

ASSESSMENT FRAMEWORK AND MODEL QUESTION PAPER

CHEMISTRY

Grade XII

NATIONAL CURRICULUM OF PAKISTAN
2022-23



SCHEME OF STUDIES 2006



FEDERAL BOARD
OF INTERMEDIATE AND SECONDARY
EDUCATION, ISLAMABAD

WE WORK FOR
EXCELLENCE



FEDERAL BOARD OF INTERMEDIATE AND SECONDARY EDUCATION

H-8/4, ISLAMABAD



ASSESSMENT FRAMEWORK
FOR
CHEMISTRY GRADE-XII
CURRICULUM 2022-23
SCHEME OF STUDIES 2006

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-XII. 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-XII 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 for Girls, Nilore, Islamabad
2. Mr. Naeem Mushtaq, Associate Professor, Islamabad Model College for Boys, G-10/4, Islamabad
3. Ms. Javeria Gul, HOD Chemistry, Pak Turk Muarrif International School, Islamabad
4. Ms. Aliya Sajid, Lecturer, Army Public School & College, Pasban, Rawalpindi

The whole work was successfully accomplished under the able supervision and guidance of Dr. Ikram Ali Malik, 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 Assessment Framework.

MIRZA ALI
Director (Test Development)
FBISE, Islamabad

ASSESSMENT FRAMEWORK FOR CHEMISTRY GRADE-XII, 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 GRADE-XII (HSSC-II)
Details of Content Areas/ SLOs

Domains	Content Area	SLO No.	SLO Description	Cognitive Level	Type of Assessment (Formative or Summative)	Remarks	Time allocation (Lectures)
A Nature of Science in Chemistry	Ethics and Values in Chemistry	[SLO:C-12-A-01]	Identify common cognitive biases/fallacies that can hinder sound scientific reasoning in physical sciences (Some examples include: <ul style="list-style-type: none"> ● the confirmation bias ● hasty generalizations ● post hoc ergo propter hoc (false cause) ● the straw man fallacy ● redefinition (moving the goalposts) ● the appeal to tradition ● false authority ● failing Occam's Razor ● argument from non-testable hypothesis ● begging the question ● fallacy of exclusion ● faulty analogy 	Understanding	Formative	Question(s) will not be given in the annual examination; however, it will be the part of classroom teaching.	02
		[SLO: C-12-A-02]	Explain the pros and cons of ethical considerations involved in the production and use of chemical substances and processes (Some examples include: the impact on human health and the environment; the responsibility of scientists and companies; the role of regulations and laws).	Understanding	Formative		
		[SLO: C-12-A-03]	Explain and apply the following terms to deconstruct the structure of a scientific argument	Application	Formative		

Domains	Content Area	SLO No.	SLO Description	Cognitive Level	Type of Assessment (Formative or Summative)	Remarks	Time allocation (Lectures)
			in a variety of formats such as speeches, written articles and advertisement brochures: <ul style="list-style-type: none">● claims● counterclaims● rebuttals● premises● conclusions● assumptions				
B Physical Chemistry	Electrochemistry	[SLO: C-12-B-01]	Apply the concept of oxidation numbers in identifying oxidation and reduction reactions	Application	Summative for theory	Question(s) will be given in the annual examination.	14
		[SL0: C-12-B-02]	Apply the concept of changes in oxidation numbers to balance chemical equations	Application	Summative for theory		
		[SL0: C-12-B-03]	Define the terms. redox, oxidation, reduction, and disproportionation (in terms of electron transfer and changes in oxidation number).	Understanding	Summative for theory		
		[SLO: C-12-B-04]	Identify the reducing agents in a redox reaction	Understanding	Summative for theory		
		[SLO: C-12-B-05]	Describe the role of oxidizing land reducing agents in the redox reaction	Understanding	Summative for theory		
		[SLO: C-12-B-06]	Explain the concept of the activity series of metals and how it relates to the ease of oxidation	Understanding	Summative for theory		
		[SLO: C-12-8-07]	Deduce the feasibility of redox reactions from activity series or reaction data.	Understanding	Summative for theory		
		[SLO: C-12-B-08]	Explain the use of the Winkler Method to measure biochemical oxygen demand (BOD) and its use as a measure of water pollution.	Understanding	Formative	Already discussed in SSC level, that is why it will not be the part of annual examination.	
		[SLO: C-12-B-09]	Explain how electrolytic cells convert electrical energy to chemical energy, with oxidation at the anode and reduction at the cathode.	Understanding	Formative		

Domains	Content Area	SLO No.	SLO Description	Cognitive Level	Type of Assessment (Formative or Summative)	Remarks	Time allocation (Lectures)
		[SLO: C-12-B-10]	Predict the identities of substances liberated during electrolysis based on the state of the electrolyte, position in the redox series, and concentration.	Knowledge	Summative for theory	Question(s) will be given in the annual examination.	
		[SLO: C-12-8-11]	Apply the relationship between the Faraday constant, Avogadro constant, and the charge on the electron to solve problems.	Application	Summative for theory	Question(s) will be given in the annual examination.	
		[SLO: C-12-B-12]	Calculate the quantity of charge passed during electrolysis and the mass or volume of substance liberated during electrolysis.	Application	Summative for theory		
		[SLO: C-12-B-13]	Deduce the Avogadro constant by an electrolytic method	Understanding	Summative for theory		
		[SLO: C-12-B-14]	Define the terms standard electrode potential and standard cell potential	Understanding	Summative for theory		
		[SLO: C-12-B-15]	Describe the standard hydrogen electrode and methods used to measure standard electrode potentials.	Understanding	Summative for theory		
		[SL0: C-12-B-16]	Calculate the standard cell potentials by combining the potentials of two standard electrodes and then use these to predict the feasibility of a reaction and the direction of electron flow in a simple cell.	Application	Summative for theory		
		[SLO: C-12-8-17]	Deduce the relative reactivity of elements, compounds, and as oxidizing agents or reducing agents from their electrode potential values.	Understanding	Summative for theory		
		[SLO: C-12-B-18]	Construct redox equations using relevant half-equations.	Application	Summative for theory		
		[SLO: C-12-B-19]	Explain how electrode potentials vary with the concentrations of aqueous ions and use the Nernst equation to predict, this quantitatively.	Understanding	Formative	Question(s) will not be given in the annual	

Domains	Content Area	SLO No.	SLO Description	Cognitive Level	Type of Assessment (Formative or Summative)	Remarks	Time allocation (Lectures)
						examination; however, it will be the part of classroom teaching.	
		[SLO: C-12-B-20]	Explain how voltaic (galvanic) cells convert energy from spontaneous, exothermic chemical processes to electrical energy with oxidation at the anode and reduction at the cathode.	Understanding	Summative for theory	Question(s) will be given in the annual examination.	
		[SLO: C-12-B-21]	Explain how voltaic cells convert chemical energy from redox reactions to electrical energy using Cu-Zn galvanic cell as an example	Understanding	Summative for theory		
	Chemical Equilibrium	[SLO: C-12-B-22]	Explain common ion effects giving suitable examples.	Understanding	Formative	Already discussed in XI Class, Question(s) will not be given in the annual examination; however, it will be the part of classroom teaching.	06
		[SLO: C-12-B-23]	Use the extent of ionization and the acid dissociation constant, K_a to distinguish between strong and weak acids.	Applications	Formative		
		[SLO: C-12-B-24]	Use the extent of ionization and the base dissociation constant, K_b , to distinguish between strong and weak bases.	Applications	Summative for theory	Question(s) will be given in the annual examination.	
		[SLO: C-12-B-25]	Explain what is meant by a chemical buffer and how a buffer system works. (For context this should include: a. Defining what is a buffer solution b. Explaining how buffer solution can be made	Understanding	Summative for theory		

Domains	Content Area	SLO No.	SLO Description	Cognitive Level	Type of Assessment (Formative or Summative)	Remarks	Time allocation (Lectures)
			c. Explaining how buffer solutions control pH; use chemical equations in these explanations d. Describe and explain the uses of buffer solutions including the role of HCO_3^{1-} in controlling PH in blood.				
		[SLO: C-12-B-26]	Calculate concentration of ions of slightly soluble salts.	Applications	Formative	Already discussed in XI Class, Question(s) will not be given in the annual examination; however, it will be the part of classroom teaching.	
		[SLO: C-12-B-27]	State what is meant by the term partition coefficient, K_{pc} ?	Knowledge	Summative for theory	Question(s) will be given in the annual examination.	
		[SLO: C-12-B-28]	Calculate a partition coefficient for a system in which the solute is in the same physical state in the two solvents.	Applications	Summative for theory		
		[SLO: C-12-B-29]	Explain the factors affecting the numerical value of a partition coefficient in terms of the polarities of the solute and the solvents used	Understanding	Summative for theory		
	Acid-Base Chemistry	[SL0: C-12-B-30]	State that $\text{pH} = -\log[\text{H}^+(\text{aq})]$ and $[\text{H}^+] = 10(\text{to the power})-\text{pH}$.	Knowledge	Formative	Already discussed in XI Class, Question(s) will not be given in the annual examination; however, it will be	02
		[SL0: C-12-B-31]	State that change of one pH unit represents a 10-fold change in the hydrogen ion concentration $[\text{H}^+]$.	Knowledge	Formative		
		[5L0: C-12-B-32]	Use the ionic product constant, $K_w = [\text{H}^{1+}][\text{OH}^{1-}] = 10^{-14}$ at 298 K to solve problems.	Application	Formative		

