



**FEDERAL BOARD OF INTERMEDIATE
AND SECONDARY EDUCATION
H-8/4, ISLAMABAD**



No.1-10/FBISE/RES/652

30 August, 2024

Subject: IMPLEMENTATION OF ASSESSMENT FRAMEWORKS AND MODEL QUESTION PAPERS DEVELOPED ON NATIONAL CURRICULUM OF PAKISTAN (NCP) 2022-2023

In continuation to this office Notifications bearing No.1-10/FBISE/RES/383 dated 14 March 2024 and No.1-10/FBISE/RES/422 dated 19 March 2024 on the subject of Implementation of National Curriculum of Pakistan (NCP) 2022-23, Assessment Frameworks, Model Question Papers along with SLOs Alignment Charts and Tables of Specifications (ToS) at SSC-I and HSSC-I levels in the subjects of English Compulsory, Urdu Compulsory, Pakistan Studies (SSC-I), Islamiyat Compulsory (HSSC-I), Physics, Chemistry, Biology, Mathematics and Computer Science are hereby uploaded on FBISE Website www.fbise.edu.pk. The Weblink is https://fbise.edu.pk/curriculum_model_paper.php.

2. It is important to note that the Assessment Frameworks which contain all the SLOs of the curriculum 2022-23 will guide students, teachers and paper setters. Students will receive clear instructions on how to prepare for examinations. Teachers will use the Frameworks to understand what to teach in class and to prepare their students for the final examinations. Similarly, paper setters will use these documents for guidance in creating examination papers. It may be noted that the SLOs of Summative Assessment mentioned in the Assessment Frameworks will be included in the Final Board Examinations, whereas the SLOs of Formative Assessment will NOT be included in the Final Board Examinations; however, they will be part of teaching-learning activity in the class.

3. It is reiterated that the examinations of all the above mentioned subjects will be based on Student Learning Outcomes (SLOs) given in the respective curriculum (Assessment Frameworks) instead of textbooks. Educational institutions, students and teachers may consult the books of publishers reviewed by National Curriculum Council available on its Weblink <https://ncc.gov.pk/SiteImage/Misc/files/Annexures.pdf>. Moreover, the institutions are free to rely on any other valid and reliable instructional/reference material to fulfil the instructional requirements of the SLOs of these subjects.

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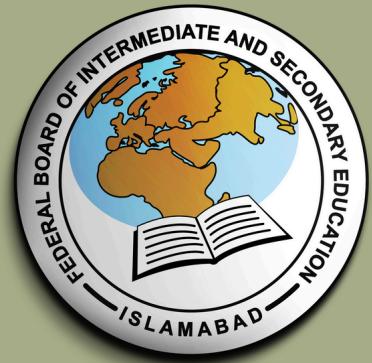
ASSESSMENT FRAMEWORK AND MODEL QUESTION PAPER

CHEMISTRY

Grade XI

NATIONAL CURRICULUM

2022-23



**FEDERAL BOARD OF
INTERMEDIATE AND
SECONDARY EDUCATION,
ISLAMABAD**

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H-8/4, ISLAMABAD



**ASSESSMENT FRAMEWORK
FOR
CHEMISTRY GRADE-XI
CURRICULUM 2022-23**

ACKNOWLEDGEMENT

It is a great honour that we, at the Federal Board of Intermediate and Secondary Education, have developed the Assessment Framework (AF) for the subject of Chemistry for Grade-XI. The primary objective of the AF is to optimize the current curriculum 2022-23. This comprehensive framework has been crafted meticulously by subject matter and assessment experts who conducted an in-depth review of all learning outcomes for Grade-XI Chemistry curriculum. They evaluated these outcomes in terms of their scope, cognitive level, and progression across the grade.

This significant undertaking was the result of a series of extensive meetings and collaborative efforts of the subject and assessment experts. Their dedication and expertise have been instrumental in bringing this framework to fruition.

The Assessment Framework will serve as a guiding document for students, teachers and paper setters. Students will receive clear directions for preparing themselves for the annual examination. Similarly, teachers will use it as a guide to understand what to teach in class and to prepare students for the final examinations accordingly. Similarly paper setters will also seek guidance from this document.

Following subject as well as assessment experts/committee members remained constantly engaged in the development of the AF:

1. Dr. Shaista Sabir, Associate Professor, PAEC Model College, Nilore, Islamabad
2. Mr. Naeem Mushtaq, Associate Professor, Islamabad Model College for Boys, G-10/4, Islamabad
3. Ms. Maryum Adeel, Deputy Director, Army Public Schools and Colleges System Secretariat, GHQ, Rawalpindi
4. Mr. Abid Latif, Associate Professor, Army Public School and College (Boys), Ordinance Road, Rawalpindi
5. Ms. Javaria Gull, HOD Chemistry, Pak Turk Maarif International School, H-8/1 Islamabad

The whole work was successfully accomplished under the able supervision and guidance of Syed Junaid Akhlaq, Chairman, FBISE and due to the hard work and dedication of the staff of Research Section of FBISE, in particular, Syed Zulfiqar Shah, Deputy Secretary, Research and Academics who played a pivotal and leading role in finalizing the AF.

MIRZA ALI
Director (Research & Academics)
FBISE, Islamabad

ASSESSMENT FRAMEWORK FOR CHEMISTRY GRADE-XI, CURRICULUM 2022-23

To ensure clarity and precision in assessment, the learning outcomes have been categorized into two distinct groups: formative and summative. This classification helps in effectively measuring student progress and understanding. Each Student learning outcome (SLO) has been carefully marked as either formative or summative within the newly developed Assessment Framework. SLOs of Summative Assessment Format will be part of the Final Examination while SLOs of Formative Assessment will although be part of the teaching-learning activity but they will **NOT** be part of Final Examinations. Estimated cognitive levels i.e Knowledge (K), Understanding (U) and Application (A) of all the SLOs have also been indicated. It may be noted that all the higher cognitive levels have been collectively accumulated in the cognitive level of 'Application'. In subjects involving Practicals (Lab work), it has been mentioned categorically whether an SLO is summative for theory or summative for Practical Based Assessment (PBA). If an SLO is summative for PBA, it means that Laboratory work is required in the teaching-learning activity and it will be part of the Practical Examination/ Practical Based Assessment.

The Assessment Framework will act as a comprehensive guide for students, teachers and paper setters. Students will have clear instructions on how to prepare for the annual examinations. Teachers will use the framework to understand the curriculum and effectively prepare their students for the final examination. Additionally, paper setters will refer to this document for guidance in setting examination papers.

A model question paper has also been developed to provide a clear structure and format for upcoming examinations. The model question paper ensures consistency and fairness, offering students a comprehensive understanding of what to expect in their examinations. By aligning the paper with the Student Learning Outcomes (SLOs) of the curriculum, we ensured that the questions accurately reflect the skills and knowledge that students are expected to acquire.

A detailed Table of Specifications (ToS) has been created to ensure equitable coverage of cognitive levels and content domains in order to generate a balanced question paper. The ToS serves as drawing scale and action plan for the question paper, ensuring that all important areas of the curriculum are adequately and proportionately assessed.

FORMATIVE ASSESSMENT: AN ESSENTIAL COMPONENT OF EFFECTIVE LEARNING

Formative assessment is a pivotal element in the educational process, distinguished by its role in providing ongoing feedback to both students and educators. Unlike summative assessments, which evaluate student learning at the end of an instructional period, formative assessments are integrated into the learning process to monitor student understanding and guide instructional decisions.

The primary objective of formative assessment is to identify learning gaps and misunderstandings as they occur, enabling timely interventions. This dynamic approach allows teachers to adjust their teaching strategies to better meet the needs of their students. For instance, if a teacher notices through a quick quiz or class discussion that a significant portion of the class struggles with a particular concept, they can revisit that topic, providing additional explanations or alternative methods of instruction. This adaptability is crucial for fostering a deeper understanding of the material.

Formative assessments come in various forms, ranging from informal methods like classroom discussions, observations, and questioning, to more structured approaches such as quizzes, peer assessments, and self-reflections. These methods are not limited to paper-and-pencil tasks but can include digital tools that provide instant feedback. The versatility of formative assessments allows educators to cater to diverse learning styles and preferences, ensuring that all students are engaged and supported in their learning journey.

Formative assessment plays a significant role in creating a supportive classroom environment. It shifts the focus from merely achieving grades to understanding the learning process. This approach reduces the pressure on students, as they perceive assessments not as a final judgment of their abilities but as a part of their learning journey. Consequently, formative assessment can lead to increased student motivation and engagement.

In conclusion, formative assessment is a powerful tool that, when effectively implemented, can significantly enhance the learning experience. It provides invaluable insights for both teachers and students, promotes a growth-oriented learning environment, and supports the continuous development of essential skills. As education evolves, the role of formative assessment will undoubtedly continue to be central in fostering successful and meaningful learning experiences.

SUMMATIVE ASSESSMENT: EVALUATING LEARNING OUTCOMES IN THE FORM OF TERMINAL/FINAL EXAMINATION

Summative assessment is a fundamental component of the educational process, designed to evaluate student learning at the conclusion of an instructional period. Unlike formative assessment, which provides ongoing feedback during the learning process, summative assessment serves as a final measure of what students have learned. Typically administered at the end of a unit, course, or academic year. Summative assessment aims to determine the extent to which educational objectives have been achieved.

The primary purpose of summative assessment is to assess the overall effectiveness of instruction and learning. It provides a conclusive evaluation of student performance, often in the form of tests, final projects, or standardized exams. These assessments generate grades or scores that reflect a student's achievement in a given subject area over a specific period or time duration.

Summative assessment is often used to make critical decisions regarding student progression, certification, or placement in subsequent educational levels. Additionally, summative assessments provide valuable data that inform curriculum development and instructional strategies. By analyzing summative assessment results, educators can identify trends, strengths, and weaknesses within their instructional approaches, allowing for improvements in future teaching.

In conclusion, summative assessment plays a critical role in the educational process by providing a final evaluation of student learning. While it differs from formative assessment in its focus and application, it is an essential tool for measuring academic achievement. When balanced with formative assessments, summative assessments contribute to a well-rounded and effective approach to evaluating and supporting student learning.

