uses of Hydrocarbons	12.4.1	explain the use of hydrocarbons as: a. fuel b. feedstock in industry;		*	
12.5	Alkanes	12.5.1	describe the structure of alkane with reference to the four bonds of each carbon atom directed to the corners of a tetrahedron;		*	
		12.5.2	describe the preparation, physical properties, chemical properties and uses of methane;		*	
		12.5.3	describe that the combustion of alkanes provide energy for heating and cooking;		*	
		12.5.4	show the preparation of alkanes from hydrogenation of alkenes and alkynes and reduction of alkyl halides using chemical equations;			*

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
		Students should be able to:				
12.6	Alkenes	12.6.1	describe the plane and angles formed by carbon atoms in alkenes;		*	
		12.6.2	describe the physical properties of ethene (ethylene);		*	
		12.6.3	show the preparation of alkenes from dehydration of alcohols and dehydrohalogenation of alkyl halides using chemical equations;			*
12.7	Alkynes	12.7.1	describe the preparation, properties and uses of ethynes (acetylene);		*	
		12.7.2	explain: a. ethyne as an acid on the basis of its chemical reaction with silver nitrate, b. ethyne as more energy producing than ethane and ethene using the process of combustion;		*	
		12.7.3	show the preparation of alkynes from dehalogenations of 1,2-dihalides and tetrahalides using chemical equations;			*
12.8	Reactions of Alkanes, Alkenes and Alkynes	12.8.1	show halogenations of alkanes, alkenes and alkynes using chemical equations;			*
		12.8.2	show oxidation of alkenes and alkynes with $KMnO_4$ using chemical equations;			*
		12.8.3	differentiate between ethene and ethyne using silver nitrate test.		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
13. Biochemistry		Students should be able to:				
13.1	Carbohydrates	13.1.1	define the term 'carbohydrates';	*		
		13.1.2	classify carbohydrates into mono-, oligo- and polysaccharides with examples;		*	
		13.1.3	compare the solubility of starch and glucose in water;		*	
		13.1.4	describe the medicinal use of dextrose;		*	
13.2	Proteins	13.2.1	define the term 'proteins';	*		
		13.2.2	describe peptide linkage between amino acids in a polypeptide chain;		*	
		13.2.3	describe the primary, secondary and tertiary structural features of protein molecule;		*	
		13.2.4	explain the denaturing of proteins;		*	
13.3	Enzymes	13.3.1	define the term 'enzymes';	*		
		13.3.2	describe the commercial uses of enzymes;		*	
13.4	Lipids	13.4.1	define the term 'lipids'	*		
		13.4.2	differentiate between fats and oil;		*	
		13.4.3	explain hydrogenation of vegetable oil;		*	
13.5	Nucleic Acids	13.5.1	define the term 'nucleic acids';	*		
		13.5.2	describe the importance of nucleic acids;		*	
		13.5.3	describe the basic structural features of deoxyribonucleic acid (DNA) and ribonucleic acid (RNA);		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
		Students should be able to:				
13.6 Vitamins	13.6.1	describe vitamins;			*	
	13.6.2	classify vitamins on the basis of solubility;			*	
	13.6.3	list the sources, functions and deficiency diseases of vitamin A, B complex, C, D, E and K;		*		
13.7 Biologically Important Minerals	13.7.1	exemplify micro and macro-minerals;			*	
	13.7.2	describe the role of calcium and zinc as nutrients;			*	
13.8 Sources and Uses	13.8.1	list the sources of carbohydrates, proteins, lipids and nucleic acids;		*		
	13.8.2	discuss the importance of carbohydrates, proteins, lipids and nucleic acids for humans;			*	
	13.8.3	discuss the importance of agricultural and nutritional sciences.			*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
14. Environmental Chemistry I: Atmosphere		Students should be able to:				
14.1	Environmental Spheres	14.1.1	define the term 'environmental chemistry';	*		
		14.1.2	differentiate among environmental spheres (lithosphere, hydrosphere, biosphere and atmosphere);		*	
14.2	Layers of Atmosphere	14.2.1	state the composition of atmosphere;	*		
		14.2.2	describe the different layers of atmosphere;		*	
		14.2.3	differentiate between stratosphere and troposphere;		*	
14.3	Air Pollutants	14.3.1	list major (primary and secondary) air pollutants;	*		
		14.3.2	describe sources and effects of air pollutants;		*	
		14.3.3	exemplify the problem of air pollution due to the incineration of waste material;		*	
		14.3.4	recommend strategies that the governments adopt to control air pollution;			*
14.4	Acid Rain and its Effects	14.4.1	describe acid rain and its effects;		*	
14.5	Ozone Depletion and its Effects	14.5.1	explain ozone formation;		*	
		14.5.2	describe ozone depletion and its effects;		*	
		14.5.3	list the uses of ozone;	*		
14.6	Global Warming and its Effects	14.6.1	define the term 'greenhouse effect';	*		
		14.6.2	explain global warming and its effects.		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
15. Environmental Chemistry II: Water		Students should be able to:				
15.1	Properties of Water	15.1.1	describe the composition, physical and chemical properties of water;		*	
		15.1.2	describe the occurrence of water in the environment;		*	
		15.1.3	explain the importance of water in the environment and industry;		*	
15.2	Water as Solvent	15.2.1	describe the unique properties of water that makes it a universal solvent;		*	
15.3	Soft and Hard Water	15.3.1	differentiate among soft, temporary and permanent hard water;		*	
		15.3.2	describe methods for eliminating temporary and permanent hardness of water;		*	
		15.3.3	explain the reason that hard water hampers the cleansing action of soap;		*	
15.4	Water Pollution	15.4.1	recognise water pollutants (agricultural, industrial and household wastes);		*	
		15.4.2	describe the effects of agricultural, industrial and household wastes on life;		*	
		15.4.3	explain the importance of water treatment;		*	
		15.4.4	compare the processes of raw water treatment and sewage treatment;		*	
		15.4.5	explain the use of chlorine in maintaining cleanliness of swimming pool;		*	
15.5	Water Borne Diseases	15.5.1	describe 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.		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
16. Chemical Industries		Students should be able to:				
16.1	Industries and Basic Metallurgical Operations	16.1.1 16.1.2	relate the study of chemistry to careers in industry; describe metallurgical operations;		* *	
16.2	Extraction of Metals	16.2.1 16.2.2 16.2.3 16.2.4	describe the extraction of iron; differentiate between iron and steel; describe the extraction and refining of copper; describe the extraction of aluminium;		* * * *	
16.3	Manufacturing of Mineral Acids	16.3.1 16.3.2	describe the manufacturing of sulphuric acid by Contact process; describe the manufacturing of nitric acid by Ostwald process;		* *	
16.4	Solvay Process	16.4.1 16.4.2	describe the basic reactions for the manufacturing of sodium carbonate by Solvay process; explain Solvay process using a flow sheet diagram;		* *	
16.5	Ammonia and its Uses	16.5.1 16.5.2 16.5.3 16.5.4	describe the manufacturing of ammonia by Haber process; state the composition and uses of urea; explain the manufacturing of urea using a flow sheet diagram; discuss advantages and disadvantages of using synthetic fertilisers versus natural fertilisers;	 * 	* * *	