Domains	Content Area	SLO No.	SLO Description	Cognitive Level	Type of Assessment (Formative or Summative)	Remarks	Time allocation (Lectures)
						the part of classroom teaching.	
		[SLO: C-12-B-33]	Sketch the pH titration curves of titrations using combinations of strong and weak acids with strong and weak alkalis	Application	Summative for theory	Question(s) will be given in the annual examination.	
C Inorganic Chemistry	Group 2	[SLO: C-12-C-01]	Describe the properties and trends of Group 2 elements, including their electron configurations, reactivity, and common compounds such as oxides, hydroxides and carbonates.	Understanding	Summative for theory	Question(s) will be given in the annual examination.	10
		[SLO: C-12-C-02]	Explain the chemical reactivity, of Group 2 elements, including their reactions with oxygen, water, and acids (Be, Mg, Ca).	Understanding	Summative for theory		
		[SLO: C-12-C-03]	Explain the reactivity of Group 2 elements in terms of their electron configuration and valence electrons.	Understanding	Summative for theory		
		[SLO: C-12-C-04]	Describe the industrial and everyday uses of Group 2 compounds, including their role in medicine and agriculture.	Knowledge	Summative for theory		
		[SLO: C-12-C-05]	Explain the term reactivity series and its application in predicting the outcome of chemical reactions.	Understanding	Summative for theory		
		[SLO: C-12-C-06]	Use the term reactivity series and its application in predicting the outcome of chemical reactions.	Application	Summative for theory		
		[SLO: C-12-C-07]	Explain the extraction and purification process of Group elements and their compounds.	Understanding	Summative for theory		
		[SLO: C-12-C-08]	Understand the term thermal decomposition and its application in the analysis of Group 2 compounds especially carbonates and nitrates.	Understanding	Summative for theory		

Domains	Content Area	SLO No.	SLO Description	Cognitive Level	Type of Assessment (Formative or Summative)	Remarks	Time allocation (Lectures)
		[SLO: C-12-C-09]	Use the term thermal decomposition and its application in the analysis of Group 2 compounds especially carbonates and nitrates.	Application	Summative for theory		
		[SLO: C-12-C-10]	Explain the trend in solubility of group 2 sulfates and hydroxides using terms enthalpy of hydration and enthalpy of solution	Understanding	Summative for theory		
		[SLO: C-12-C-11]	Compare the properties and reactivity of Group 2 elements with group 1 in the periodic table.	Understanding	Summative for theory		
		[SLO: C-12-C-12]	Explain the term complex ion and its application in the formation of Group 2 compounds.	Understanding	Formative	Question(s) will not be given in the annual examination; however, it will be the part of classroom teaching.	
		[SLO: C-12-C-13]	Explain the term basic oxide and its application in the formation of Group 2 compounds.	Understanding	Summative for theory	Question(s) will be given in the annual examination.	
		[SLO: C-12-C-14]	Describe qualitatively the trend in the thermal stability of the nitrates and carbonates including the effect of ionic radius on the polarization of the large anion.	Understanding	Summative for theory		
		[SLO: C-12-C-15]	Describe qualitatively the variation in solubility and of enthalpy change of solution, ΔH_{sol} , of the hydroxides and sulfates in terms of relative magnitudes of the enthalpy change of hydration and the lattice energy.	Understanding	Summative for theory		
	Transition Metals	[SLO: C-12-C-16]	Identify the general physical and chemical properties of the first row of transition elements, titanium to copper.	Understanding	Summative for theory	Question(s) will be given in the annual examination.	16

Domains	Content Area	SLO No.	SLO Description	Cognitive Level	Type of Assessment (Formative or Summative)	Remarks	Time allocation (Lectures)
		[SLO: C-12-C-17]	Define a transition element as a d block element which forms one or more stable ions with incomplete d orbitals.	Understanding	Summative for theory	Already discussed in XI Class, Question(s) will not be given in the annual examination; however, it will be the part of classroom teaching.	
		[SLO:C-12-C-18]	Sketch the shape of 3dxy orbital and 3dxz orbital	Application	Formative		
		[SLO: C-12-C-19]	Identify the properties of transition elements Some examples include: a. they have variable oxidation states b. they behave as , catalysts c. they form complex ions d. they form coloured compounds.	Understanding	Summative for theory		
		[SLO: C-12-C-20]	Explain why transition elements. have variable oxidation states in terms of the similarity in energy of the 3d and the 4s subshells	Understanding	Summative for theory		
		[SLO: C-12-C-21]	Explain why transition elements behave as catalysts in terms of having more than one stable oxidation state, and vacant d orbitals that are energetically accessible and can form dative bonds with ligands	Understanding	Summative for theory		
		[SLO: C-12-C-22]	Explain why transition elements form complex ions in terms of vacant d orbitals that are energetically accessible	Understanding	Summative for theory		
		[SLO: C-12-C-23]	Explain the reactions of transition elements. with ligands to form complexes, including the	Understanding	Summative for theory		

Domains	Content Area	SLO No.	SLO Description	Cognitive Level	Type of Assessment (Formative or Summative)	Remarks	Time allocation (Lectures)
			complexes of copper(II) and cobalt(II) ions with water and ammonia molecules and hydroxide and chloride ions				
		[SLO: C-12-C-24]	Define the term ligand as a species that contains a lone pair of electrons that forms a dative covalent bond to a central metal atom /ion.	Understanding	Summative for theory		
		[SLO: C-12-C-25]	Use the term monodentate ligand including as examples H ₂ O, NH ₃ , Cl ¹⁻ and CN ¹⁻	Application	Summative for theory		
		[SLO: C-12-C-26]	Use the term bidentate ligand including as examples 1,2-Diaminoethane, H ₂ NCH ₂ CH ₂ NH ₂ , and the ethanedioate ion, C ₂ O ₄ ²⁻ , polydentate ligand including as an example EDTA	Application	Summative for theory		
		[SLO: C-12-C-27]	Define the term complex as a molecule or ion formed by a central metal atom / ion surrounded by one or more ligands	Understanding	Summative for theory		
		[SLO: C-12-C-28]	Describe the geometry (shape and bond angles) of transition element complexes which are linear, square planar, tetrahedral or octahedral.	Understanding	Summative for theory		
		[SLO: C-12-C-29]	State what is meant by coordination number?	Knowledge	Summative for theory		
		[SLO: C-12-C-30]	Predict the formula and charge of a complex ion, given the metal ion, its charge or oxidation state, the ligand and its coordination number or , Geometry.	Application	Summative for theory		
		[SLO: C-12-C-31]	Explain qualitatively that ligand exchange can occur, including the complexes of copper (II) ions and cobalt (I) ions with water and ammonia molecules and hydroxide and chloride ions.	Understanding	Formative	Question(s) will not be given in the annual examination; however, it will be	

Domains	Content Area	SLO No.	SLO Description	Cognitive Level	Type of Assessment (Formative or Summative)	Remarks	Time allocation (Lectures)
						the part of classroom teaching.	
		[SLO: C-12-C-32]	Predict, using E^0 values, the feasibility of redox reactions involving transition elements and their ions.	Application	Summative for theory	Question(s) will be given in the annual examination.	
		[SLO: C-12-C-33]	Analyze reactions involving $\text{MnO}_4^{2-}/\text{C}_2\text{O}_4^{2-}$, in acid solution given suitable data (including describing the reaction and doing calculations).	Application	Formative for theory Summative for PBA	In the annual examination Question(s) will be given in the practical based assessment paper, not in the theory paper.	
		[SLO: C-12-C-34]	Analyze reactions involving $\text{MnO}_4^{1-}/\text{Fe}^{2+}$ in acid solution given suitable data (including describing the reaction and doing calculations)	Application	Formative for theory Summative for PBA	Question(s) will be given in the annual examination.	
		[SLO: C-12-C-35]	Analyze reactions involving $\text{Cu}^{2+}/\text{I}^-$ given suitable data (including describing the reactions and doing calculations) perform calculations involving other redox systems given suitable data.	Application	Summative for theory	Question(s) will be given in the annual examination.	
		[SLO: C-12-C-36]	Perform calculations involving other redox systems given suitable data.	Application	Formative for theory Summative for PBA	In the annual examination Question(s) will be given in the practical based assessment paper, not in the theory paper.	
		[SLO: C-12-C-37]	Explain why transition elements form coloured compounds in terms of the frequency of light absorbed as an electron is promoted between two non- degenerate d, orbitals	Application	Summative for theory	Question(s) will be given in the annual examination.	