National Curriculum of Pakistan 2022-2023

Assessment Framework CHEMISTRY (Theory)

Details of Content Areas/ SLOs Grade XI (11)

Domain	Content Area	SLO No.	SLO Description	Cognitive Level	Type of Assessment	Remarks	Time allocation (lectures)
A	Nature of Science in Chemistry	SLO:C-11-A-01	Describe how Al Ghazali's burning cotton thought experiment highlight the challenges of inductive reasoning examples of deductive reasoning with respect to chemistry.	Understanding	Formative	Question(s) will not be asked in the annual examination, however it will be the part of classroom teaching.	01
B	Atomic Structure	SLO: C-11-B-01	Describe that, each atomic shell and subshell are further divided into degenerate orbitals having the same energy.	Understanding	Summative	Question(s) will be asked in the annual examination.	10
		SLO: C-11-B-02	Describe protons, neutrons and electrons in terms of their relative charges and relative masses.	Understanding	Summative		
		SLO: C-11-B-03	Recognize that the terms atomic and proton number represent the same concept.	Understanding	Summative		
		SLO: C-11-B-04	Recognize the terms mass and nucleon number represent the same concept.	Understanding	Summative		
		SLO: C-11-B-05	Describe the behavior of beams of protons, neutrons and electrons moving at the same velocity in an electric field.	Understanding	Summative		
		SLO: C-11-B-06	Determine the numbers of protons, neutrons and electrons present in both atoms and ions given atomic or proton number, mass/or nucleon number and charge.	Knowledge	Summative		
		SLO: C-11-B-07	Explain the change in atomic and ionic radius across a period and down a group.	Understanding	Summative		
		SLO: C-11-B-08	Determine the electronic configuration of elements and their ions with proton numbers. (Some examples include:	Knowledge	Summative		

		SLO: C-11-B-09	a). simple configuration e.g. 2,8, b). Subshells e.g. $1s^2$, $2s^2$, $2p^6$, $3s^1$ c). Students should be able to determine both of these from the periodic table and are not required to memorize these. d) Students should understand that chemical properties of an atom are governed by valence electrons).	Knowledge	Summative		
		SLO: C-11-B-10	Define terms related to electronic configuration (Some examples include shells, subshells, orbitals, principal quantum number (n), ground state).	Understanding	Summative		
		SLO: C-11-B- 11	Relate Quantum Numbers to Electronic distribution of elements.	Understanding	Summative		
		SLO: C-11-B- 12	Describe the number of orbitals making up s, p d and f subshells, and the number of electrons that can fill s, p d and f subshells.	Application	Summative		
		SLO: C-11-B-13	Apply aufbau principle, pauli exclusion principle and hunds rule to write the electronic configuration of elements	Understanding	Summative		
		SLO: C-11-B-14	Describe the order of increasing energy of the subshells (s,p,d and f).	Understanding	Summative		
		SLO: C-11-B-15	Describe the electronic configurations to include the number of electrons in each shell, subshell and orbital.	Understanding	Summative		
		SLO: C-11-B-16	Explain the electronic configurations in terms of energy of the electrons and inter-electron repulsion.	Understanding	Summative		
		SLO: C-11-B-17	Determine the electronic configuration of atoms and ions given the proton or electron number and charge,	Understanding	Summative		
		SLO: C-11-B-18	Illustrate the importance of electronic configurations in the development of new materials for electronic devices. (For example, semiconductors such as silicon have a specific electronic configuration that makes them ideal for use in electronic devices.)	Understanding	Summative		
		SLO: C-11-B-19	Describe the shapes of s, p and d orbitals.	Understanding	Summative		
		SLO: C-11-B-20	Describe a free radical as a species with one or more unpaired electrons.	Understanding	Summative		
		SLO: C-11-B-21	Explain that ionization energies are due to the attraction between the nucleus and the outer electron.	Understanding	Summative		
			Explain how ionization energy helps account for the trends across a period and down a group of the Periodic Table.	Understanding	Summative		

		SLO: C-11-B-22	Account for the variation in successive ionization energies of an element.	Understanding	Summative		
		SLO: C-11-B-23	Explain the factors influencing the ionization energies of elements in terms of nuclear charge, atomic/ionic radius, shielding by inner shells and subshells and spin-pair repulsion.	Understanding	Summative		
		SLO: C-11-B-24	Deduce the electronic configurations of elements using successive ionization energy data.	Application	Summative		
		SLO: C-11-B-25	Deduce the position of an element in the Periodic Table using successive ionization energy data.	Application	Summative		
		SLO: C-11-B-26	Explain how a mass spectrometer can be used to determine the relative atomic mass of an element from its isotopic composition.	Understanding	Summative		
		SLO: C-11-B-27	Perform calculations involving non-integer relative atomic masses and abundance of isotopes from given data, including mass spectra.	Application	Summative		
		SLO: C-11-B-28	Explain the concept of emission spectra. Use the concept of emission spectra to deduce the electronic configuration of elements.	Understanding	Formative	Question(s) will not be asked in the annual examination, however it will be the part of class room teaching.	
	Chemical Bonding	SLO: C-11-B-29	Define electronegativity as the power of an atom to attract electrons to itself.	Knowledge	Summative	Question(s) will be asked in the annual examination.	13
		SLO: C-11-B-30	Explain the factors influencing the electronegativities of elements in terms of nuclear charge, atomic radius, shielding by inner shells and subshells.	Understanding	Summative		
		SLO: C-11-B-31	Explain the trends in electronegativity across a period and down a group of the Periodic Table.	Understanding	Summative		
		SLO: C-11-B-32	Use the differences in Pauling electronegativity values to predict the formation of ionic and covalent bonds.	Application	Summative		
		SLO: C-11-B-33	Describe covalent bonding in molecules using the concept of hybridization to describe sp, sp ² and sp ³ orbitals.	Understanding	Summative		

		SLO: C-11-B-34	Use bond energy values and the concept of bond length to compare the reactivity of covalent molecules	Application	Summative		
		SLO: C-11-B-35	Describe the shapes and bond angles in molecules using VSEPR theory (including describing by sketching)	Understanding	Summative		
		SLO: C-11-B-36	Predict the shapes, and bond angles in molecules and ions.	Understanding	Summative		
		SLO: C-11-B-37	Explain hybridization and types of hybridization.	Understanding	Summative		
		SLO: C-11-B-38	Explain valence bond theory.	Understanding	Summative		
		SLO: C-11-B-39	Explain the importance of VSEPR theory in the field of drug design by discussing how the shape and bond angles of the molecules helps chemists predict their interactions in the body.	Understanding	Formative	Question(s) will not be asked in the annual examination, however it will be the part of classroom teaching.	
		SLO: C-11-B-40	Explain the salient features of molecular orbital theory.	Understanding	Summative	Question(s) will be asked in the annual examination.	
		SLO: C-11-B-41	Explain the paramagnetic nature of Oxygen molecule in the light of MOT.	Understanding	Summative	Question(s) will be asked in the annual examination.	
		SLO: C-11-B-42	Calculate Bond order of N ₂ , O ₂ , F ₂ & He	Understanding	Summative		
		SLO: C-11-B-43	Describe the types of Van der Waals' force including a. instantaneous dipole – induced dipole (id-id) force, also called London dispersion forces b. permanent dipole – permanent dipole (pd-pd) force, including hydrogen bonding c. Hydrogen bonding as a special case of permanent dipole – permanent dipole force between molecules where hydrogen is bonded to a highly electronegative atom).	Understanding	Summative		
		SLO: C-11-B-44	Describe hydrogen bonding, limited to molecules containing N–H, O–H and H–F groups, (including ammonia, water and H–F as simple examples).	Understanding	Summative		
		SLO: C-11-B-45	Use the concept of hydrogen bonding to explain the anomalous properties of H ₂ O (ice and water).	Understanding	Summative		
		SLO: C-11-B-46	Use the concept of electronegativity to explain bond polarity and dipole moments of molecules	Understanding	Summative		

		SLO: C-11-B-47	State that, in general, ionic, covalent and metallic bonding are stronger than intermolecular forces	Understanding	Summative		
		SLO: C-11-B-48	Recognize that molecular ions/polyatomic ions can have expanded octets e.g. sulfate and nitrate	Understanding	Formative	Question(s) will not be asked in the annual examination, however it will be the part of classroom teaching.	
		SLO: C-11-B-49	Analyze the formation of dative bond in CO, ozone and H ₃ O ⁺ ion (resonance structure not required)	Understanding	Summative	Question(s) will be asked in the annual examination.	
Stoichiometry		SLO: C-11-B-50	Express balanced chemical equations in terms of moles, representative particles, masses, and volumes of gases (at STP).	Application	Summative	Question(s) will be asked in the annual examination.	10
		SLO: C-11-B-51	Explain the concept of limiting reagents.	Understanding	Summative	Question(s) will be asked in the annual examination.	
		SLO: C-11-B-52	Calculate the maximum amount of product and amount of any unreacted excess reagent.	Application	Summative	Question(s) will be asked in the annual examination.	
		SLO: C-11-B-53	Calculate theoretical yield, actual yield, and percentage yield when given appropriate information.	Application	Summative	Question(s) will be asked in the annual examination.	
		SLO: C-11-B-54	State the volume of one mole of a gas at STP.	Knowledge	Summative	Question(s) will be asked in the annual examination.	
		SLO: C-11-B-55	Use the volume of one mole of gas at STP to solve mole volume problem.	Knowledge	Summative	Question(s) will be asked in the annual examination.	
		SLO: C-11-B-56	Calculate the gram molecular mass of a gas from density measurements at STP.	Application	Summative	Question(s) will be asked in the annual examination.	
		SLO: C-11-B-57	Derive measurements of mass, volume, and number of particles using moles.	Application	Summative	Question(s) will be asked in the annual examination.	
		SLO: C-11-B-58	Calculate the quantities of reactants and products involved in a chemical reaction using stoichiometric principles (Some examples include calculations involving reacting masses, volumes of gasses, volumes, and concentrations of solutions, limiting reagent and excess reagent, percentage yield calculations).	Application	Summative	Question(s) will be asked in the annual examination.	
		SLO: C-11-B-59	Explain, with examples, the importance of stoichiometry in the production and dosage of medicine.	Understanding	Formative	Question(s) will not be asked in the annual examination.	

						annual examination, however it will be the part of class room teaching.	
	Electrochemistry	SLO: C-11-B-60	Explain the merits of photovoltaic cells as sustainable ways of meeting energy demands by making reference to the photovoltaic principle.	Understanding	Formative	Question(s) will not be asked in the annual examination, however it will be the part of class room teaching.	01
	States and phases of matter	SLO: C-11-B-61	Describe simple properties of liquids e.g., diffusion, compression, expansion, motion of molecules, spaces between them, intermolecular forces and kinetic energy based on kinetic molecular theory.	Understanding	Formative	Question(s) will not be asked in the annual examination, since already covered in previous classes. However, it will be the part of class room teaching.	08
		SLO: C-11-B-62	Describe types of intermolecular forces.	Understanding	Summative	Question(s) will be asked in the annual examination.	
		SLO: C-11-B-63	Explain the strength and applications of dipole-dipole forces, hydrogen bonding and London forces.	Understanding	Summative		
		SLO: C-11-B-64	Describe physical properties of liquids such as evaporation, vapor pressure, boiling point, viscosity and surface tension.	Understanding	Summative		
		SLO: C-11-B-65	Apply the concept of hydrogen bonding to explain the properties of water (specifically high surface tension, high specific heat, low vapor pressure, high heat of vaporization, and high boiling point).	Application	Summative		
		SLO: C-11-B-66	Define molar heat of fusion and molar heat of vaporization.	Knowledge	Formative	Question(s) will not be asked in the annual examination, however it will be the part of classroom teaching.	

		SLO: C-11-B-67	Describe how heat of fusion and heat of vaporization affect the particles that make up matter.	Understanding	Summative	Question(s) will be asked in the annual examination.	
		SLO: C-11-B-68	Outline the importance of heat of fusion in the study of glaciers and ice sheets (particularly while studying polar ice caps).	Understanding	Summative		
		SLO: C-11-B-69	Describe the physical properties of gases (including compressibility, expandability and pressure exerted by gases)	Understanding	Formative	Question(s) will not be asked in the annual examination	
		SLO: C-11-B-70	Describe liquid crystals and give their uses in daily life.	Understanding	Formative	Question(s) will not be asked in the annual examination, since already covered in previous classes.	
		SLO: C-11-B-71	Differentiate liquid crystals from pure liquids and crystalline solids.	Understanding	Formative	However, it will be the part of class room teaching.	
		SLO: C-11-B-72	Describe simple properties of solids e.g. compression, expansion, motion of molecules, interparticle space, intermolecular forces and kinetic energy based on kinetic molecular theory.	Understanding	Formative		
		SLO: C-11-B-73	Differentiate between amorphous and crystalline solids.	Knowledge	Summative	Question(s) will be asked in the annual examination.	
		SLO: C-11-B-74	Describe properties of crystalline solids like geometrical shape, melting point, cleavage planes, habit of a crystal, crystal growth.	Understanding	Summative		
	Energetics	SLO: C-11-B-75	Describe that chemical reactions are accompanied by enthalpy changes and these changes can be exothermic (ΔH is negative) or endothermic (ΔH is positive).	Understanding	Summative	Question(s) will be asked in the annual examination.	10
		SLO: C-11-B-76	Interpret a reaction pathway diagram, in terms of the enthalpy change of the reaction and of the activation energy.	Application	Summative		
		SLO: C-11-B-77	Define terms such as standard conditions, enthalpy change, reaction, formation, combustion, neutralization.	Understanding	Summative		
		SLO: C-11-B-78	Explain that energy transfer occurs during chemical reactions because of the breaking and making of bonds.	Understanding	Summative		
		SLO: C-11-B-79	Calculate the bond energies for the enthalpy change of reaction, ΔH .	Application	Summative		
		SLO: C-11-B-80	Describe that some bond energies are exact, and some bond energies are approximate.	Understanding	Summative		
		SLO: C-11-B-81	Calculate enthalpy changes from appropriate experimental results, including the use of the relationships $q = mc\Delta T$ and $\Delta H = -mc\Delta T/n$	Application	Formative	Question(s) will not be asked in the annual examination, however it will be	