Topics and Sub-topics	Student Learning Outcomes		Cognitive Level		
			K	U	A
	Students should be able to:				
16.6 Petroleum Industry	16.6.1	define the term ‘petroleum’;	*		
	16.6.2	state the composition of petroleum and natural gas;	*		
	16.6.3	explain the formation of petroleum and natural gas;		*	
	16.6.4	describe the fractional distillation of petroleum;		*	
	16.6.5	discuss the need for different methods and materials to put out (extinguish) different types of fire (wood, oil, electric).		*	

Scheme of Assessment

Grade IX

Table 1: Number of Student Learning Outcomes by Cognitive Level

Topic No.	Topics	No. of Sub-topics	SLOs			Total
			K	U	A	
1.	Fundamentals of Chemistry	5	9	8	8	25
2.	Atomic Structure	5	0	6	5	11
3.	Periodic Table and Periodicity	2	2	5	2	09
4.	Structure of Molecules	6	1	17	4	22
5.	States of Matter	6	1	9	0	10
6.	Solutions	7	7	9	6	22
7.	Electrochemistry	6	7	13	5	25
8.	Chemical Reactivity	3	0	11	0	11
	Total	**40**	**27**	**78**	**30**	**135**
	Percentage		**20**	**58**	**22**	**100**

Table 2: Exam Specifications

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

Grade X

Table 3: Number of Student Learning Outcomes by Cognitive Level

Topic No.	Topics	No. of Sub-topics	SLOs			Total
			K	U	A	
9.	Chemical Equilibrium	3	4	3	7	14
10.	Acids, Bases and Salts	7	4	17	3	24
11.	Organic Chemistry	5	4	9	3	16
12.	Hydrocarbons	8	1	12	7	20
13.	Biochemistry	8	7	17	0	24
14.	Environmental Chemistry I: Atmosphere	6	5	9	1	15
15.	Environmental Chemistry II: Water	5	0	13	0	13
16.	Chemical Industries	6	3	16	0	19
	Total	**48**	**28**	**96**	**21**	**145**
	Percentage		**20**	**66**	**14**	**100**

Table 4: Exam Specifications

Topic No.	Topics	Marks Distribution			Total Marks
		MCQs	CRQs	ERQs	
9.	Chemical Equilibrium	5	Total 4 Marks (1 CRQ)		9
10.	Acids, 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.	Biochemistry	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**

- 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.

- Tables 1 and 3 indicate the number and nature of SLOs in each topic in grades IX and X respectively. This will serve as a guide in the construction of the examination paper. It also indicates that more emphasis has been given to the Understanding (58% in IX and 66% in X), Application and higher order skills (22% in IX and 14% in X) to discourage rote memorisation. Tables 1 and 3, however, do not translate directly into marks.