Domains	Content Area	SLO No.	SLO Description	Cognitive Level	Type of Assessment (Formative or Summative)	Remarks	Time allocation (Lectures)
		[SLO: C-12-C-38]	Describe the splitting of degenerate d orbitals into two non-degenerate sets of d orbitals of higher energy and use of ΔE in: a. octahedral complexes, two higher and three lower d orbitals b. tetrahedral complexes, three higher and two lower d orbitals.	Understanding	Summative for theory		
		[SLO: C-12-C-39]	Explain why transition elements form coloured compounds in terms of the frequency of light absorbed as an electron is promoted between two non- degenerate d, orbitals.	Understanding	Summative for theory		
		[SLO: C-12-C-40]	Describe, in qualitative terms, the effects of different ligands on ΔE, frequency of light absorbed, and hence the complementary colour that is observed.	Understanding	Summative for theory		
		[SLO: C-12-C-41]	Use the complexes of copper (I) ions and cobalt (II) ions with water and ammonia molecules and hydroxide, chloride ions as examples of ligand exchange affecting the colour observed.	Applications	Formative		
		[SLO: C-12-C-42]	Stereoisomerism in transition element complexes. Describe the types of stereoisomerism shown by complexes, including those associated with bidentate ligands: a. geometrical (cis-trans) isomerism, e.g. square planar such as [Pt(NH ₃) ₂ Cl ₂] and octahedral such as [Co(NH ₃) ₄ (H ₂ O) ₂] ²⁺ and [Ni(H ₂ NCH ₂ CH ₂ NH ₂) ₂ (H ₂ O) ₂] b. Optical isomerism, e.g. [Ni(H ₂ NCH ₂ CH ₂ NH ₂) ₃] ²⁺ and	Understanding	Formative		

Domains	Content Area	SLO No.	SLO Description	Cognitive Level	Type of Assessment (Formative or Summative)	Remarks	Time allocation (Lectures)
			$[\text{Ni}(\text{H}_2\text{NCH}_2\text{CH}_2\text{NH}_2)_2(\text{H}_2\text{O})_2]^{2+}$.			Question(s) will be given in the annual examination.	
		[SLO: C-12-C-43]	Deduce the overall polarity of complexes	Understanding	Summative for theory		
		[SLO: C-12-C-44]	Define the stability constant, K_{stab} , of a complex as the equilibrium constant for the formation of the complex ion in a solvent (from its constituent ions or molecules).	Understanding	Summative for theory		
		[SLO: C-12-C-45]	Write an expression for a K_{stab} of a complex $[\text{H}_2\text{O}]$ should not be included).	Application	Summative for theory		
		[SLO: C-12-C-46]	Use K_{stab} expressions to perform calculations.	Application	Summative for theory		
		[SLO: C-12-C-47]	Explain ligand exchanges in terms of K_{stab} values and understand that a large K_{stab} is due to the formation of a stable complex ion.	Understanding	Formative	Question(s) will not be given in the annual examination; however, it will be the part of classroom teaching.	
E Organic Chemistry	Organic Chemistry	SLO: C-12-E-01	Explain stereoisomerism and its division into geometrical (cis/trans) and optical isomerism.	Understanding	Summative for theory	Question(s) will be given in the annual examination.	08
		SLO: C-12-E-02	Describe geometrical (cis/trans) isomerism in alkenes, and explain its origin in terms of restricted rotation due to the presence of π bonds.	Understanding	Summative for theory		
		[SLO: C-12-E03]	Describe the shape of benzene and other aromatic molecules, including sp^2 hybridization, in terms of σ bonds and a delocalized π system.	Understanding	Summative for theory		
		SLO: C-12-E-04	Explain what is meant by a chiral center and that such a center gives rise to two optical isomers (enantiomers).	Understanding	Summative for theory		

Domains	Content Area	SLO No.	SLO Description	Cognitive Level	Type of Assessment (Formative or Summative)	Remarks	Time allocation (Lectures)
		SLO: C-12-E-05	Describe that enantiomers have identical physical and chemical properties except for their ability to rotate plane- polarized light and potential biological activity.	Understanding	Summative for theory		
		[SLO: C-12-E-06]	Apply the terms optically active, racemic mixture and meso compounds on given structure.	Application	Summative for theory		
		[SLO: C-12-E-07]	Describe the effect of two optical isomers of a single substance on a plane polarized light.	Understanding	Summative for theory		
		[SLO: C-12-E-08]	Explain the significance of chirality in the synthetic preparation of drug molecules, including the potential different biological activity of enantiomers, the need to separate racemic mixtures, and the use of chiral catalysts to produce a single pure optical isomer using thalidomide as an example when describing the arrangement of atoms in organic molecules.	Understanding	Formative	Question(s) will not be given in the annual examination; however, it will be the part of classroom teaching.	
	Hydrocarbon	[SLO: C-12-E-09]	Explain the shape of the benzene molecule (molecular/orbital aspect).	Understanding	Summative for theory	Question(s) will be given in the annual examination.	10
		[SLO: C-12-E-10]	Define resonance, resonance energy and relative stability of benzene.	Understanding	Summative for theory		
		[SLO: C-12-E-11]	Compare the reactivity of benzene with alkanes and alkenes.	Understanding	Summative for theory		
		[SLO: C-12-E-12]	Describe the mechanism of substitution reactions with chlorine and bromine, including the formation of ortho, para, and meta isomers, and predict the major product(s) of the reaction.	Understanding	Summative for theory		
		[SLO: C-12-E-13]	Explain the mechanism of nitration, including the formation of a nitronium ion, and predict the major product(s) of the reaction.	Understanding	Summative for theory		

Domains	Content Area	SLO No.	SLO Description	Cognitive Level	Type of Assessment (Formative or Summative)	Remarks	Time allocation (Lectures)
		[SLO: C-12-E-14]	Explain the mechanism of Friedel-Crafts alkylation and acylation, respectively, including the role of the Lewis acid catalyst, and predict the major product(s) of the reaction.	Understanding	Summative for theory		
		[SLO: C-12-E-15]	Explain the mechanism of side chain oxidation, including the formation of a benzoic acid, and predict the major product(s) of the reaction.	Understanding	Summative for theory		
		[SLD C-12-E-16]	Explain the mechanism of hydrogenation, including the role of a metal catalyst, and predict the major product(s) of the reaction, which is cyclohexane.	Understanding	Summative for theory		
		[SLO: C-12-E-17]	Describe the mechanism of electrophilic aromatic substitution, including the role of the electrophile and the formation of a sigma complex, and predict the major product(s) of the reaction based on the directing effects of substituents on the aromatic ring.	Understanding	Summative for theory		
	Halogenoalkanes	[SLO: C-12-E-18]	Describe production of halogenoarenes i.e. reaction of benzene with Cl_2 and Br_2 in the presence of catalyst	Understanding	Summative for theory	Question(s) will be given in the annual examination.	07
		[SLO: C-12-E-19]	Compare the reactivity of halogenoalkane and halogenoarenes using chloroethane and chlorobenzene as examples.	Understanding	Summative for theory		
		[SLO: C-12-E-20]	Predict the major product(s) based on the reaction conditions and the molecular structure of the halogenoalkane.	Understanding	Summative for theory		
		[SLO: C-12-E-21]	Analyze the mechanism and products of a reaction pathway involving a halogenoalkane, and use retro- synthesis to deduce the starting materials.	Understanding	Summative for theory		

Domains	Content Area	SLO No.	SLO Description	Cognitive Level	Type of Assessment (Formative or Summative)	Remarks	Time allocation (Lectures)
		[SLO: C-12-E-22]	Describe the SN1 and SN2 mechanisms of nucleophilic substitution in halogenoalkanes including the inductive effects of alkyl groups.	Understanding	Summative for theory		
		[SLO: C-12-E-23]	Identify that primary halogenoalkanes tend to react via the SN2 mechanism; tertiary halogenoalkanes via the SN1 mechanism; and secondary halogenoalkanes by a mixture of the two, depending on structure.	Knowledge	Summative for theory		
		[SLO: C-12-E-24]	Explain the different reactivities of halogenoalkanes (with particular reference to the relative strengths of the C-X bonds as exemplified by the reactions of halogenoalkanes with aqueous silver nitrates).	Understanding	Formative	Already discussed in XI Class, Question(s) will not be given in the annual examination; however, it will be the part of classroom teaching.	
	Hydroxy Compounds	[SLO: C-12-E-25]	Describe the reaction with acyl chlorides to form - esters using ethyl ethanoate.	Understanding	Summative for theory	Question(s) will be given in the annual examination.	06
		[SLO: C-12-E-26]	Recall the reactions (reagents and conditions) by which phenol can be produced: reaction of phenylamine with HNO ₃ or NaNO ₃ , and dilute acid below 1°C to produce the diazonium salt; further warming of the diazonium salt with H ₂ O to give phenol.	Knowledge	Summative for theory		
		[SLO: C-12-E-27]	Recall the chemistry of phenol, as exemplified by the following reactions: a. with bases, for example NaOH (aq) to produce sodium phenoxide b. with Na(s) to produce sodium phenoxide and H ₂ (g)	Knowledge	Summative for both theory and PBA	SLO: C-12-E-27 part (a-d) will be included in the theory paper of annual examination, whereas part (e) will	