					the part of classroom teaching.
SLO: C-11-B-82	Define terms such as enthalpy change of atomization, ΔH_{atm} , lattice energy, $\Delta H_{\text{lattice}}$, first electron affinity, EA	Knowledge	Summative	Question(s) will be asked in the annual examination.	
SLO: C-11-B-83	Use terms such as enthalpy change of atomization, ΔH , lattice energy, ΔH , first electron affinity, EA.	Application	Summative		
SLO: C-11-B-84	Explain the factors affecting the electron affinities of elements.	Understanding	Summative		
SLO: C-11-B-85	Construct Born–Haber cycles for ionic solids.	Application	Summative		
SLO: C-11-B-86	Perform calculations involving Born–Haber cycles.	Application	Summative		
SLO: C-11-B-87	Explain the effect of ionic charge and ionic radius on the numerical magnitude of lattice energy.	Understanding	Summative		
SLO: C-11-B-88	Apply enthalpy change with reference to hydration, and solution.	Application	Summative		
SLO: C-11-B-89	Construct an energy cycle involving enthalpy change of solution, lattice energy and enthalpy change of hydration.	Application	Summative		
SLO: C-11-B-90	Perform calculations involving the energy cycles.	Application	Summative		
SLO: C-11-B-91	Explain the effect of ionic charge and ionic radius on the numerical magnitude of an enthalpy change of hydration.	Understanding	Summative		
SLO: C-11-B-92	Define the term entropy, S, as the number of possible arrangements of the particles and their energy in a given system.	Understanding	Summative		
SLO: C-11-B-93	Explain the sign of the entropy changes that occur during a change in state, temperature change and a reaction in which there is a change in the number of gaseous molecules.	Understanding	Summative		
SLO: C-11-B-94	Calculate the entropy change for a reaction, ΔS , given the standard entropies, S, of the reactants and products.	Application	Summative		
SLO: C-11-B-95	Explain the concept of heat as a form of energy.	Understanding	Formative	Question(s) will not be asked in the annual examination, however it will be	
SLO: C-11-B-96	Explain the relationship between temperature and kinetic energy of particles.	Understanding	Formative	Question(s) will not be asked in the annual examination, however it will be	

		SLO: C-11-B-97	State that total energy is conserved in chemical reaction.	Knowledge	Formative	the part of classroom teaching.	
		SLO: C-11-B-98	Explain the concept of standard conditions and standard states in measuring energy changes.	Understanding	Summative	Question(s) will be asked in the annual examination.	
		SLO: C-11-B-99	Explain Hess's Law.	Understanding	Summative		
		SLO: C-11-B-100	Apply Hess's Law to calculate enthalpy changes in a reaction carried out in multiple steps.	Application	Summative		
		SLO: C-11-B-101	Explain the relationship between bond formation energy, and bond breaking energy.	Understanding	Summative		
		SLO: C-11-B-102	Explain Gibbs free energy.	Understanding	Summative		
		SLO: C-11-B-103	Apply the concept of Gibbs free energy to solve problems.	Application	Formative	Question(s) will not be asked in the annual examination, since already covered in previous classes. However, it will be the part of class room teaching.	
		SLO: C-11-B-104	Outline how enthalpy change relates to the calorie content of the food we eat.	Application	Summative	Question(s) will be asked in the annual examination.	
	Chemical Kinetics	SLO: C-11-B-105	Explain the rate of reaction and rate constant.	Understanding	Summative	Question(s) will be asked in the annual examination.	07
		SLO: C-11-B-106	Use experimental data to calculate the rate of a reaction.	Application	Summative		
		SLO: C-11-B-107	Explain the concept of activation energy and its role in chemical reactions.	Understanding	Summative		
		SLO: C-11-B-108	Use the Boltzmann distribution curve to explain the effect of temperature on the rate of a reaction.	Understanding	Summative		
		SLO: C-11-B-109	Explain the concept of catalyst and how they increase the rate of a reaction by lowering the activation energy.	Understanding	Summative		
		SLO: C-11-B-110	Interpret reaction pathway diagrams, including in the presence and absence of catalysts.	Application	Summative		

		SLO: C-11-B-111	Explain the relationship between Gibbs free energy change, ΔG , and the feasibility of a reaction.	Understanding	Formative	Question(s) will not be asked in the annual examination, however it will be the part of class room teaching.	
		SLO: C-11-B-112	Use rate equations, including orders of reaction and rate constants.	Application	Summative	Question(s) will be asked in the annual examination.	
		SLO: C-11-B-113	Calculate the numerical value of a rate constant using the initial rates and half-life method.	Application	Summative	Question(s) will be asked in the annual examination.	
		SLO: C-11-B-114	Suggest a reaction mechanism that is consistent with a given rate equation and rate-determining step.	Understanding	Summative	Question(s) will be asked in the annual examination.	
		SLO: C-11-B-115	Describe the effect of temperature change on the rate constant and rate of a reaction.	Understanding	Summative	Question(s) will be asked in the annual examination.	
	Chemical Equilibrium	SLO: C-11-B-116	Describe what is meant by a reversible reaction and dynamic equilibrium in terms of the rate of forward and reverse reactions being equal and the concentration of reactants and products remaining constant.	Understanding	Summative	Question(s) will be asked in the annual examination.	10
		SLO: C-11-B-117	Define dynamic equilibrium between two physical states.	Knowledge	Summative	Question(s) will be asked in the annual examination.	
		SLO: C-11-B-118	State the necessary conditions for equilibrium and the ways that equilibrium can be recognized.	Knowledge	Summative	Question(s) will be asked in the annual examination.	
		SLO: C-11-B-119	Describe the microscopic events that occur when a chemical system is in equilibrium Define with examples.	Understanding	Summative	Question(s) will be asked in the annual examination.	
		SLO: C-11-B-120	Deduce the equilibrium constant expression K_c from an equation for homogeneous reaction.	Understanding	Summative	Question(s) will be asked in the annual examination.	
		SLO: C-11-B-121	Determine the relationship between different equilibrium constants (K_c) for the same reaction at the same temperature.	Understanding	Formative	Question(s) will not be asked in the annual examination, however it will be the part of class room teaching.	
		SLO: C-11-B-122	Write the equilibrium expression for a given chemical reaction in terms of concentration, K_c , partial pressure, number of moles and mole fraction.	Application	Summative	Question(s) will be asked in the annual examination.	

		SLO: C-11-B-123	Differentiate between Microscopic and Macroscopic events in a chemical reaction.	Understanding	Formative	Question(s) will not be asked in the annual examination, however it will be the part of class room teaching.	
		SLO: C-11-B-124	Propose microscopic events that account for observed macroscopic changes that take place during a shift in equilibrium.	Understanding	Formative		
		SLO: C-11-B-125	Determine if the equilibrium constant will increase or decrease when temperature is changed, given the equation for the reaction.	Understanding	Summative	Question(s) will be asked in the annual examination.	
		SLO: C-11-B-126	State Le Chatelier's Principle and be able to apply it to systems in equilibrium with changes in concentration, pressure, temperature, or the addition of catalyst.	Knowledge	Summative		
		SLO: C-11-B-127	Explain industrial applications of Le Chatelier's Principle using Haber's process and the Contact Process as an example.	Understanding	Summative		
		SLO: C-11-B-128	Discuss the industrial applications of chemical equilibria and how it can be used to optimize chemical reactions to maximize yields and minimize waste products.	Understanding	Summative		
		SLO: C-11-B-129	Use the concept of hydrolysis to explain why aqueous solutions of some salts are acidic or basic.	Application	Summative		
	Acids, Bases and Salts	SLO: C-11-B-130	Define conjugate acid-base pair.	Understanding	Summative	Question(s) will be asked in the annual examination.	08
		SLO: C-11-B-131	Identify conjugate acid-base pairs in reactions.	Understanding	Summative		
		SLO: C-11-B-132	Apply the concept of conjugate acid and conjugate base on salt hydrolysis.	Application	Summative		
		SLO: C-11-B-133	Define mathematically the terms pH, Ka , pKa and Kw and use them in calculations (Kb and the equation Kw = Ka x Kb will not be tested).	Application	Summative		
		SLO: C-11-B-134	Calculate $[H^{+}_{(aq)}]$ and pH values for (a) strong acids (b) strong alkalis (c) weak acids (d) weak alkalies.	Application	Summative		
		SLO: C-11-B-135	Distinguish that Lewis acids accept lone pair, and Lewis bases donate lone pair to make a coordinate covalent bond.	Understanding	Summative		
		SLO: C-11-B-136	Calculate the pH of buffer solutions in given appropriate data.	Application	Summative		

		SLO: C-11-B-137	Demonstrate the ability to comprehend and effectively apply the concept of solubility product. (K_{sp})	Application	Summative		
		SLO: C-11-B-138	Construct an expression for K_{sp} .	Application	Summative		
		SLO: C-11-B-139	Calculate K_{sp} from concentrations and vice versa.	Application	Summative		
		SLO: C-11-B-140	Apply the concept of the common ion effect to describe why the solubility of a substance changes when it is dissolved in a solution containing a common ion.	Application	Summative		
		SLO: C-11-B-141	Perform calculations using K_{sp} values and concentration of a common ion.	Application	Summative		
		SLO: C-11-B-142	Use the concept of hydrolysis to explain why aqueous solutions of some salts are acidic or basic.	Understanding	Summative		
		SLO: C-11-B-143	Calculate the $[H_3O^+]$ given the K_a and molar concentration of weak acid.	Application	Summative		
		SLO: C-11-B-144	Calculate concentrations of ions of slightly soluble salts.	Application	Summative		
		SLO: C-11-B-145	Perform acid-base titrations to calculate molarity and strength of given sample solutions.	Application	Summative for Practical Based Assessment (PBA).	Lab Work, Question(s) will be asked in PBA.	
		SLO: C-11-B-146	Select suitable indicators for acid-alkali titrations, given appropriate data (pKa values will not be used).	Understanding	Summative for PBA		

C	Periodic Table	SLO: C-11-C-01	Explain the arrangement of elements in the periodic table.	Understanding	Summative	Question(s) will be asked in the annual examination.	10
		SLO: C-11-C-02	Explain that the periodic table is arranged into four blocks associated with the four sublevels—s, p, d, and f.	Understanding	Summative		
		SLO: C-11-C-03	Recognize that the period number (n) is the outer energy level that is occupied by electrons.	Understanding	Summative		