- 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 of 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 response options.

- Paper II theory will carry 25 marks and consist of a number of compulsory, structured questions and a number of extended response questions. Each extended response question will be presented in an either/or form.

- All constructed response questions will be in a booklet which will also serve as an answer script.

***Practical:**

- In each grade, practical examination will be conducted separate from the theory paper and will consist of 10 marks.

- Practical examination 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.

- 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.

- 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 to make sure that each student is provided the opportunity to do the practical activities.

Annex A: Practical Activities

Grade IX

S. No.	SLO No.	PRACTICAL ACTIVITY	EQUIPMENT	CHEMICAL
		Topic 1: Fundamentals of Chemistry		
1.	1.2.8	Separate the mixture of iron fillings, sand and alum by physical method.	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, water
		Topic 5: States of Matter		
2.	5.4.1	Determine 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
3.	5.5.1	Determine the melting point of wax/ naphthalene.	Beaker, iron stand, clamp, glass rod thermometer, capillary tube, tripod stand, wire gauze, match box, Bunsen burner or spirit lamp, thread	Sample of wax/ naphthalene and water
4.	5.5.1	Demonstrate sublimation using solid ammonium chloride.	Test tube, cotton, test tube holder, match box, Bunsen burner or spirit lamp	Ammonium chloride

S. No.	SLO No.	PRACTICAL ACTIVITY	EQUIPMENT	CHEMICAL
		Topic 6: Solutions		
5.	6.4.3	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
6.	6.4.6	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
7.	6.5.3	Demonstrate that temperature affects solubility.	Beaker, glass rod, Bunsen burner or spirit lamp, tripod stand, wire gauze, match box	Sucrose and water
8.	6.6.3	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
		Topic 7: Electrochemistry		
9.	7.4.6	Demonstrate the conductivity of different solutions.	Beakers, wires, battery, electrodes, bulb, crocodile clips, bulb holder, stirrer	Distilled water, sugar, NaCl, vinegar, HCl, NaOH, $CuSO_4$ solution
10.	7.4.8	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

S. No.	SLO No.	PRACTICAL ACTIVITY	EQUIPMENT	CHEMICAL
		Topic 8: Chemical Reactivity		
11.	8.1.1	Demonstrate that two elements combine to form a binary compound.	Test tubes, test tube holder, Bunsen burner or spirit lamp	Iron and sulphur
12.	8.2.4	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, lime water (solution of calcium hydroxide)

Grade X

S. No.	SLO No.	PRACTICAL ACTIVITY	EQUIPMENT	CHEMICAL
		Topic 10: Acids, Bases and Salts		
1.	10.5.2	Determine the pH of different solutions by the help of pH paper.	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, oxalic acid etc.
2.	10.6.1	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
3.	10.6.1	Determine 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
4.	10.7.2	Identify Cl^-, Br^-, I^- ions in NaCl, NaBr and NaI solutions, respectively.	Test tube, test tube stand, stirrer	NaI, NaBr, NaCl and $AgNO_3$, H_2SO_4, MnO_2 and NH_4OH
5.	10.7.2	Identify sodium, calcium, strontium, barium, copper and potassium ions by flame test.	Platinum wire/ glass rod, match box, watch glass, Bunsen burner or spirit lamp	Salt each of sodium, strontium, potassium, barium, copper, calcium, concentrated HCl
		Topic 11: Organic Chemistry		
6.	11.5.4	Identify ketones using 2,4-dinitrophenyl hydrazine test.	Test tubes, test tube holder, test tube stand, Bunsen burner or spirit lamp, match box, dropper, water bath	Fructose solution, distilled water, 2,4-dinitrophenyl hydrazine solution

S. No.	SLO No.	PRACTICAL ACTIVITY	EQUIPMENT	CHEMICAL
7.	11.5.4	Identify aldehydes using Fehling's and Tollen's test.	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, glucose solution
8.	11.5.4	Identify carboxylic acids using sodium carbonate test (C.T lime water test for evolution of CO_2).	Test tubes, test tube holder, test tube stand, delivery tube, dropper	Lime water, carboxylic acid, solid sodium carbonate, distilled water
9.	11.5.4	Identify phenol using ferric chloride test.	Test tubes, test tube holder, test tube stand, dropper	Phenol solution, freshly prepared ferric chloride solution, distilled water
		Topic 12: Hydrocarbons		
10.	12.2.2	Identify saturated and unsaturated organic compounds by $KMnO_4$ test.	Test tubes, test tube holder, test tube stand, dropper	Cinnamic acid solution, ghee, vegetable oil, $KMnO_4$ solution
		Topic 13: Biochemistry		
11.	13.1.1	Demonstrate that sugar decomposes into elements or other compounds.	China dish or beaker, Bunsen burner or spirit lamp, tripod stand, wire gauze, match box, spatula, watch glass, safety goggles.	Sugar
		Topic 15: Environmental Chemistry II: Water		
12.	15.3.2	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, sodium zeolite

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