Domains	Content Area	SLO No.	SLO Description	Cognitive Level	Type of Assessment (Formative or Summative)	Remarks	Time allocation (Lectures)
			c. in NaOH(aq) with diazonium salts to give azo compounds. d. nitration of the aromatic ring with dilute HNO ₃ ,(aq) at room temperature to give a mixture of 2-nitrophenol and 4-nitrophenol e. bromination of the aromatic ring. with Br ₂ (aq) to form 2,4,6- tribromophenol.			be included in the practical based assessment.	
		[SLO: C-12-E-28]	Explain the acidity of phenol.	Understanding	Summative for theory	Question(s) will be given in the annual examination.	
		[SLO: C-12-E-29]	Describe the relative acidities of water, phenol and ethanol.	Understanding	Summative for theory		
		[SLO: C-12-E-30]	Explain why the reagents and conditions for the nitration and bromination of phenol are different from those for benzene.	Understanding	Summative for theory		
		[SLO: C-12-E-31]	Recall that the hydroxyl group of a phenol directs to the 2-, 4-and 6- positions.	Understanding	Summative for theory		
		[SLO: C-12-E-32]	Apply knowledge of the reactions of phenol to those of other phenolic compounds, e.g. naphthol.	Application	Formative	Question(s) will not be given in the annual examination; however, it will be the part of classroom teaching.	
	Carbonyl Compounds	[SLO: C-12-E-33]	State the reaction by which benzoic acid can be produced: reaction of an alkyl benzene with hot alkaline KMnO ₄ and then dilute acid, exemplified by methylbenzene.	Knowledge	Summative for theory	Question(s) will be given in the annual examination.	07
		[SLO: C-12-E-34]	Describe the reaction of carboxylic acids with PCl ₃ and heat, PCl ₅ , or SOCl ₂ to form acyl chlorides.	Understanding	Summative for theory		

Domains	Content Area	SLO No.	SLO Description	Cognitive Level	Type of Assessment (Formative or Summative)	Remarks	Time allocation (Lectures)
		[SLO: C-12-E-35]	Recognize that some carboxylic acids can be further oxidized: a. The oxidation of methanoic acid, HCOOH, with Fehling's reagent or Tollens' reagent or acidified KMnO ₄ or acidified K ₂ Cr ₂ O ₄ to carbon dioxide and water. b. The oxidation of ethane dioic acid, HOOC-COOH, with warm acidified KMnO ₄ , to carbon dioxide.	Understanding	Summative for theory		
		[SLO: C-12-E-36]	Explain the relative acidities of carboxylic acids, phenols and alcohols.	Understanding	Summative for theory		
		[SLO: C-12-E-37]	Explain the relative acidities of chlorine substituted carboxylic acids.	Understanding	Summative for theory		
		[SLO: C-12-E-38]	Recall the reaction by which esters can be produced: reaction of alcohols with acyl chlorides using the formation of ethyl ethanoate and phenyl benzoate as examples.	Knowledge	Summative for theory		
		[SLO: C-12-E-39]	Recall the reactions (reagents and conditions) by which is acyl chlorides can be produced: reaction of carboxylic acids with PCl ₃ and heat, PCl ₅ , or SOCl ₂ .	Knowledge	Summative for theory		
		[SLO: C-12-E-40]	Describe the following reactions of acyl chlorides: a. Hydrolysis on addition of water at room temperature to give the carboxylic acid and HCl. b. Reaction with an alcohol at room temperature to produce an ester and HCl. c. Reaction with phenol at room temperature to produce an ester and HCl.	Understanding	Summative for theory		

Domains	Content Area	SLO No.	SLO Description	Cognitive Level	Type of Assessment (Formative or Summative)	Remarks	Time allocation (Lectures)
			d. Reaction with ammonia at room temperature to produce an amide and HCl. e. Reaction with a primary or secondary amine at room temperature to produce.				
		[SLO: C-12-E-41]	Describe the addition-elimination mechanism of acyl chlorides in reactions.	Understanding	Summative for theory		
		[SLO: C-12-E-42]	Explain the relative ease of hydrolysis of acyl chlorides, alkyl chlorides and halogenoarenes (aryl chlorides).	Understanding	Summative for theory		
	Nitrogen Compounds	[SLO: C-12-E-43]	Primary and secondary amines, recall the reactions (reagents and conditions) by which primary and secondary amines are produced: a. reaction of halogenoalkanes with NH_3 in ethanol heated under pressure b. reaction of halogenoalkanes with primary amines in ethanol, heated in a sealed tube / under pressure. c. the reduction of amides with LiAlH_4 , d. the reduction of nitriles with LiAlH_4 or H_2/Ni .	Knowledge	Summative for theory	Question(s) will be given in the annual examination.	10
		[SLO: C-12-E-44]	Describe the reactions by which nitriles can be produced: reaction of a halogenoalkane with KCN in ethanol and heat.	Understanding	Summative for theory		
		[SLO: C-12-E-45]	Recall the reactions by which hydroxy nitriles can be produced: the reaction of aldehydes and ketones with HCN , and heat.	Knowledge	Summative for theory		
		[SLO: C-12-E-46]	Describe the hydrolysis of nitriles with dilute acid or dilute alkali followed by acidification.	Understanding	Summative for theory		
		[SLO: C-12-E-47]	Describe the basicity of aqueous solutions of amines.	Understanding	Summative for theory		

Domains	Content Area	SLO No.	SLO Description	Cognitive Level	Type of Assessment (Formative or Summative)	Remarks	Time allocation (Lectures)
		[SLO: C-12-E-48]	Phenylamine and azo compounds. Describe the reaction of phenylamine with Br ₂ (aq) at room temperature.	Understanding	Summative for theory		
		[SLO: C-12-E-49]	Describe the reaction of phenylamine with HNO ₂ or NaNO ₂ and dilute acid below 1°C to produce the diazonium salt; further warming of the diazonium salt with H ₂ O to give phenol.	Understanding	Summative for theory		
		[SLO: C-12-E-50]	Explain the relative basicities of aqueous ammonia, ethylamine and phenylamine.	Understanding	Summative for theory		
		[SLO: C-12-E-51]	Identify the properties of azo compounds (Some examples include: (a) Describe the coupling of benzenediazonium chloride with phenol in NaOH(aq) to form an azo compound (b) identify the azo group (c) state that azo compounds are often used as dyes Recognize that other azo dyes can be formed via a similar route).	Understanding	Summative for theory		
		[SLO: C-12-E-52]	Amides Identify the reactions (reagents and conditions) by which amides are produced (Some examples include: a. the reaction between ammonia and an acyl chloride at room temperature. b. the reaction between a primary amine and an acyl chloride at room temperature).	Understanding	Summative for theory		
		[SLO: C-12-E-53]	Describe the reactions of amides (Some examples include:	Understanding	Summative for theory		

Domains	Content Area	SLO No.	SLO Description	Cognitive Level	Type of Assessment (Formative or Summative)	Remarks	Time allocation (Lectures)
			a. hydrolysis with aqueous alkali or aqueous acid b. the reduction of the CO group in amides with LiAlH ₄ to form an amine).				
		[SLO: C-12-E-54]	Explain why amides are much weaker bases than amines.	Understanding	Summative for theory		
		[SLO: C-12-E-55]	Describe the acid/ base properties of amino acids and the formation of zwitterions.	Understanding	Summative for theory		
		[SLO: C-12-E-56]	Describe the formation of amide (peptide) bonds between amino acids to give di-and tripeptides.	Understanding	Summative for theory		
		[SLO: C-12-E-57]	Predict the results of electrophoresis on mixtures of amino acids and dipeptides at varying pHs.	Application	Summative for theory		
	Polymers	[SLO: C-12-E-58]	Explain the chemical processes and properties of PVC and nylon, and the applications of these polymers in the industry.	Understanding	Formative	Question(s) will not be given in the annual examination; however, it will be the part of classroom teaching.	06
		[SLO: C-12-E-59]	describe the condensation reaction of ammonia or an amine with an acyl chloride at room temperature to give an amide	Understanding	Formative		
		[SLO: C-12-E-60]	Discuss the importance of chemical industries in the economy of Pakistan, and describe the raw materials that are available in the country for various chemical industries.	Understanding	Formative		
		[SLO: C-12-E-61]	Describe the chemical processes of addition and condensation polymerization and the differences between them. Examples include, a. addition polymers such as poly(ethene) and poly(chloroethene), PVC, b. polyesters (from reactions of diol and dicarboxylic or dioyl acid, and from hydroxycarboxylic acid),	Understanding	Summative for theory	Question(s) will be given in the annual examination.	