		SLO: C-11-C-04	State that the number of the principal energy level and the number of the valence electrons in an atom can be deduced from its position on the periodic table.	Knowledge	Summative		
		SLO: C-11-C-05	Identify the positions of metals, nonmetals and metalloids in the periodic table.	Understanding	Summative		
		SLO: C-11-C-06	Explain that vertical and horizontal trends in the periodic table exist for atomic radius, ionic radius, ionization energy, electron affinity and electronegativity.	Understanding	Summative		
		SLO: C-11-C-07	Recognize that trends in metallic and non-metallic behavior are due to the trends in valence electrons.	Understanding	Summative		
		SLO: C-11-C-08	Deduce the electron configuration of an atom from the element's position on the periodic table, and vice versa (based on s,p,d and f subshells).	Understanding	Summative		
		SLO: C-11-C-09	Write equations for, the reactions of Na and Mg with oxygen, chlorine and water.	Application	Summative		
		SLO: C-11-C-10	Explain the variation in the oxidation number of the oxides and chlorides (NaCl , MgCl_2 in terms of their outer shell (valence shell) electrons.	Understanding	Summative		
		SLO: C-11-C-11	Describe (including writing equations for) the reactions, if any, of the oxides (acidic and basic) with water (including the likely pHs of the solutions obtained).	Understanding	Summative		
		SLO: C-11-C-12	Explain with the help of equations for, the acid / base behavior of the oxides and the hydroxides NaOH , $\text{Mg}(\text{OH})_2$ including, where relevant, amphoteric behavior in reactions with acids and bases (sodium hydroxide only).	Understanding	Summative		
		SLO: C-11-C-13	Explain with equations for, the reactions of the chlorides with water including the likely pHs of the solutions obtained.	Understanding	Summative		
		SLO: C-11-C-14	Explain the variations and trends in terms of bonding and electronegativity.	Understanding	Summative		
		SLO: C-11-C-15	Suggest the types of chemical bonding present in the chlorides and oxides from observations of their chemical and physical properties.	Understanding	Summative		

		SLO: C-11-C-16 SLO: C-11-C-17 SLO: C-11-C-18	Predict the characteristic properties of an element in a given group by using knowledge of chemical periodicity Deduce the nature, possible position in the Periodic Table and identity of unknown elements from given information about physical and chemical properties. Explain the trends in the ionization energies and electron affinities of the Group 1 and Group 17 elements.	Application Understanding Understanding Understanding	Summative Summative Summative		
	Group 17	SLO: C-11-C-19 SLO: C-11-C-20 SLO: C-11-C-21	Describe the colors and trend in volatility of chlorine, bromine and iodine. Describe the trend in bond strength of halogen molecules. Interpret the volatility of the elements in terms of instantaneous dipole-induced dipole forces.	Understanding Understanding Understanding	Formative Formative Formative	Question(s) will not be asked in the annual examination, however it will be the part of classroom teaching.	04
		SLO: C-11-C-22 SLO: C-11-C-23 SLO: C-11-C-24 SLO: C-11-C-25 SLO: C-11-C-26	Describe the relative reactivity of the halogen elements as oxidizing agents. Describe the reactions of the elements with hydrogen and explain their relative reactivity in these reactions. Describe the relative thermal stabilities of the hydrogen halides and explain these in terms of bond strengths. Describe the relative reactivity of halide ions as reducing agents. Explain the reactions of halide ions with aqueous silver ions and concentrated sulfuric acid.	Understanding Understanding Understanding Understanding	Summative Summative Summative Summative	Question(s) will be asked in the annual examination.	
		SLO: C-11-C-27	Describe the reaction of halides with aqueous silver ions followed by aqueous ammonia.	Understanding	Summative for Practical Based Assessment (PBA)	Lab Work, Question(s) will be asked in PBA.	
		SLO: C-11-C-28	Interpret the reaction of chlorine with cold and hot aqueous sodium hydroxide as disproportionation reactions.	Understanding	Formative	Question(s) will not be asked in the annual examination, however it will be	

						the part of classroom teaching.	
		SLO: C-11-C-29	Explain the use of chlorine in water purification, including the production of the active species HOCl and ClO ⁻ which kill bacteria.	Understanding	Summative	Question(s) will be asked in the annual examination.	
Nitrogen and Sulphur	SLO: C-11-C-30 SLO: C-11-C-31 SLO: C-11-C-32 SLO: C-11-C-33 SLO: C-11-C-34	Explain the lack of reactivity of nitrogen due to its triple bond strength and lack of polarity.	Understanding	Formative	Formative	Formative	Formative
		Describe the basicity of ammonia using the Brønsted–Lowry theory.	Understanding	Formative	Formative	Formative	Formative
		Identify the structure of the ammonium ion and explain how it is formed by an acid-base reaction.	Understanding	Formative	Formative	Formative	Formative
		Describe how ammonia can be displaced from ammonium salts through acid-base reactions.	Understanding	Formative	Formative	Formative	Formative
		Describe the natural and man-made occurrences of oxides of nitrogen and their catalytic removal from exhaust gases of internal combustion engines.	Understanding	Formative	Formative	Formative	Formative
	SLO: C-11-C-35	Explain the role of NO and NO ₂ in the formation of photochemical smog, specifically in the reaction with unburned hydrocarbons to form Peroxyacetyl nitrate (PAN).	Understanding	Summative	Summative	Question(s) will be asked in the annual examination.	
	SLO: C-11-C-36 SLO: C-11-C-37 SLO: C-11-C-38 SLO: C-11-C-39 SLO: C-11-C-40	Differentiate between nitrification and denitrification.	Knowledge	Formative	Formative	Formative	Formative
		Explain the lack of reactivity of sulfur, with reference to its bonding and stability of its compounds.	Understanding	Formative	Formative	Formative	Formative
		Describe the different oxidation states of sulfur and their relative stability.	Understanding	Formative	Formative	Formative	Formative
		Describe the properties and uses of sulfuric acid, including its production and industrial applications.	Understanding	Formative	Formative	Formative	Formative
		Describe the chemical reactions and processes involving sulfur, such as combustion and oxidation.	Understanding	Formative	Formative	Formative	Formative

		SLO: C-11-C-4I	Explain the uses of sulfur compounds in industry and everyday life, such as in fertilizers, gunpowder and rubber, and in the Synthetic organic chemistry, including the synthesis of dyes, drugs and fragrances.	Understanding	Summative	Question(s) will be asked in the annual examination.	
D	Environmental Chemistry Air	SLO: C-11-D-01	Identify the properties and composition of the atmosphere. (Include the concepts of 4 layers of atmosphere and their composition).	Understanding	Formative	Question(s) will not be asked in the annual examination, since already covered in previous classes. However, it will be the part of class room teaching.	03
		SLO: C-11-D-02	Describe the factors that affect air quality.	Understanding	Summative	Question(s) will be asked in the annual examination.	
		SLO: C-11-D-03	Describe the sources and understand the effects of air pollution, (This can include both natural and human-caused pollutants including O ₃ , Pb, Hg, Polycyclic aromatic hydrocarbons, Persistent organic pollutants, Greenhouse gases (such as CO ₂ , CH ₄ and N ₂ O), CFCs and other ozone-depleting substances, Volatile organic compounds, Heavy metals (such as Pb, Hg, and Cd).	Understanding	Formative	Question(s) will not be asked in the annual examination, since already covered in previous classes. However, it will be the part of class room teaching.	
		SLO: C-11-D-04	Familiarize with use of the methods and techniques to measure and monitor air quality.	Understanding	Formative	Question(s) will not be asked in the annual examination, since already covered in previous classes. However, it will be the part of class room teaching.	
		SLO: C-11-D-05	Describe the impact of human activities on the atmosphere, including the effects of burning fossil fuels and deforestation.	Understanding	Formative	Question(s) will not be asked in the annual examination, since already covered in previous classes. However, it will be the part of class room teaching.	
		SLO: C-11-D-06	Identify the chemical reactions and processes that occur in the atmosphere (some examples include the formation of smog and acid rain).	Understanding	Summative	Question(s) will be asked in the annual examination.	
		SLO: C-11-D-07	Identify laws and regulations related to air quality and the measures used to control air pollution.	Understanding	Formative	Question(s) will not be asked in the annual examination, since already covered in previous classes. However, it will be	
		SLO: C-11-D-08	Analyze data and interpret air quality measurements and trends.	Understanding	Formative	Question(s) will not be asked in the annual examination, since already covered in previous classes. However, it will be	
		SLO: C-11-D-09	Explain the link between air quality and human health.	Understanding	Formative	Question(s) will not be asked in the annual examination, since already covered in previous classes. However, it will be	

		SLO: C-11-D-10 SLO: C-11-D-11 SLO: C-11-D-12 SLO: C-11-D-13 SLO: C-11-D-14	Evaluate the potential health risks associated with air pollution. Explain the technologies and strategies used to reduce air pollution and improve air quality, such as emissions control and renewable energy sources. Design experiments and collect data to test hypotheses about air quality Identify the global scale problems of air pollution, such as global warming and the greenhouse effect. Analyze the economic, social and political issues related to air pollution and air quality management and demonstrate through answers.	Understanding Understanding Application Understanding Understanding	Formative Formative Formative Formative Formative	the part of class room teaching.	
	Environmental Chemistry-Water	SLO: C-11-D-15 SLO: C-11-D-16 SLO: C-11-D-17 SLO: C-11-D-18 SLO: C-11-D-19 SLO: C-11-D-20 SLO: C-11-D-21	Identify different types of water pollution, (some examples include point source and nonpoint source pollution) Identify common water pollutants (Some examples include oil, pesticides, and heavy metals) Identify and explain the sources and effects of water pollution on human health and the environment. Identify and explain water treatment methods and technologies, such as filtration and purification. Explain the laws and regulations related to water pollution and conservation. Evaluate the impact of human activities on water resources, such as agriculture and industrial processes. Explain conservation and management strategies for protecting and preserving water resources.	Understanding Understanding Understanding Understanding Understanding Understanding	Formative Formative Formative Formative Formative Summative	Question(s) will not be asked in the annual examination, since already covered in previous classes. However, it will be the part of class room teaching.	03

		SLO: C-11-D-22	Explain the chemical properties of water and how they relate to water quality and pollution.	Understanding	Formative	Question(s) will not be asked in the annual examination, since already covered in previous classes. However, it will be the part of class room teaching.	
E	Organic Chemistry	SLO: C-11-E-01 SLO: C-11-E-02 SLO: C-11-E-03 SLO: C-11-E-04 SLO: C-11-E-05 SLO: C-11-E-06 SLO: C-11-E-07 SLO: C-11-E-08 SLO: C-11-E-09 SLO: C-11-E-10	Recognize that hydrocarbons are compounds made up of C and H atoms only. Recognize that alkanes are simple hydrocarbons with no functional group. Recognize that compounds contain a functional group which dictates their physical and chemical properties. Interpret the general, structural, displayed, and skeletal formulae of the classes of compounds. Describe the use of systematic nomenclature of simple aliphatic organic molecules with functional groups. Deduce the molecular and/or empirical formula of a compound, given its structural, displayed, or skeletal formula. Describe terminology associated with the types of organic compounds and reactions (Some examples include: homologous series, saturated and unsaturated, homolytic and heterolytic fission, free radical, initiation, propagation, termination, nucleophile, electrophile, nucleophilic, electrophilic, addition, substitution, elimination, hydrolysis, condensation, oxidation and reduction) Define catenation and explain its importance in organic chemistry. Describe terminology associated with types of organic mechanisms (Some examples include: free-radical substitution, electrophilic addition, nucleophilic substitution, nucleophilic addition) Draw the mechanism of a chemical reaction using curly arrows to represent the movement of a pair of electrons in at least three different	Understanding Understanding Understanding Application Understanding Application Understanding Knowledge Understanding Understanding	Summative Summative Summative Summative Summative Summative Summative Summative Summative	Question(s) will be asked in the annual examination.	11

		SLO: C-11-E-11 SLO: C-11-E-12	<p>types of reactions, including nucleophilic substitution, electrophilic addition, and elimination reactions.</p> <p>Apply the term ‘planar’ when describing the arrangement of atoms in organic molecules.</p> <p>Describe structural isomerism (in the context of organic molecules) and its division into chain, positional, functional group isomerism metamerism and tautomerism.</p>	Application Understanding	Summative Summative		
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	Hydrocarbons	SLO: C-11-E-13	Classify hydrocarbons as aliphatic and aromatic.	Understanding	Summative	Question(s) will be asked in the annual examination.	10
		SLO: C-11-E-14	Describe nomenclature of alkanes and cycloalkanes.	Understanding	Summative		
		SLO: C-11-E-15	Explain the shapes of alkanes and cycloalkanes exemplified by ethane and cyclopropane.	Understanding	Summative		
		SLO: C-11-E-16	Explain unreactive nature of alkanes towards polar reagents.	Understanding	Summative		
		SLO: C-11-E-17	Define homolytic and heterolytic fission, free radical initiation, propagation, and termination.	Understanding	Summative		
		SLO: C-11-E-18	Describe the mechanism of free radical substitution in alkanes exemplified by methane and ethane.	Understanding	Summative		
		SLO: C-11-E-19	Identify organic redox reactions.	Understanding	Summative		
		SLO: C-11-E-20	Explain the nomenclature of alkenes.	Understanding	Summative		
		SLO: C-11-E-21	Explain shape of ethene molecule in terms of structure and bonding..	Understanding	Summative		
		SLO: C-11-E-22	Describe the structure and reactivity of alkenes as exemplified by ethene.	Understanding	Summative		
		SLO: C-11-E-23	Explain with suitable examples the terms isomerism, stereoisomerism and structural isomerism.	Understanding	Formative	Question(s) will not be asked in the annual examination, however it will be the part of classroom teaching.	
		SLO: C-11-E-24	Explain dehydration of alcohols and dehydrohalogenation of RX for the preparation of ethene.	Understanding	Summative	Question(s) will be asked in the annual examination.	
		SLO: C-11-E-25	Describe the chemistry of alkenes by the following reactions of ethene: hydrogenation, hydrohalogenation, hydration, halogenation, halohydratation, epoxidation, ozonolysis, polymerization.	Understanding	Summative		
		SLO: C-11-E-26	Explain the concept of conjugation in alkenes having alternate double bonds.	Understanding	Summative		

		SLO: C-11-E-27 SLO: C-11-E-28 SLO: C-11-E-29	Use the IUPAC naming system for alkenes. Describe the mechanism of electrophilic addition in alkenes, using bromine / ethene and hydrogen bromide /propene as examples. Explain the inductive effects of alkyl groups on the stability of primary, secondary and tertiary cations formed during electrophilic addition (this should be used to explain Markovnikov addition).	Understanding Understanding Understanding	Summative Summative Summative		
	Halogeno alkanes	SLO: C-11-E-30 SLO: C-11-E-31 SLO: C-11-E-32 SLO: C-11-E-33	Classify halogenoalkanes based on the type of halogen atom and its position in the carbon chain, and explain how the molecular structure affects their reactivity. Explain the organic functional groups involved in a simple halogenoalkane synthesis, and predict the major product(s) based on the reaction conditions. (this includes: a) the free-radical substitution of alkanes by Cl or Br in the presence of ultraviolet light, as exemplified by the reactions of ethane. b) Electrophilic addition of an alkene with a halogen, X_2 , or hydrogen halide, $HX(g)$, at room temperature. c) substitution of an alcohol, e.g. by reaction with HX or KBr with H_2SO_4 or H_3PO_4 ; or with PCl_3 and heat; or with PCl_5 ; or with $SOCl_2$). Describe nucleophilic substitution reactions (specifically: a. the reaction with $NaOH(aq)$ and heat to produce an alcohol b. the reaction with KCN in ethanol and heat to produce a nitrile. c. the reaction with NH_3 in ethanol heated under pressure to produce an amine. d. the reaction with aqueous silver nitrate in ethanol as a method of identifying the halogen present as exemplified by bromoethane). Describe the elimination reaction with $NaOH$ in ethanol and heat to produce an alkene as exemplified by bromoethane.	Understanding Understanding Understanding Understanding	Summative Summative Summative Summative	Question(s) will be asked in the annual examination.	05

	Hydroxy Compounds	SLO: C-11-E-34	<p>State the reactions (reagents and conditions) by which alcohols can be produced: (a) electrophilic addition of steam to an alkene, $\text{H}_2\text{O(g)}$ and H_3PO_4 catalyst (b) reaction of alkenes with cold dilute acidified potassium manganate(VII) to form a diol (c) substitution of a halogenoalkane using NaOH (aq) and heat (d) reduction of an aldehyde or ketone using NaBH_4 or LiAlH_4 (e) reduction of a carboxylic acid using LiAlH_4 (f) hydrolysis of an ester using dilute acid or dilute alkali and heat describe the reaction with oxygen (combustion) of organic hydroxy compounds.</p>	Knowledge	Summative	Question(s) will be asked in the annual examination. Question(s) will be asked in the annual examination.	07
		SLO: C-11-E-35	Describe substitution to halogenoalkanes, e.g. by reaction with HX or KBr with H_2SO_4 or H_3PO_4 ; or with PCl_3 and heat; or with PCl_5 ; or with SOCl_2 .	Understanding	Summative		
		SLO: C-11-E-36	Describe the reaction of hydroxy organic compounds with Na(s) .	Understanding	Summative		
		SLO: C-11-E-37	Describe the oxidation with acidified $\text{K}_2\text{Cr}_2\text{O}_7$ or acidified KMnO_4 to: carbonyl compounds by distillation, carboxylic acids by refluxing (primary alcohols give aldehydes which can be further oxidized to carboxylic acids, secondary alcohols give ketones, tertiary alcohols cannot be oxidized).	Understanding	Summative		
		SLO: C-11-E-38	Describe the dehydration of alcohols to alkenes by using a heated catalyst, e.g. Al_2O_3 or a concentrated acid.	Understanding	Summative		
		SLO: C-11-E-39	Describe the formation of esters by reaction with carboxylic acids and concentrated H_2SO_4 or H_3PO_4 as catalyst as exemplified by ethanol.	Understanding	Summative		
		SLO: C-11-E-40	Classify alcohols as primary, secondary and tertiary alcohols, to include examples with more than one alcohol group.	Understanding	Summative		
		SLO: C-11-E-41	State characteristic distinguishing reactions, e.g. mild oxidation with acidified $\text{K}_2\text{Cr}_2\text{O}_7$, colour change from orange to green	Understanding	Summative		
		SLO: C-11-E-42	Deduce the presence of a $\text{CH}_3\text{CH(OH)}-$ group in an alcohol, $\text{CH}_3\text{CH(OH)}-\text{R}$, from its reaction with alkaline I_2 (aq) to form a yellow precipitate of tri-iodomethane and an ion, RCO_2^-	Application	Summative		
		SLO: C-11-E-43	Explain the acidity of alcohols compared with water	Understanding	Summative		

	Carbonyl Compounds	SLO: C-11-E-44	State the reactions (reagents and conditions) by which aldehydes and ketones can be produced: a. the oxidation of primary alcohols using acidified $K_2Cr_2O_7$ or acidified $KMnO_4$ and distillation to produce aldehydes b. the oxidation of secondary alcohols using acidified $K_2Cr_2O_7$ or acidified $KMnO_4$ and distillation to produce ketones	Understanding	Summative	Question(s) will be asked in the annual examination.	08
		SLO: C-11-E-45	Describe: a. the reduction of aldehydes and ketones, using $NaBH_4$ or $LiAlH_4$ to produce alcohols b. the reaction of aldehydes and ketones with HCN, KCN as catalyst, and heat to produce hydroxynitriles exemplified by ethanal and propanone	Understanding	Summative		
		SLO: C-11-E-46	Describe the mechanism of the nucleophilic addition reactions of hydrogen cyanide with aldehydes and ketones.	Understanding	Summative		
		SLO: C-11-E-47	Describe the use of 2,4-dinitrophenylhydrazine (2,4-DNPH reagent) to detect the presence of carbonyl compounds.	Understanding	Summative		
		SLO: C-11-E-48	Deduce the nature (aldehyde or ketone) of an unknown carbonyl compound from the results of simple tests (Fehling's and Tollens' reagents; ease of oxidation)	Understanding	Summative		
		SLO: C-11-E-49	Deduce the presence of a CH_3CO^- group in an aldehyde or ketone, CH_3COR , from its reaction with alkaline $I_2(aq)$ to form a yellow precipitate of tri-iodomethane and an ion, RCO_2^- .	Application	Summative		
		SLO: C-11-E-50	Recall the reactions by which carboxylic acids can be produced: a) oxidation of primary alcohols and aldehydes with acidified $K_2Cr_2O_7$ or acidified $KMnO_4$ and refluxing b) hydrolysis of nitriles with dilute acid or dilute alkali followed by acidification c) hydrolysis of esters with dilute acid or dilute alkali and heat followed by acidification	Knowledge	Summative		
		SLO: C-11-E-51	Describe a. the redox reaction with reactive metals to produce a salt and $H_2(g)$ b. the neutralization reaction with alkalis to produce a salt and H_2O c. the acid–base reaction with carbonates to produce a salt and $H_2O(l)$ and $CO_2(g)$ d. esterification with alcohols with concentrated H_2SO_4 as catalyst e. reduction by $LiAlH_4$ to form a primary alcohol.	Understanding	Summative		
		SLO: C-11-E-52	Recall the reaction (reagents and conditions) by which esters can be produced: the condensation reaction between an alcohol and a carboxylic acid with concentrated H_2SO_4 as catalyst.	Knowledge	Summative		

		SLO: C-11-E-53	Describe the hydrolysis of esters by dilute acid and by dilute alkali and heat	Understanding	Summative		
	Nitrogen Compounds- Amines	SLO: C-11-E-54	Define primary and secondary amines, and explain their basic properties and reactivity.	Understanding	Summative	Question(s) will be asked in the annual examination.	03
		SLO: C-11-E-55	Identify the differences between primary and secondary amines in terms of their structure and chemical properties.	Understanding	Summative		
		SLO: C-11-E-56	Describe the preparation methods of primary and secondary amines, including nucleophilic substitution reactions and reduction of nitro compounds.	Understanding	Summative		
		SLO: C-11-E-57	Explain the properties and reactivity of phenylamine and azo compounds, including their use as dyes and pigments.	Understanding	Summative		
	Organic Synthesis	SLO: C-11-E-58	Explain the concept of organic synthesis and functional group interconversions.	Understanding	Summative	Question(s) will be asked in the annual examination.	03
		SLO: C-11-E-59	Identify organic functional groups using the reactions in this progression grid.	Understanding	Summative		
		SLO: C-11-E-60	Predict properties and reactions of organic molecules based on functional group presence.	Application	Summative		
		SLO: C-11-E-61	Devise multi-step synthetic routes for preparing organic molecules.	Understanding	Summative		
		SLO: C-11-E-62	Analyze a given synthetic route in terms of type of reaction and reagents used for each step of it, and possible by products.	Understanding	Summative		
		SLO: C-11-E-63	Explain the concept of retrosynthesis and its application in organic synthesis.	Understanding	Formative	Question(s) will not be asked from 63, it needs more explanation. Could be possible in grade 12	

F	Energy	SLO: C-11-F-01	Differentiate between the difference between petrochemical and chemicals derived from them,	Understanding	Formative	Question(s) will not be asked in the annual examination, however it will be part of classroom teaching.	02
		SLO: C-11-F-02	Identify the various raw materials for the petrochemical industry.	Understanding	Formative		
		SLO: C-11-F-03	Explain the process of fractional distillation and refining of petroleum and identify the important fractions.	Understanding	Formative		
		SLO: C-11-F-04	Describe the basic building block processes in petrochemical technology and explain the petrochemical process technology.	Understanding	Formative		
		SLO: C-11-F-05	List some major petrochemicals and understand the importance of petrochemicals in the modern world.	Understanding	Formative		
		SLO: C-11-F-06	Distinguish between energy density and specific energy of different energy sources, and explain the efficiency of energy transfer.	Understanding	Formative		
		SLO: C-11-F-07	Explain the formation, properties, and uses of fossil fuels, and the importance of fossil fuels in the modern world.	Understanding	Summative	Question(s) will be asked in the annual examination.	
		SLO: C-11-F-08	Explain the mechanism and importance of nuclear fusion and fission and explain the importance of nuclear energy in the modern world.	Understanding	Formative	Question(s) will not be asked in the annual examination, however it will be part of classroom teaching.	
		SLO: C-11-F-09	Explain the importance and mechanism of solar energy and its importance as a source of renewable energy in the modern world.	Understanding	Formative		
		SLO: C-11-F-10	Explain the environmental impact of energy consumption, particularly in relation to global warming and its relation to the importance of reducing carbon footprint and moving towards sustainable energy sources.	Understanding	Formative		
		SLO: C-11-F-11	Apply knowledge of energy sources and their properties to critically evaluate the advantages and disadvantages of different energy sources and make informed decisions about energy consumption.	Application	Formative		
							Total Lectures for theory = 150