Domains	Content Area	SLO No.	SLO Description	Cognitive Level	Type of Assessment (Formative or Summative)	Remarks	Time allocation (Lectures)
			c. polyamides (from reactions of a diamine and a dicarboxylic acid or dioylchloride, of an amino carboxylic acid, or between amino acids).				
		[SLO: C-12-E-62]	Identify the polymer formed, the monomer present in a section of polymer, and classify them as one of the two polymers.	Understanding	Summative for theory		
		[SLO: C-12-E-63]	Deduce the repeating unit of a polymer obtained from a given monomer or pair of monomers and identify the monomers present in a given section of; a polymer molecule.	Understanding	Summative for theory		
		[SLO:C-12-E-64]	Predict the type of polymerization reaction for a given monomer or pair of monomers.	Understanding	Summative for theory		
		[SLO: C-12-E-65]	Explain the challenges associated with the disposal of non- biodegradable polymers.	Understanding	Formative	Question(s) will not be given in the annual examination; however, it will be the part of classroom teaching.	
		[SLO: C-12-E-66]	Recognize that poly(alkenes) are chemically inert and can therefore be difficult to biodegrade.	Understanding	Summative for theory	Question(s) will be given in the annual examination.	
		[SLO: C-12-E-67]	Recognize that some polymers can be degraded by the action of light.	Understanding	Summative for theory		
		[SLO: C-12-E-68]	Recognize that polyesters and polyamides are biodegradable by acidic and alkaline hydrolysis.	Understanding	Summative for theory		
		[SLO: C-12-E-69]	Outline the use of polymers to create artificial organs in biomedical science.	Understanding	Formative	Question(s) will not be given in the annual examination; however, it will be	

Domains	Content Area	SLO No.	SLO Description	Cognitive Level	Type of Assessment (Formative or Summative)	Remarks	Time allocation (Lectures)
						the part of classroom teaching.	
	Organic Synthesis	[SLO: C-12-E-70]	Describe the use of Artificial Intelligence tools in designing organic molecules may have the potential to be used as medicine. (Halicin can be used as an example)	Understanding	Formative	Question(s) will not be given in the annual examination; however, it will be the part of classroom teaching.	01
	Biochemistry	[SLO: C-12-E-71]	Explain the basis of classification and structure-function relationship of carbohydrates.	Understanding	Summative for theory	Question(s) will be given in the annual examination.	07
		[5L0: C-12-E-72]	Explain the role of various carbohydrates in health and diseases.	Understanding	Formative	Question(s) will not be given in the annual examination; however, it will be the part of classroom teaching.	
		[5L0: C-12-E-73]	Identify the nutritional importance of carbohydrates and their role as energy storage.	Understanding	Formative	Question(s) will not be given in the annual examination; however, it will be the part of classroom teaching.	
		[SLO: C-12-E-74]	Explain the basis of classification and structure-function relationship of proteins.	Understanding	Summative for theory	Question(s) will be given in the annual examination.	
		[SLO: C-12-E-75]	Describe the role of various proteins in maintaining body functions and their nutritional importance.	Understanding	Formative	Question(s) will not be given in the annual examination; however, it will be the part of classroom teaching.	

Domains	Content Area	SLO No.	SLO Description	Cognitive Level	Type of Assessment (Formative or Summative)	Remarks	Time allocation (Lectures)
		[SLO: C-12-E-76]	Describe the role of enzyme as biocatalyst and relate this role to various functions such as digestion of food	Understanding	Summative for theory	Question(s) will be given in the annual examination.	
		[SLO: C-12-E-77]	Identify factors that affect enzyme activity such as the effect of temperature and PH.	Understanding	Summative for theory		
		[SLO: C-12-E-78]	Explain the role of inhibitors of enzyme catalyzed reactions.	Understanding	Summative for theory		
		[SLO: C-12-E-79]	Describe the basis of classification and structure-function relationship of lipids.	Understanding	Summative for theory		
		[SLO: C-12-E-80]	Identify the nutritional and biological importance of lipids.	Understanding	Formative	Question(s) will not be given in the annual examination; however, it will be the part of classroom teaching.	
		[SLO: C-12-E-81]	Importance of lipids repetition Identify the structural components of DNA and RNA.	Understanding	Formative		
		[SLO: C-12-E-82]	Differentiate between the structures of DNA polymer (double strand) and RNA (single strand).	Understanding	Summative for theory	Question(s) will be given in the annual examination.	
		[SLO: C-12-E-83]	Relate DNA sequences to its function as storage of genetic information.	Understanding	Formative	Question(s) will not be given in the annual examination; however, it will be the part of classroom teaching.	
		[SLO: C-12-E-84]	Relate RNA sequence (transcript) to its role in transfer of information to protein (translation).	Understanding	Formative		
		[SLO: C-12-E-85]	Identify the sources of minerals such as iron, calcium, phosphorus and zinc.	Understanding	Formative		
		[SLO: C-12-E-86]	Describe the role of iron, calcium, phoshorous and zinc in nutrition.	Understanding	Formative		
		[SLO: C-12-E-87]	Explain why animals and humans have large glycogen deposits for sustainable ‘muscular activities. Hibernating animals (polar bear,	Understanding	Formative		

Domains	Content Area	SLO No.	SLO Description	Cognitive Level	Type of Assessment (Formative or Summative)	Remarks	Time allocation (Lectures)
			reptiles and amphibians) accumulate fat to meet energy resources during hibernation.				
		[SLO: C-12-E-88]	Identify complex carbohydrates which provide lubrication to the elbow and knee.	Understanding	Formative		
		[SLO: C-12-E-89]	Describe fibrous proteins from hair and silk	Understanding	Formative		
		[SLO: C-12-E-90]	Explain how cholesterol and amino acid serve as hormones	Understanding	Formative		
		[SLO: C-12-E-91]	Identify insulin as a protein hormone whose deficiency leads to diabetes mellitus.	Understanding	Formative		
		[SLO: C-12-E-92]	Explain the role of ‘minerals in structure and function.	Understanding	Formative		
		[SLO: C-12-E-93]	Identify calcium as a requirement for coagulation.	Understanding	Formative		
		[SLO: C-12-E-94]	Identify how milk proteins can be precipitated by lowering the pH using lemon juice.	Understanding	Formative		
F Empirical Data Collection and Analysis	Uncertainties and errors in measurement and results	SLO: C-12-F-01]	Uncertainties and errors in measurement and results Differentiate between Qualitative data and Quantitative Data -(Qualitative data includes all non-numerical information obtained from observations not from measurement. - Quantitative data are obtained from measurements, and are always associated with random errors/uncertainties, determined by the apparatus, and by human limitations such as reaction times).	Understanding	Formative	Question(s) will not be given in the annual examination; however, it will be the part of classroom teaching.	02
		[SLO: C-12-F-02]	Justify that the propagation of random errors in data processing shows the impact of the uncertainties on the final result. (Some examples may include:	Understanding	Formative		

Domains	Content Area	SLO No.	SLO Description	Cognitive Level	Type of Assessment (Formative or Summative)	Remarks	Time allocation (Lectures)
			<ul style="list-style-type: none"> When we process data that contains random errors, these errors can propagate or accumulate throughout the calculation, resulting in larger uncertainties in the final result. - For example, if we measure the length and width of a rectangle to calculate its area, any small errors in the measurement of length and width will propagate through to the area calculation, resulting in a larger uncertainty in the final area measurement. <p>This information is critical in scientific research as it helps us assess the reliability of our data and draw valid conclusions from our experiments).</p>				
		[SLO:C-12-F-03]	Analyze the concept that experimental design and procedure usually lead to systematic errors in measurement, which cause a deviation in a particular direction.	Understanding	Formative		
		[SLO:C-12-F-04]	Justify that repeat trials and measurements will reduce random errors but not systematic errors.	Understanding	Formative		
		[SLO: C-12-F-05]	Graphical techniques Explain that graphical techniques are an effective means of communicating the effect of an independent variable on a dependent variable, and can lead to determination of physical quantities.	Understanding	Summative for theory	Question(s) will be given in the annual examination.	
		[SLO: C-12-F-06]	Discuss that sketched graphs have labeled but unscaled axes, and are used to show qualitative trends, such as variables that are proportional or inversely proportional.	Understanding	Formative	Question(s) will not be given in the annual examination; however, it will be	

Domains	Content Area	SLO No.	SLO Description	Cognitive Level	Type of Assessment (Formative or Summative)	Remarks	Time allocation (Lectures)
		[SLO: C-12-F-07]	Discuss that drawn graphs have labelled and scaled axes, and are used in quantitative measurements.	Understanding	Formative	the part of classroom teaching.	
	Qualitative analysis (Mass Spectrometry)	[SLO: C-12-F-08]	Analyze mass spectra in terms of m/e values and isotopic abundances (knowledge of the working of the mass spectrometer is not required).	Understanding	Formative	Already discussed in XI Class, that is why it will not be the part of annual examination.	03
		[SLO: C-12-F-09]	Calculate the relative atomic mass of an element, given the relative abundances of its isotopes, or its mass spectrum.	Application	Formative		
		[SLO: C-12-F-10]	Deduce the molecular mass of an organic molecule from the molecular ion peak in a mass spectrum.	Application	Summative for theory	Question(s) will be given in the annual examination.	
		[SLO: C-12-F-11]	Suggest the identity of molecules formed by simple fragmentation in a given mass spectrum.	Understanding	Summative for theory		
		[SLO: C-12-F-12]	Deduce the number of carbon atoms, n, in a compound using the M ⁺ peak and the formula, $n = \frac{100 \times \text{abundance of } [M + 1] \text{ peak}}{1.1 \times \text{Abundance of } M^+ \text{ peak}}$	Understanding	Summative for theory		
		[SLO: C-12-F13]	Deduce the presence of bromine and chlorine atoms in a compound using the M ⁺ peak.	Understanding	Summative for theory		
	Spectroscopy	[SLO: C-12-F14]	Explain that the degree of unsaturation or index of hydrogen deficiency (IHD) can be used to determine from a molecular formula the number of rings or multiple bonds in a molecule.	Understanding	Formative	Question(s) will not be given in the annual examination; however, it will be the part of classroom teaching.	04
		[SLO: C-12-F15]	Explore how Mass spectrometry (MS), proton nuclear magnetic resonance spectroscopy (¹ H NMR) and infrared spectroscopy (IR) are	Understanding	Summative for theory	Question(s) will be given in the annual examination.	