G	Practically perform chemical experiments	SLO: C-11-G-01 SLO: C-11-G-02 SLO: C-11-G-03 SLO: C-11-G-04 SLO: C-11-G-05 SLO: C-11-G-06 SLO: C-11-G-07	Identify the chemical hazards in the lab in context of the experiment being conducted. Test that the equipment is working properly without any potential risk of injury before conducting an experiment. Ensure that workspace for conducting the experiment is not crowded with apparatus as to be hazardous. Ensure that safe distance is kept at all times from other investigators who may be handling lab apparatus. Identify what potential bodily harm could occur from physical, chemical, biological and safety hazards in the context of the experiment being conducted. Recognise that it is always better to ask for help from the lab instructor when unsure of how to use new apparatus. Identify the proper waste disposal system for chemicals being used.	Knowledge Knowledge Knowledge Knowledge Knowledge Knowledge Knowledge	Formative Formative Formative Formative Formative Formative Formative	Question will not be asked in PBA, however, it will be part of Lab work	02
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	Practically perform chemical experiments	SLO: C-11-G-08 SLO: C-11-G-09 SLO: C-11-G-10 SLO: C-11-G-11 SLO: C-11-G-12 SLO: C-11-G-13 SLO: C-11-G-14 SLO: C-11-G-15 SLO: C-11-G-16 SLO: C-11-G-17	<p>Set up apparatus following instructions given in written or diagrammatic form.</p> <p>Use apparatus to collect an appropriate quantity of data</p> <p>Make observations, including subtle differences in colour, solubility or quantity of materials</p> <p>Make measurements using pipettes, burettes, measuring cylinders, thermometers and other common laboratory apparatus.</p> <p>Decide how many tests or observations to perform</p> <p>Identify where repeated readings or observations are appropriate</p> <p>Replicate readings or observations as necessary, including where an anomaly is suspected</p> <p>Identify where confirmatory tests are appropriate and the nature of such tests</p> <p>Select reagents to distinguish between given ions.</p> <p>Carry out procedures using simple apparatus, in situations where the method may not be familiar to the candidate</p>	Understanding Understanding Understanding Understanding Understanding Understanding Understanding Knowledge Application	Formative Formative Formative Formative Formative Formative Formative Formative Formative	Question will not be asked in PBA, however, it will be part of Lab work	
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	Acid Base Titration	SLO: C-11-G-18	Describe an acid-base titration to include the use of a: a. burette b. volumetric pipette c. suitable indicator	Understanding	Summative for Practical Based Assessment (PBA).			16
		SLO: C-11-G-19	Describe how to identify the endpoint of a titration using an indicator	Understanding	Summative for PBA.			
		SLO: C-11-G-20	Describe tests to identify the anions: a. CO_3^{2-} : By reaction with dilute acid and then testing for carbon dioxide gas. b. Cl^{1-} / Br^{1-} / I^{1-} : By acidifying with dilute nitric acid then adding aqueous silver nitrate. c. NO_3^{1-} : By reduction with aluminum foil and aqueous sodium hydroxide and then testing for ammonia gas. d. SO_4^{2-} : By acidifying with dilute nitric acid then adding aqueous barium nitrate. e. SO_3^{2-} : By reaction with acidified aqueous potassium manganate(VII).	Understanding	Summative for PBA.	Laboratory work-will be assessed in PBA.		
		SLO: C-11-G-21	Describe tests using aqueous sodium hydroxide and aqueous ammonia to identify the aqueous cations: a) aluminum, Al^{3+} b) ammonium, NH_4^{1+} c) calcium, Ca^{2+} d) chromium(III), Cr^{3+} e) copper(II), Cu^{2+} f) iron(II), Fe^{2+} g) iron(III), Fe^{3+} h) zinc, Zn^{2+}	Understanding	Summative for PBA.			
		SLO: C-11-G-22	Present numerical data, values or observations in a single table of results with headings and units that conform to accepted scientific conventions.	Application	Summative for PBA.			

	Data representation and analysis	SLO: C-11-G-22 SLO: C-11-G-23 SLO: C-11-G-24 SLO: C-11-G-25 SLO: C-11-G-26 SLO: C-11-G-27 SLO: C-11-G-28 SLO: C-11-G-29 SLO: C-11-G-30 SLO: C-11-G-31 SLO: C-11-G-32	Record raw readings of a quantity to the same degree of precision and observations to the same level of detail. Show working in calculations and key steps in reasoning. Use the correct number of significant figures for calculated quantities. Draw an appropriate table in advance of taking readings or making observations and record all data in the table. Use the appropriate presentation method to produce a clear presentation of the data. Plot appropriate variables on appropriate, clearly labelled x- and y-axes with carefully chosen scales. Draw straight lines or smooth curves of best fit to show the trend of a graph. Describe the patterns and trends shown by data in tables and graphs. Describe and summarize the key points of a set of observations. Determine the gradient of a straight-line graph and extrapolate the line of a graph. Draw conclusions from an experiment, giving an outline description of the main features of the data, considering whether experimental data support a given hypothesis, and making further predictions.	Application Application Application Application Application Application Application Application Application Application	Summative for PBA. Summative for PBA.	Laboratory work-will be assessed in PBA.		02
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	Suggest improvements based on validity, reliability and safety.	SLO: C-11-G-33	Draw conclusions from interpretations of observations, data and calculated values.	Application	Formative		02
		SLO: C-11-G-34	Make scientific explanations of data, observations and conclusions that they have described.	Application	Formative		
		SLO: C-11-G-35	Analyse intrinsic errors in measuring device.	Application	Formative		
		SLO: C-11-G-36	Describe systematic errors.	Understanding	Formative		
		SLO: C-11-G-37	Identify the most significant sources of error in an experiment	Understanding	Formative		
		SLO: C-11-G-38	State the uncertainty in a quantitative measurement and express such uncertainty in a measurement as an actual or percentage error	Understanding	Formative		
		SLO: C-11-G-39	Analyse the limitations of the experimental design and propose appropriate modifications that will improve the accuracy of the experiment.	Application	Formative	Question will not be asked in PBA, however, it will be part of Lab work	
		SLO: C-11-G-40	Evaluate the validity of the methods used	Understanding	Formative		
		SLO: C-11-G-41	Explain improvements or extensions to the methods used.	Understanding	Formative		
		SLO: C-11-G-42	Apply scientific language effectively.	Application	Formative		
		SLO: C-11-G-43	Document the work of others and sources of information used	Application	Formative		
		SLO: C-11-G-44	Suggest ways in which to extend the investigation to answer a new question.	Application	Formative		
		SLO: C-11-G-45	Suggest alternate chemicals in experimental design which contribute to green chemistry.	Application	Formative		
Total lectures for Practical's = 22							
Total Lectures for Theory + practical's = 150 + 20 = 172							

Note: **PBA STANDS FOR “PRACTICAL BASED ASSESSMENT”**



Federal Board HSSC-I Examination

Chemistry Model Question Paper

(Curriculum 2022-2023)

Section - A (Marks 17)

Time Allowed: 25 minutes

Section – A is compulsory. All parts of this section are to be answered on this page and handed over to the Centre Superintendent. Deleting/overwriting is not allowed.
Do not use lead pencil.

ROLL NUMBER					
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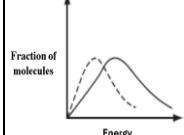
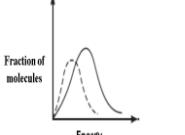
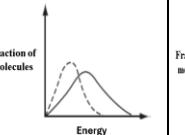
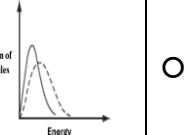
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(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)
(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)
(8)	(8)	(8)	(8)	(8)	(8)	(8)	(8)	(8)	(8)
(9)	(9)	(9)	(9)	(9)	(9)	(9)	(9)	(9)	(9)

Candidate Sign. _____

Invigilator Sign. _____

Q1. Fill the relevant bubble against each question according to curriculum. Each part carries one mark.

	Question	A	B	C	D	A	B	C	D
i.	0.1 mole of NaCl contains 6.02×10^{22}	molecules	formula units	ions	atoms	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>
ii.	Which solid-line curve most accurately represents the distribution of molecular energy in a gas at 500 K if the dotted-line curve represents the corresponding distribution for the same gas at 300 K?					<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>
iii.	For the rate law , Rate = $k[A]^{\frac{1}{2}}[B]$, predict order with respect to A, the order with respect to B and the total order.	$\frac{1}{2}; 0; \frac{1}{2}$	$\frac{1}{2}; 1; 1$	$\frac{1}{2}; 1; \frac{3}{2}$	$\frac{1}{2}; 1; 2$	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>
iv.	1 st Electron affinity of oxygen atom is greater than nitrogen because of,	greater nuclear charge of Nitrogen	more Screening effect of oxygen	less nuclear force of attraction of Nitrogen	greater nuclear force of attraction of oxygen	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>
v.	If the total energy of the product is greater than the reactants, identify the reaction.	Exothermic	Endothermic	Reduction	oxidation	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>
vi.	Suggest volume occupied by one mole of gas at STP.	224.14dm ³	2.414dm ³	0.022414cm ³	22414cm ³	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>

vii.	When bromine reacts with propene in an organic solvent at room temperature, what is the mechanism by which the bromine attacks the propene?	Electrophilic substitution	Electrophilic addition	Nucleophilic addition	Nucleophilic substitution	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>
viii.	Which one of the following reacts with aldehyde to give red precipitates of copper(I) oxide	Grignard's Reagent	Fehlings solution	Tollen's solution	KMnO ₄	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>
ix.	Identify termination step in free radical substitution reaction of methane with chlorine.	$\text{CH}_4 + \text{Cl}\cdot \rightarrow \text{HCl} + \text{CH}_3$	$\text{CH}_3\cdot + \text{Cl}\cdot \rightarrow \text{CH}_3\text{Cl}$	$\text{Cl}_2 \rightarrow 2\text{Cl}\cdot$	$\text{Cl}\cdot + \text{H}_2 \rightarrow \text{HCl} + \text{H}\cdot$	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>
x.	Predict the geometry of XeF ₄	Tetrahedral	Trigonal planner	Square planner	V-shaped	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>
xi.	Which electronic configuration represents the most electronegative element?	ns ² np ²	ns ² np ¹	ns ² np ⁴	ns ² np ⁵	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>
xii.	Predict which specie upon hydrolysis gives acidic solution?	Na ₂ CO ₃	NaNO ₃	Cu(OH) ₂	AlCl ₃	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>
xiii.	Identify the most basic amine.	CH ₃ CH ₂ NH ₂	(CH ₃) ₃ N	CH ₃ NHCH ₃	CH ₃ CH ₂ NHCH ₃	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>
xiv.	Which one of the following is a nucleophile?	NH ₄ ⁺	SO ₃	NH ₃	NO ₂ ¹⁺	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>
xv.	Identify which reagent is used to convert ethanal into ethanol?	KMnO ₄	Zn/HCl	H ₂ SO ₄	LiAlH ₄	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>
xvi.	Suggest why I ₂ is solid while Br ₂ is liquid at room temperature?	Due to strong hydrogen bonding in I ₂	Due to stronger London dispersion forces in I ₂	Due to dipole dipole force in Br ₂	Due to ion dipole force in Br ₂	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>
xvii.	Identify carbonyl compound that forms an iodoform.	Propanal	Methanal	3-hexanone	Propanone	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>

SECTION – B (Marks 42)

Q. 2	Attempt the following questions			(11x3 = 33)														
(i)	Explain with equations the reactions of the following chlorides with water, Also mention pH of resulting mixture. a. AlCl ₃ b. PCl ₃	1.5+1.5	OR	Draw the shape of 3s, 3p _x and 3d _{z²} orbitals.														
(ii)	Identify alcohol and carboxylic acid use to prepare methyl propanoate. Give equation for the reaction.	03	OR	Write three points of differences between amorphous and crystalline solids.														
(iii)	When Chloro ethane reacts with sodium hydroxide different products are formed under different sets of conditions used. Write down the structural formulae of the products which are formed under these conditions. Also write the type of each reaction.	1+1+1	OR	Reducing power of halide ions increases down the group. Explain this fact with the help of reaction of Cl ⁻ and Br ⁻¹ ions with conc. H ₂ SO ₄ .														
(iv)	Calculate the enthalpy (ΔH) change of reaction by using the following data $C_2H_2 + \frac{5}{2} O_2 \rightarrow 2CO_2 + H_2O$ ΔH_f of CO ₂ = -393.5 KJ mol ⁻¹ ΔH_f of H ₂ O = -285.5 KJ mol ⁻¹ ΔH_f of C ₂ H ₂ = 227.3 KJmol ⁻¹	03	OR	Starting from 20g of N ₂ , calculate the mass of gaseous product (NH ₃) in the given reaction. $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$														
(v)	The table lists the equations for six processes. For each process, predict the sign of ΔS . <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th align="center">Process</th> <th align="center">Sign of ΔS</th> </tr> </thead> <tbody> <tr> <td align="center">NaCl(s) + (aq) → NaCl(aq)</td> <td></td> </tr> <tr> <td align="center">H₂O(g) → H₂O(l)</td> <td></td> </tr> <tr> <td align="center">2H₂O(g) → 2H₂(g) + O₂(g)</td> <td></td> </tr> <tr> <td align="center">CuSO₄(s) + 6H₂O(l) → CuSO₄.6H₂O(s)</td> <td></td> </tr> <tr> <td align="center">Zn(s) + 2HCl(aq) → ZnCl₂(aq) + H₂(g)</td> <td></td> </tr> <tr> <td align="center">C₂H₅OH(l) + 3O₂(g) → 2CO₂(g) + 3H₂O(l)</td> <td></td> </tr> </tbody> </table>	Process	Sign of ΔS	NaCl(s) + (aq) → NaCl(aq)		H ₂ O(g) → H ₂ O(l)		2H ₂ O(g) → 2H ₂ (g) + O ₂ (g)		CuSO ₄ (s) + 6H ₂ O(l) → CuSO ₄ .6H ₂ O(s)		Zn(s) + 2HCl(aq) → ZnCl ₂ (aq) + H ₂ (g)		C ₂ H ₅ OH(l) + 3O ₂ (g) → 2CO ₂ (g) + 3H ₂ O(l)		$\frac{1}{2} \times 6$	OR	Oxygen molecules show a paramagnetic behavior. Draw molecular orbital diagram of O ₂ molecule and explain this statement on the basis of MOT.
Process	Sign of ΔS																	
NaCl(s) + (aq) → NaCl(aq)																		
H ₂ O(g) → H ₂ O(l)																		
2H ₂ O(g) → 2H ₂ (g) + O ₂ (g)																		
CuSO ₄ (s) + 6H ₂ O(l) → CuSO ₄ .6H ₂ O(s)																		
Zn(s) + 2HCl(aq) → ZnCl ₂ (aq) + H ₂ (g)																		
C ₂ H ₅ OH(l) + 3O ₂ (g) → 2CO ₂ (g) + 3H ₂ O(l)																		
(vi)	Explain the preparation of ethene from, a. Ethanol b. Chloro ethane	1.5+1.5	OR	Identify types of intermolecular forces among the following molecules. Also write the ascending order of their strength. HCl, NH ₃ , O ₂ , HF														
(vii)	Write chemical equations involved in the preparation of Propan-1-ol from the following reagents a) Propene b) 1-Chloro Propane	1.5+1.5	OR	Catenation increases diversity of organic compounds. Define catenation and explain this statement with suitable examples.														
(viii)	Give role of NO _x in the formation of PAN (Peroxyacetyl nitrate). Explain with chemical reactions.	1+2	OR	Describe mechanism of the formation of CH ₃ Cl by the reaction of methane with chlorine.														
(ix)	Write electronic configuration of following elements. a. $^{55}_{25}Mn$ b. $^{64}_{32}P$	1.5+1.5	OR	Give two possible ways to recognize an equilibrium.														
(x)	 How can you distinguish the above compounds A and B from each other. Give a chemical test?	1.5+1.5	OR	Describe the preparation methods of diethyl amine, (C ₂ H ₅) ₂ NH using a. nucleophilic substitution reactions b. reduction of nitro compounds														

(xi)	A naturally occurring sample of cerium contains only four isotopes. ^{136}Ce having isotopic mass of 135.91 and %age abundance 0.185%, ^{138}Ce having isotopic mass of 137.91 and %age abundance of 0.25%, ^{140}Ce having isotopic mass of 139.91 and %age abundance of 88.45%. The relative atomic mass of the Ce is 140.116. Use these data to calculate the relative isotopic mass of the fourth isotope in this sample of cerium.	1+2	OR	Lead(II) chloride is sparingly soluble in water. Solubility of lead (II) chloride at 25 °C is 0.5 gdm ⁻³ . Calculate Ksp of lead(II) chloride at 25 °C.	1.5+1.5								
(xii)	For 6f orbital, give allowed values of following quantum numbers. i. Principal quantum number ii. Azimuthal quantum number iii. Magnetic quantum number	1+1+1	OR	Define the following with at least one equation in each case. a. Standard enthalpy of atomization (ΔH_{atm}). b. Standard enthalpy of Lattice ($\Delta H_{lattice}$)	1.5+1.5								
(xiii)	Define electronegativity. Explain the trend of electronegativity down the group of the periodic table.	1+2	OR	Calculate volume of 4.5g of H ₂ at STP by using mole-volume relationship.	03								
(xiv)	What is meant by vapour pressure? Following is a table of the vapour pressure of water, ethanol and pentane. <table border="1"> <thead> <tr> <th>Liquid</th> <th>Vapour Pressure</th> </tr> </thead> <tbody> <tr> <td>Water (H₂O)</td> <td>2.44</td> </tr> <tr> <td>Ethanol (C₂H₅OH)</td> <td>5.83</td> </tr> <tr> <td>Pentane (C₅H₁₀)</td> <td>59.9</td> </tr> </tbody> </table> Explain these variations in vapour pressure.	Liquid	Vapour Pressure	Water (H ₂ O)	2.44	Ethanol (C ₂ H ₅ OH)	5.83	Pentane (C ₅ H ₁₀)	59.9	1+2	OR	Calculate pH of a buffer solution containing 0.11M HCOOH and 0.11M HCOONa. pKa of methanoic acid at 25 °C is 3.76.	1+2
Liquid	Vapour Pressure												
Water (H ₂ O)	2.44												
Ethanol (C ₂ H ₅ OH)	5.83												
Pentane (C ₅ H ₁₀)	59.9												

SECTION – C (Marks 26)

Note: Attempt the following questions

Q.3	Given the following data for a first-order reaction: Initial concentration of reactant (A): $[A]_0 = 0.10 \text{ moldm}^{-3}$ Initial rate at $[A]^0$: Rate ₁ = $2.0 \times 10^{-3} \text{ moldm}^{-3}s^{-1}$ Concentration of reactant A after a certain time: $[A] = 0.05 \text{ moldm}^{-3}$ Half-life of the reaction: $t_{\frac{1}{2}} = 100 \text{ s}$ Calculate the numerical value of the rate constant (k) for this reaction using the initial rates and half-life method.	3+3	OR	Ammonia is produced by the following reaction. $2\text{NH}_4\text{Cl} + \text{Ca}(\text{OH})_2 \longrightarrow \text{CaCl}_2 + 2\text{H}_2\text{O} + 2\text{NH}_3$ When 200 g of ammonium chloride and 100 g calcium hydroxide are used then a. Calculate the amount of ammonia in grams produced during this reaction. b. Calculate the amount of excess reactant left unreacted after the completion of chemical reaction.	3+3
Q.4	Write down the reagents and conditions used to prepare propanoic acid from following. a. Propanal b. Propane nitrile c. Methyl propanoate	2+2+2	OR	The following is an important industrial reaction, $2\text{SO}_2 + \text{O}_2 \rightleftharpoons 2\text{SO}_3 \quad \Delta H = -250 \text{ kJ mol}^{-1}$ Explain three factors that can increase the yield sulphur trioxide in this reaction.	2+2+2
Q.5	Consider an alcohol with molecular formula C ₄ H ₁₀ O. It exists in different isomeric forms. a. Write structural formulas of four isomers, also write their names.	6+ 1	OR	a. Compare the reactivity of different Alkyl halides (R-F, R-Cl, R-Br and R-I). Explain your answer. b. Write down the identifying test of halogens present in the alkyl halides. Also write down the equations involved.	3+4

	b. What type of isomerism is shown by these compounds?				
Q.6	Ethanol reacts with HBr, SOCl_2 and PCl_5 by substitution reactions. a. Define substitution reactions. b. Write complete balanced equations for the reaction of ethanol with these three reagents. Also write the conditions involved in each reaction.	1+6	OR	What is meant by sp^3 -hybridization. Explain in detail the type of hybridization in the following molecules. Also draw diagrams of hybridized orbitals. a. PH_3 b. C_2H_2	1+6

Section-A (17 Marks)

Q1.	SLO's	Domain	Cognitive level	Marks
i.	[SLO: C-11-B-57] Derive measurements of mass, volume, and number of particles using moles.	B	A	1
ii.	[SLO: C-11-B-108] Use the Boltzmann distribution curve to explain the effect of temperature on the rate of reaction explain the rate of reaction and rate constant.	B	U	1
iii.	[SLO: C-11-B-106] Use experimental data to calculate the rate of a reaction.	B	A	1
iv.	[SLO: C-11-B-84] Explain the factors affecting the electron affinities of elements.	B	U	1
v.	[SLO: C-11-B-75] Describe that chemical reactions are accompanied by enthalpy changes and these changes can be exothermic (ΔH is negative) or endothermic (ΔH is positive).	B	U	1
vi.	[SLO: C-11-B-73] State the volume of one mole of a gas at STP.	B	K	1
vii.	[SLO: C-11-E-28] Describe the mechanism of electrophilic addition in alkenes, using bromine/ethene as example.	E	U	1
viii.	[SLO: C-11-E-48] Deduce the nature (aldehyde or ketone) of an unknown carbonyl compound from the results of simple tests (Fehling's and Tollens' reagents; ease of oxidation).	E	K	1
ix.	[SLO: C-11-E-18] Describe the mechanism of free radical substitution in alkanes exemplified by methane and ethane.	E	U	1
x.	[SLO: C-11-B-35] Describe the shapes and bond angles in molecules using VSEPR theory (including describing by sketching),	B	U	1
xi.	[[SLO: C-11-C-17] Deduce the nature, possible position in the Periodic Table and identity of unknown elements from given information about physical and chemical properties.	C	U	1
xii.	[SLO: C-11-E-142 Use the concept of hydrolysis to explain why aqueous solutions of some salts are acidic or basic.	E	U	1
xiii.	[SLO: C-11-E-54] Define primary and secondary amines, and explain their basic properties and reactivity.	E	U	1
xiv.	[SLO: C-11-E-07] Describe terminology associated with the types of organic compounds and reactions (Some examples include: homologous series, saturated and unsaturated, homolytic and heterolytic fission, free radical, initiation, propagation, termination, nucleophile, electrophile, nucleophilic, electrophilic, addition, substitution, elimination, hydrolysis, condensation, oxidation and reduction)	E	U	1
xv.	[SLO: C-11-E-45] Describe: a. the reduction of aldehydes and ketones, using NaBH_4 or LiAlH_4 to produce alcohols.	E	U	1

xvi.	[SLO: C-11-B-63] Explain the strength and applications of dipole-dipole forces, hydrogen bonding and London forces.	B	U	1
xvii.	[SLO: C-11-E-49] Deduce the presence of a CH ₃ CO – group in an aldehyde or ketone, CH ₃ CO–R, from its reaction with alkaline I ₂ (aq) to form a yellow precipitate of tri-iodomethane and an ion, RCOO(–).	E	U	1