Domains	Content Area	SLO No.	SLO Description	Cognitive Level	Type of Assessment (Formative or Summative)	Remarks	Time allocation (Lectures)
			techniques that can be used to help identify compounds and to determine their structure				
		[SLO: C-12-F-16]	Interpret an infrared (IR) spectrum of a simple molecule to identify functional groups	Understanding	Summative for theory		
		[SLO: C-12-F-17]	Deduce possible structures for organic compounds using IR spectrum and molecular formula (Examples: phenol, acetone, ethanol)	Understanding	Summative for theory		
		[SLO: C-12-F-18]	Predict whether a given molecule will absorb in the UV/visible region.	Application	Summative for theory		
		[SLO: C-12-F-19]	Predict the color of a transition metal complex from its UV/visible spectrum.	Application	Summative for theory		
		[SLO: C-12-F-20]	Explain atomic emission and atomic absorption spectrum.	Understanding	Summative		
	NMR	[SLO: C-12-F-21]	Analyze the different environments of carbon atoms present in a simple molecule using a ^{13}C -NMR spectrum.	Understanding	Summative for theory	Question(s) will be given in the annual examination.	06
		[SLO: C-12-F-22]	Use a ^{13}C NMR spectrum to deduce possible structures of a simple molecule.	Application	Summative for theory		
		[SLO: C-12-F-23]	Predict the number of peaks in a ^{13}C NMR spectrum for a given molecule.	Application	Summative for theory		
		[SLO: C-12-F-24]	Analyze the different environments of protons present in a simple molecule using a ^1H (proton) NMR spectrum.	Understanding	Summative for theory		
		[SLO: C-12-F-25]	Use a ^1H (superscript)(proton) NMR spectrum to deduce relative numbers of each type of proton present, the number of equivalent protons on the carbon atom adjacent to the one to which the given proton is attached,	Application	Summative for theory		
		[SLO: C-12-F-26]	Deduce possible structures for the molecule	Application	Summative for theory		

Domains	Content Area	SLO No.	SLO Description	Cognitive Level	Type of Assessment (Formative or Summative)	Remarks	Time allocation (Lectures)
		[SLO: C-12-F-27]	Predict the chemical shifts and splitting patterns of the protons in a given molecule.	Application	Summative for theory		
		[SLO: C-12-F-28]	Explain the use of tetramethylsilane, TMS, as the standard for chemical shift measurement.	Understanding	Summative for theory		
		[SLO: C-12-F-29]	Recognize the need for deuterated solvents, e.g. CDCl ₃ , when obtaining a proton NMR spectrum.	Understanding	Summative for theory		
		[SLO: C-12-F-30]	Describe the identification of O-H and N—H protons by proton exchange using D ₂ O.	Understanding	Summative for theory		
	Chromatography	[SLO: C-12-F-31]	Describe the terms stationary phase, mobile phase, R _f value, baseline and solvent front.	Understanding	Summative for theory	Question(s) will be given in the annual examination.	04
		[SLO: C-12-F-32]	Explain the principles and applications of thin layer chromatography in colorless forensic chemistry and analysis of unknown materials.	Understanding	Summative for theory		
		[SLO: C-12-F-33]	Interpret R _f values and retention times in chromatograms to determine the composition of a mixture.	Understanding	Formative	Question(s) will not be given in the annual examination; however, it will be the part of classroom teaching.	
		[SLO: C-12-F-34]	Explain the importance of selecting the appropriate stationary and mobile phases in chromatography and their impact on the separation of compounds.	Understanding	Summative for theory	Question(s) will be given in the annual examination.	
		[SLO: C-12-F-35]	Describe the use of mass spectrometry in combination with chromatography for identifying and quantifying small amounts of unknown materials in forensic analysis.	Understanding	Formative	Question(s) will not be given in the annual examination; however, it will be the part of classroom teaching.	

Domains	Content Area	SLO No.	SLO Description	Cognitive Level	Type of Assessment (Formative or Summative)	Remarks	Time allocation (Lectures)
	Materials	[SLO: C-12-F-36]	Explain the properties of different materials and how they can be applied to desired structures.	Understanding	Formative	Question(s) will not be given in the annual examination; however, it will be the part of classroom teaching.	02
		[SLO: C-12-F-37]	Explain the process of extracting metals from ores and alloying them to achieve desired characteristics.	Understanding	Summative for theory	Question(s) will be given in the annual examination.	
		[SLO: C-12-F-38]	Explain the mechanism of catalysts and how they increase the rate of a reaction while remaining unchanged at the end.	Understanding	Summative for theory		
		[SLO: C-12-F-39]	Explain the challenges associated with recycling and toxicity of some materials produced through materials science.	Understanding	Formative	Question(s) will not be given in the annual examination; however, it will be the part of classroom teaching.	
		[SLO: C-12-F-40]	Explain the use of X-ray crystallography in analyzing structures.	Understanding	Formative		
	Medicine	[SLO: C-12-F-40]	Recognize the concept of therapeutic index and therapeutic window in relation to drug administration	Understanding	Formative	Question(s) will not be given in the annual examination; however, it will be the part of classroom teaching.	01
		[SLO: C-12-F-41]	Explain the mechanism of action and uses of aspirin and penicillin and. explain the chemical structure of the same	Understanding	Formative		
		[SLO: C-12-F-42]	Describe the mechanism of action of opiates and the concept of opioid receptors in the brain	Understanding	Formative		

Domains	Content Area	SLO No.	SLO Description	Cognitive Level	Type of Assessment (Formative or Summative)	Remarks	Time allocation (Lectures)
		[SLO: C-12-F-43]	Describe the pH regulation of stomach and its relation to the concept of nonspecific reactions and active metabolites	Understanding	Formative		
		[SLO: C-12-F-44]	Recognize the challenges in treating viral infections with drugs and the concept of antiviral medications.	Understanding	Formative		
	Agriculture	[SLO: C-12-F-45]	Explain the chemical composition and Junction of different types of fertilizers, including their role in providing essential nutrients to crops and the impact of their application on soil health.	Understanding	Summative for theory	Question(s) will be given in the annual examination.	03
		[SLO: C-12-F-46]	Identify the different types of pesticides used in agriculture and describe their mode of action, including the potential benefits and risks associated with their use.	Understanding	Summative for theory		
		[SLO: C-12-F-47]	Identify the chemical reactions that occur when acid rain falls on crops and soil and explain the effects it has on crop, growth, including nutrient uptake and crop yield.	Understanding	Summative for theory		
		[SLO: C-12-F-48]	Explain the basics of genetic engineering and how it is used in agriculture, including the development of genetically modified crops and the potential benefits and risks associated with their use.	Understanding	Formative	Question(s) will not be given in the annual examination; however, it will be the part of classroom teaching.	
		[SLO: C-12-F-49]	Explain how changes in temperature, precipitation, and extreme weather events can affect crop growth and yield, including the potential for crop failures and food shortages, as well as the potential to develop new crop varieties that are more resilient to changing climate conditions.	Understanding	Formative		

Domains	Content Area	SLO No.	SLO Description	Cognitive Level	Type of Assessment (Formative or Summative)	Remarks	Time allocation (Lectures)
	Industry	[SLO: C-12-F-50]	Justify the importance and significance of industrial chemistry in various industries such as manufacturing, energy, healthcare, and environmental protection.	Understanding	Summative for theory	Question(s) will be given in the annual examination.	03
		[SLO: C-12-F-51]	Describe the chemical processes involved in industrial production, including addition and condensation polymerization, and the properties and uses of resulting materials. Condensation polymerization, and the properties and uses of resulting materials.	Understanding	Summative for theory		
		[SLO: C-12-F-52]	Identify the raw materials and resources used in industrial chemistry, including those readily available in the context of Pakistan.	Understanding	Summative for theory		
		SLO: C-12-F-53]	Explain the applications of industrial chemistry in industries such as petrochemical, cosmetics, cement, food production and more.	Understanding	Formative	Question(s) will not be given in the annual examination; however, it will be the part of classroom teaching.	
		[SLO: C-12-F-54]	Elaborate on the safety measures and precautions necessary in industrial chemical processes and facilities.	Understanding	Formative		
G Lab and Practical Skills	Basic Instruction	[SLO: C-12-G-01]	Analyze risks associated with experiments in the lab and suggest strategies to minimize hazards	Understanding	Formative for PBA	Question(s) will not be given in the annual examination in the practical based	22
		[SLO: C-12-G-02]	Develop guidelines for lab experiments that incorporate appropriate safety measures.	Understanding	Formative for PBA		

Domains	Content Area	SLO No.	SLO Description	Cognitive Level	Type of Assessment (Formative or Summative)	Remarks	Time allocation (Lectures)
		[SLO: C-12-G-03]	Communicate laboratory safety protocols to their peers and colleagues.	Application	Formative for PBA	assessment, However it will be the part of lab work teaching.	
		[SLO:C-12-G-04]	Analyze chemical hazards in terms of impact on the environment.	Understanding	Formative for PBA		
	Titrations	[SLO: C-12-G-05]	(Use the following types of titrations as examples: acid-alkali titration (this could be weak or strong acid and weak or strong alkali), potassium manganate (VII) titration with hydrogen peroxide, iron(II) ions, nitrite ions or ethanedioic acid or its salts and sodium thiosulfate and iodine titration)	Understanding	Summative for PBA	Question(s) will be given in the annual examination in the practical based assessment paper.	
		[SLO: C-12-G-06]	Understand how to correctly set up a burette in order to carry out titrations.	Understanding	Formative for PBA	Question(s) will not be given in the annual examination; however, it will be the part of lab work teaching.	
		[SLO: C-12-G-07]	Identify the importance of carrying out a rough titration before	Understanding	Formative for PBA		
		[SLO: C-12-G-08]	Carry out titrations until concordant results are obtained.	Application	Summative for PBA	Question(s) will be given in the annual examination in the practical based assessment paper.	
		[SLO: C-12-G-09]	Identify and use appropriate indicators in the titration.	Understanding	Summative for PBA		
		[SLO: C-12-G-10]	Carry out rate investigation by mixing reagents and recording the time for an observation to occur.	Application	Summative for PBA		
	Measurement of rate of reaction	[SLO: C-12-G-11]	Suggest experimental designs to measure the rate of a reaction.	Understanding	Formative for PBA	Question(s) will not be given in the annual examination;	

Domains	Content Area	SLO No.	SLO Description	Cognitive Level	Type of Assessment (Formative or Summative)	Remarks	Time allocation (Lectures)
						however, it will be the part of lab work teaching.	
	Gravimetric analysis	[SLO: C-12-G-12]	Prepare a sample for gravimetric analysis.	Application	Summative for PBA	Question(s) will be given in the annual examination in the practical based assessment paper.	
		[SLO: C-12-G-13]	Perform gravimetric analysis using appropriate techniques (may include precipitation and filtration).	Application	Summative for PBA		
		[SLO: C-12-G-14]	Ensure quality of observation by properly controlling variables, using appropriate equipment, and making accurate and precise measurements (for example heat a solid in a crucible on a pipe- clay triangle and record any mass change).	Understanding	Formative for PBA	Question(s) will not be given in the annual examination; however, it will be the part of lab work teaching.	
		[SLO: C-12-G-15]	Prepare and set up a sample for a thermometric analysis, including appropriate mixing and stirring techniques.	Application	Formative for PBA		
		[SLO: C-12-G-16]	Accurately use and take readings from thermometers.	Application	Formative for PBA		
		[SLO: C-12-G-17]	Set up and Prepare a gas volume experiment, including appropriate apparatus selection and assembly techniques.	Application	Formative for PBA		
		[SLO: C-12-G-18]	Use a gas syringe, gas burette, or other appropriate equipment to measure gas volume	Application	Formative for PBA	Question(s) will be given in the annual examination in the practical based assessment paper.	
		[SLO: C-12-G-19]	Understand the appropriate methods to be used when carrying out qualitative analysis tests: <ul style="list-style-type: none">to treat all unknown materials with caution	Understanding	Summative for PBA		

Domains	Content Area	SLO No.	SLO Description	Cognitive Level	Type of Assessment (Formative or Summative)	Remarks	Time allocation (Lectures)
			<ul style="list-style-type: none"> to use an appropriate quantity of the material under test to add only the specified amount to work safely, to use a test-tube holder when heating a solid in a hard-glass test tube to record all observations, even when this is 'no change' or 'remains a colourless solution' to use excess alkali where a precipitate is produced on addition of NaOH(aq) or NH₃ (aq) to determine its solubility or identify a gas whose formation is shown by effervescence. 				
	Test of Functional groups and organic analysis	[SLO: C-12-G-20]	Perform the following organic analysis tests and functional group present: <ul style="list-style-type: none"> the production of an orange/red precipitate with Fehling's reagent to indicate the presence of the aldehyde functional group the production of a silver mirror/black precipitate with Tollens' reagent to indicate the presence of the aldehyde functional group the production of a yellow precipitate with alkaline aqueous iodine to indicate the presence of the CH₃CO or CH₃CH(OH) group the change in colour of acidified potassium manganate (VII) from purple to 	Application	Summative for PBA	Question(s) will be given in the annual examination in the practical based assessment paper.	

Domains	Content Area	SLO No.	SLO Description	Cognitive Level	Type of Assessment (Formative or Summative)	Remarks	Time allocation (Lectures)
			colourless to indicate the presence of a compound that can be oxidized.				
		[SLO: C-12-G-21]	Identify the best way to present collected and transformed data based on the experiment being performed.	Understanding	Formative for PBA	Question(s) will not be given in the annual examination; however, it will be the part of lab work teaching.	
		[SLO:C-12-G-22]	Interpret the collected data to draw conclusions based on the experiment being performed.	Understanding	Formative for PBA		
						Total Lectures:	162



Federal Board HSSC-II Examination
Model Question Paper Chemistry
(Curriculum 2022-2023) Scheme of Studies 2006

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					
0	0	0	0	0	0
1	1	1	1	1	1
2	2	2	2	2	2
3	3	3	3	3	3
4	4	4	4	4	4
5	5	5	5	5	5
6	6	6	6	6	6
7	7	7	7	7	7
8	8	8	8	8	8
9	9	9	9	9	9

Version No.			
0	0	0	0
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9

Invigilator Sign. _____

Candidate Sign. _____

Q1. Fill the relevant bubble against each question. Each part carries ONE mark.

S. No	Question	A	B	C	D	A	B	C	D
i.	In which of the following reactions is there the greatest change in oxidation number of nitrogen?	$4\text{NH}_3 + 5\text{O}_2 \rightarrow 4\text{NO} + 6\text{H}_2\text{O}$	$3\text{NO}_2 + \text{H}_2\text{O} \rightarrow 2\text{HNO}_3 + \text{NO}$	$2\text{NO} + \text{O}_2 \rightarrow 2\text{NO}_2$	$4\text{NH}_3 + 6\text{NO} \rightarrow 5\text{N}_2 + 6\text{H}_2\text{O}$	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
ii.	The base dissociation constants (K_b) for four bases are given below: W: 1.2×10^{-4} X: 3.5×10^{-2} Y: 6.8×10^{-6} Z: 2.1×10^{-3} Which base is the strongest?	W	Y	Z	X	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
iii.	How many ions are produced from $[\text{Co}(\text{NH}_3)_6]\text{Cl}_3$ in the solution?	3	4	5	6	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
iv.	Which of the following group 2 compounds is commonly used to diagnose disorders of the intestine and stomach.	Magnesium sulfate	Calcium carbonate	Barium sulfate	Strontium nitrate	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
v.	When benzene is nitrated, conc. Nitric and sulphuric acid react to form an intermediate which attack the benzene ring, which one of the following represents this intermediate?	NO^+	NO_2	NO_2^-	NO_2^+	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
vi.	A transition metal ion with a $3d^8$ electronic configuration commonly forms a four coordinate complex. Which geometry is most likely observed for such a complex?	Linear	Tetrahedral	Square Planar	Octahedral	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

vii.	What is the least number of carbon atoms in a non-cyclic alkane molecule that has a chiral centre?	7	8	9	10	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>
viii.	Which of the following substituents is an electron-withdrawing, meta-directing group?	–OH	–CH ₃	–NO ₂	–NH ₂	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>
ix.	Which of the following halogenoalkanes is most likely to undergo an SN1 reaction?	Methyl chloride	Ethyl bromide	Isopropyl chloride	Tert-butyl bromide	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>
x.	Which of the following reagent and condition is required for the diazotization reaction of phenylamine before coupling with phenol?	NaOH and heat	HNO ₃ at room temperature	HNO ₂ and HCl below 5°C	Br ₂ in the presence of FeBr ₃	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>
xi.	Which of the following best explains why phenol is more acidic than alcohols?	Phenol has a hydroxyl group	The phenoxide ion is stabilized by resonance	Phenol has a higher molecular weight.	Alcohols do not undergo electrophilic substitution reactions	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>
xii.	Which one of the following is not a bidentate ligand?	Ethanedioate ion	Oxalate ion	Thiocyanate ion	1,2-Diaminoethane	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>
xiii.	What is a key structural component that differentiates RNA from DNA?	RNA contains ribose sugar, while DNA contains deoxyribose sugar.	DNA contains only thymine base, while RNA contains only uracil base.	RNA is always found in a double-helix structure.	DNA and RNA have the same sugar and nitrogenous bases.	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>
xiv.	Which of the following compounds will NOT produce benzoic acid when treated with hot alkaline KMnO ₄ ?	Methyl benzene	Ethyl benzene	Benzene	Isopropyl benzene	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>
xv.	How can colourless compounds be detected in Thin Layer Chromatography (TLC)?	By observing their natural colors under normal light.	By using ultraviolet (UV) light or chemical staining reagents.	By heating the TLC plate until compounds become visible.	By dissolving the TLC plate in a solvent.	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>
xvi.	Which of the following sections of a polymer chain represents a polyamide?	-CH₂-CH₂-O-CO-O-CH₂-CH₂-	-CH₂-CH₂-NH-CH₂-CH₂-	-CH₂-CH₂-Cl-CH₂-CH₂-	-CH₂-CH₂-CONH-CH₂-CH₂-	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>
xvii.	According to the activity series of metals, which of the following metals can displace zinc from a zinc sulphate solution in a displacement reaction?	Magnesium	Gold	Silver	Copper	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>



Federal Board HSSC-II Examination

Model Question Paper Chemistry

(Curriculum 2022-2023) Scheme of Studies 2006

Time allowed: 2.35 hours

Total Marks: 68

Note: Answer all parts from Section 'B' and all questions from Section 'C' on the E-sheet. Write your answers on the allotted/given spaces.