SECTION- B

Q. 2. Attempt the following questions.

(14x3 = 42)

Q No	SLO	Marks	Cognitive level	Domain	SLO	Marks	Cognitive level	Domain
(i)	[SLO: C-11-C-13] Explain with equations for, the reactions of the chlorides with water including the likely pH of the solutions obtained.	1.5+ 1.5	U	C	OR [SLO: C-11-B-18] Describe the shapes of s, p and d orbitals.	3	U	C
(ii)	[SLO: C-11-E-52] Recall the reaction (reagents and conditions) by which esters can be produced: the condensation reaction between an alcohol and a carboxylic acid with concentrated H_2SO_4 as catalyst.	03	K	E	OR [SLO: C-11-B-73] Differentiate between amorphous and crystalline solids.	1.5+ 1.5	K	C
(iii)	[SLO: C-11-E-32] Describe nucleophilic substitution reactions (specifically: a. the reaction with $NaOH(aq)$ and heat to produce an alcohol. [SLO: C-11-E-33] Describe the elimination reaction with $NaOH$ in ethanol and heat to produce an alkene.	3	U	E	OR [SLO: C-11-C-26] Describe the relative reactivity of halide ions as reducing agents.	1.5+ 1.5	U	B
(iv)	[SLO: C-11-B-79] Calculate the bond energies for the enthalpy change of reaction, ΔH	03	A	B	OR [SLO: C-11-B-52] Calculate the maximum amount of product and amount of any unreacted excess reagent.	1+2	A	B
(v)	[SLO: C-11-B-93] Explain the sign of the entropy changes that occur during a change in state, temperature change and a reaction in which there is a change in the number of gaseous molecules.	03	U	E	OR [SLO:C-11-B-41] Explain the paramagnetic nature of Oxygen molecule in the light of MOT.	03	U	B
(vi)	[SLO: C-11-E-24] Explain dehydration of alcohols and dehydrohalogenation of RX for the preparation of ethene.	1.5+ 1.5	U	E	OR [SLO: C-11-B-63] Explain the strength and applications of dipole-dipole forces, hydrogen bonding and London forces.	2+1	U	E

(vii)	[SLO: C-11-E-34] State the reactions (reagents and conditions) by which alcohols can be produced: a) electrophilic addition of steam to an alkene, H ₂ O(g) and H ₃ PO ₄ catalyst b) reaction of alkenes with cold dilute acidified potassium manganate(VII) to form a diol c) substitution of a halogenoalkane using NaOH (aq) and heat d) reduction of an aldehyde or ketone using NaBH ₄ or LiAlH ₄ e) reduction of a carboxylic acid using LiAlH ₄ f) hydrolysis of an ester using dilute acid or dilute alkali and heat.	1.5+ 1.5	K	E	OR	[SLO: C-11-E-08] Define catenation and explain its importance in organic chemistry.	1+2	K	E
(viii)	[SLO: C-11-C-35] Explain the role of NO and NO ₂ in the formation of photochemical smog, specifically in the reaction with unburned hydrocarbons to form Peroxyacetyl nitrate (PAN).	1+2	U	C	OR	[SLO: C-11-E-18] Describe the mechanism of free radical substitution in alkanes exemplified by methane and ethane.	03	U	E
(ix)	[SLO: C-11-F-06] Determine the electronic configuration of elements and their ions with proton numbers. (Some examples include: a. simple configuration e.g. a). 2,8, b). subshells e.g. 1s ² , 2s ² , 2p ⁶ , 3s ¹ c). Students should be able to determine both of these from the periodic table and are not required to memorize these.	1.5 +1.5	K	F	OR	[SLO: C-11-B-118] State the necessary conditions for equilibrium and the ways that equilibrium can be recognized.	1.5+ 1.5	K	B
(x)	[SLO: C-11-E-59] Identify organic functional groups using the reactions in this progression grid.	1.5+ 1.5	U	E	OR	[SLO: C-11-E-56] Describe the preparation methods of primary and secondary amines, including nucleophilic substitution reactions and reduction of nitro compounds.	1.5+ 1.5	U	E
(xi)	[SLO: C-11-B-27] Perform calculations involving non-integer relative atomic masses and abundance of isotopes from given data, including mass spectra.	1+2	A	B	OR	[SLO: C-11-B-139] Calculate k _{sp} from concentration and vice versa.	1.5+ 1.5	A	B

(xii)	[SLO: C-11-B-10] Relate Quantum Numbers to Electronic distribution of elements.	1+1+1	K	B	OR	[SLO: C-11-B-82] Define terms such as enthalpy change of atomization, ΔH_{atom} , lattice energy, $\Delta H_{\text{lattice}}$, first electron affinity, EA	1.5+1.5	K	B
(xiii)	[SLO: C-11-B-29] Define electronegativity as the power of an atom to attract electrons to itself.	1+2	K	B	OR	[SLO: C-11-B-55] Use the volume of one mole of gas at STP to solve mole volume problem.	03	K	B
(xiv)	SLO: C-11-B-65] Apply the concept of hydrogen bonding to explain the properties of water (specifically high surface tension, high specific heat, low vapor pressure, high heat of vaporization, and high boiling point)	1+2	A	B	OR	[SLO: C-11-B-136] Calculate the pH of buffer solutions in given appropriate data.	1+2	A	B

SECTION – C (Marks 26)

Note: Attempt the following questions

Q No	SLO	Marks	Cognitive level	Domain		SLO	Marks	Cognitive level	Domain
Q No3	[SLO: C-11-B-113]. Calculate the numerical value of a rate constant using the initial rates and half-life method.	3+3	A	B	O R	[SLO: C-11-B-52] Calculate the maximum amount of product and amount of any unreacted excess reagent.	3+3	A	B
Q No4	[SLO: C-11-E-50] Recall the reactions by which carboxylic acids can be produced: a) oxidation of primary alcohols and aldehydes with acidified $\text{K}_2\text{Cr}_2\text{O}_7$ or acidified KMnO_4 and refluxing b) hydrolysis of nitriles with dilute acid or dilute alkali followed by acidification c) hydrolysis of esters with dilute acid or dilute alkali and heat followed by acidification.	2+2+2	K	E	O R	[SLO: C-11-B-126] State Le Chatelier's Principle and be able to apply it to systems in equilibrium with changes in concentration, pressure, temperature, or the addition of catalyst.	2+2	K	B

Q No 5	[SLO: C-11-E-23] Explain with suitable examples the terms isomerism, stereoisomerism and structural isomerism.	6+1	U	E	O R	[SLO: C-11-E-30] Classify halogenoalkanes based on the type of halogen atom and its position in the carbon chain, and explain how the molecular structure affects their reactivity. [SLO: C-11-E-32] Describe nucleophilic substitution reactions (specifically: d. the reaction with aqueous silver nitrate in ethanol as a method of identifying the halogen present as exemplified by bromoethane.)	3+4	U	E
Q No 6	[SLO: C-11-E-31] Explain the organic functional groups substitution of an alcohol, e.g. by reaction with HX or KBr with H_2SO_4 or H_3PO_4 ; or with PCl_3 and heat; or with PCl_5 ; or with SOCl_2 .	1+6	U	E	O R	[SLO: C-11-B-37] Explain hybridization and types of hybridization.	1+6	U	B

Table of Specification of the Model Paper Grade---XI, (HSSC-I)

Domain	A	B								C		
Cognitive Levels	History of Chemistry	Atomic Structure	Chemical Bonding	Stoichiometry	States and Phases of Matter	Energetics	Chemical Kinetics	Chemical Equilibrium	Acids – Bases Chemistry	Periodic Table	Nitrogen and Sulphur	Group 17
Knowledge	Formative	Q2(xii/f)(3) Q2(ix/f)(3)	Q2(xiii/f)(3)	Q2(xiii/s)(3) Q1(vi)(1)	Q2(ii/s)3	Q2(xii/s)(3)		Q4(s)(6) Q2(ix/s)(3)				
Understanding		Q2(i/s)(3)	Q2(v/s)(3) Q6(s)(7) Q1(x)(1)		Q1(xvi)(1) Q2(vi/s)(3)	Q1(v)(1) Q1(iv)(1) Q2(v/f)(3)	Q1(ii)(1)		Q1(xii)(1)	Q2(viii/s)(3) Q2(i/f)(3) Q1(xi)(1)	Q2(viii/f)(3)	Q2(iii/s)(3)
Application		Q2(xi/f)(3)		Q2(iv/s)(3) Q3(s)(6) Q1(i)(1)	Q2(xiv/f)(3)	Q2(iv/f)(3)	Q3(f)(6) Q1(iii)(1)		Q2(xi/s)(3) Q2(xiv/s)(3)			
Total	0	12	14	14	10	11	8	9	7	7	3	3
Content %	0	7.84	9.15	9.15	6.53	7.19	5.22	5.88	4.58	4.58	1.97	1.97

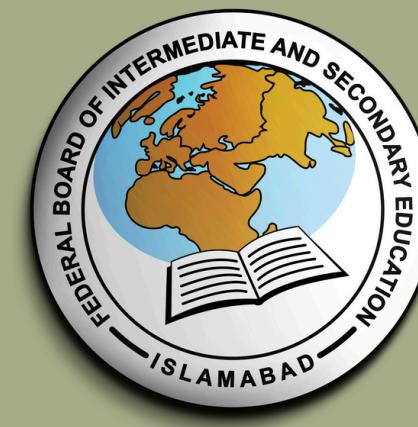
Cont

Cognitive Levels	E								F	Total	%	
	Environmental Chemistry-Air	Environmental Chemistry-Water	Organic Chemistry	Hydrocarbons	Halogeno alkanes	Hydroxy Compounds	Carbonyl Compounds	Nitrogen Compound s- Amines	Organic Synthesis			
Knowledge	Formativ e	Formative	Q2(vii/s)(3)			Q2(vii/f)(3)	Q1(viii)(1) Q4(f)(6) Q2(ii/f)(3)			Formative	44	29
Understanding			Q1(xiv)(1)	Q2(vi/f)(3) Q5(f)(7) Q1(ix)(1) Q1(vii)(1)	Q2(iii/f)(3) Q5(s)(7)	Q6(f)(7)	Q1(xv)(1) Q1(xvii)(1)	Q2(x/s)(3) Q1(xiii)(1)	Q2(x/f)(3)		77	50
Application											32	21
Total	0	0	4	12	10	10	12	04	3	0	153	100
Content %	0	0	2.62	7.84	6.53	6.53	7.85	2.62	1.97	0		100

Note:

- 1 This ToS does not reflect policy, but it is particular to this model question paper.
- 2 Proportionate / equitable representation of the content areas may be ensured.
- 3 The percentage of cognitive Level is 30%, 50%, and 20% for knowledge, understanding, and application, respectively with **± 5%** variation.
- 4 While selecting alternative questions for Short Response Questions (SRQs) and Extended Response Questions (ERQs), it must be kept in mind that:
 - Difficulty levels of two alternative questions of the internal choice will be same
 - SLOs of the two alternative questions of the internal choice must be different

Key: Question Number (part/ first choice) marks. Example: **Q2 (i/f) 3**, Question Number (part/second choice) marks. Example: **Q2 (i/s) 3**



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