SECTION – B (Marks 42)

(14 × 3 = 42)

Q. 2	Attempt the following questions	(14x3 = 42)															
(i)	What is meant by coordination number? Complete the table for the following two complexes. <table><tr><td>Central Metal ion</td><td>Ligand</td><td>Coordination number</td><td>Formula of complex ion</td></tr><tr><td>Fe³⁺</td><td>CN⁻</td><td></td><td>K₃[Fe(CN)₆]</td></tr><tr><td>Pt⁴⁺</td><td>NH₂CH₂CH₂NH₂</td><td></td><td>[Pt(NH₂CH₂CH₂NH₂)₂]⁴⁺</td></tr></table>	Central Metal ion	Ligand	Coordination number	Formula of complex ion	Fe ³⁺	CN ⁻		K ₃ [Fe(CN) ₆]	Pt ⁴⁺	NH ₂ CH ₂ CH ₂ NH ₂		[Pt(NH ₂ CH ₂ CH ₂ NH ₂) ₂] ⁴⁺	03	OR	Starting from an acyl chloride, how would you prepare the following compounds? Provide chemical equations. i. Phenyl benzoate ii. Propyl ethanoate	1.5 + 1.5
Central Metal ion	Ligand	Coordination number	Formula of complex ion														
Fe ³⁺	CN ⁻		K ₃ [Fe(CN) ₆]														
Pt ⁴⁺	NH ₂ CH ₂ CH ₂ NH ₂		[Pt(NH ₂ CH ₂ CH ₂ NH ₂) ₂] ⁴⁺														
(ii)	How can nylon-6,6 be prepared from Hexandioic acid ? Give complete chemical reaction. Also mention type of polymerization.	02 + 01	OR	An unknown organic compound has a strong absorption band around 1700 cm ⁻¹ in its IR spectrum. What functional group is likely present? Suggest a possible structure if its molecular formula is C ₃ H ₆ O.	03												
(iii)	Electrophoresis can be used to separate amino acids which are produced by the hydrolysis of a polypeptide. Using glycine (NH ₂ CH ₂ COOH) as an example, explain why the result of electrophoresis depends on pH.	03	OR	Copper and silver both are transition metals. Copper (I) and silver (I) compounds are colourless. Suggest your answer.	03												
(iv)	What information can be obtained from the number of signals in a ¹ H NMR spectrum? Support your answer with a suitable example.	03	OR	-OH group is a characteristics functional group of ethanol and phenol. Explain why phenol is more acidic than ethanol?	03												
(v)	Describe how acyl chlorides can be prepared using phosphorus trichloride (PCl ₃). Include reagents and conditions in your answer.	03	OR	Write down the steps involved in the mechanism of the reaction between an aldehyde or ketone and hydrogen cyanide.	03												
(vi)	Explain the molecular orbital structure of benzene and how delocalized π-electrons contribute to its relative stability.	03	OR	Benzene can be converted into acetophenone by Friedel Craft acylation. Write down the steps involved in the mechanism of the formation of Acetophenone from benzene.	03												
(vii)	Use the following data to construct redox equations, and calculate the standard cell potentials, for the reactions between acidified H ₂ O ₂ (aq) and KI (aq). I ₂ + 2e ⁻ → 2I ⁻ E° = 0.54V O ₂ + 2H ⁺ + 2e ⁻ → H ₂ O ₂ E° = 0.68 V	03	OR	A 20.0 cm ³ sample of 0.200 moldm ⁻³ NH ₃ (aq) was titrated with 0.100 moldm ⁻³ HCl. Sketch how the pH changes during this titration. Mark clearly where the end point occurs.	03												
(viii)	What are enzyme inhibitors? Differentiate between competitive and non-competitive inhibition with examples.	03	OR	Describe the mechanism by which a catalyst speeds up a chemical reaction. Explain this using the oxidation of sulfur dioxide) to sulfur trioxide in the presence of vanadium (V) oxide as a catalyst.	03												
(ix)	Hex-2-ene shows one of the type of isomerism. Draw displayed formulae of its two isomers.	03	OR	Write at least three repeating unit of the polymer formed from the monomer CH ₂ =CHCl, and classify it as either an addition polymer or a condensation polymer.	03												

(x)	Explain what is meant by the term chiral center. Draw displayed formulae for the isomers of CH ₃ CH(OH)CO ₂ H.	03	OR	Explain why chloroethanoic acid is a stronger acid than ethanoic acid.	03
(xi)	Describe and explain how the thermal stabilities of the Group II nitrates vary down the group.	1+2	OR	Write a balanced chemical equation for the reaction of acid rain (containing sulphuric acid) with calcium carbonate in the soil. Explain how this reaction affects soil pH and crop growth.	03
(xii)	Describe and explain the trend in the solubilities of the sulphates of the Group II elements.	1+2	OR	The three Chloro compounds acyl chloride, aryl chloride and alkyl chloride vary in their ease of hydrolysis. Suggest an explanation for these differences in reactivity.	03
(xiii)	When 100 cm ³ of an aqueous solution containing 0.50 g of an organic compound A was shaken with 20 cm ³ of hexane, it was found that 0.40 g of A was extracted into the hexane. Calculate the partition coefficient of A between hexane and water.	3	OR	Balance the following redox equation by oxidation number method. HNO ₃ + Zn → Zn(NO ₃) ₂ + N ₂ O + H ₂ O	03
(xiv)	How is calcium hydroxide (slaked lime) used in agriculture, and why is it important for soil treatment?	03	OR	During the electrolysis of copper (II) sulphate (CuSO ₄) solution using inert electrodes. Name the products formed at the anode and cathode. Explain your reasoning.	2+1

SECTION – C (Marks 26)

Note: Attempt all questions. Marks of each question are given.

Q.3	Consider a following reaction where stable complex is formed. $[\text{Cd}(\text{H}_2\text{O})_6]^{2+} + \text{EDTA}^{4-} \rightleftharpoons [\text{Cd}(\text{EDTA})]^{2-} + 6\text{H}_2\text{O}$ <p>(a) Write an expression of K_{stab} for this reaction and state its unit.</p> <p>(b) At equilibrium at 298K, concentration of [Cd(H₂O)₆]²⁺ and EDTA⁴⁻ was found to be 3×10⁻⁸ moldm⁻³ and 4×10⁻¹⁰ moldm⁻³. Calculate concentration of [Cd(EDTA)]²⁻ in this solution. K_{stab} of [Cd(EDTA)]²⁻ is 6.3×10¹⁹.</p>	02 04	OR	Use the following E° values to predict whether a reaction will occur when the following pairs of aqueous solutions are mixed. If a reaction occurs, write a balanced equation and calculate the E° cell. Fe ³⁺ + e ⁻ ⇌ Fe ²⁺ E° = 0.77 V Cl ₂ + 2e ⁻ ⇌ 2Cl ⁻ E° = 1.36 V Br ₂ + 2e ⁻ ⇌ 2Br ⁻ E° = 1.07 V I ₂ + 2e ⁻ ⇌ 2I ⁻ E° = 0.54 V Co ³⁺ + e ⁻ ⇌ Co ²⁺ E° = 1.82 V Cr ³⁺ + e ⁻ ⇌ Cr ²⁺ E° = -0.41 V (i) Fe ³⁺ (aq) and Cl ⁻ (aq) (ii) Co ³⁺ (aq) and Br ⁻ (aq) (iii) Cr ²⁺ (aq) and I ₂ (aq)	02 02 02
Q.4	(a) What is meant by buffer solution? (b) Write suitable equations to show how a mixture of ethanoic acid, CH ₃ CO ₂ H, and sodium ethanoate acts as a buffer solution to control the pH when either an acid or an alkali is added. (c) Briefly describe how the pH of blood is controlled.	01 03 02	OR	Describe the SN ₁ and SN ₂ mechanisms of nucleophilic substitution in halogenoalkanes. Explain the step-by-step mechanism of each reaction with suitable examples.	06
Q.5	Write down the reagents and conditions used to prepare primary and secondary amines starting from a. Chloro ethane b. Ethanamide c. Methyl cyanide	07	OR	Complete the following reactions of phenol. Draw and write the name of the compounds formed (A –G). C ₆ H ₅ OH + NaOH → A C ₆ H ₅ OH + Na → B + C C ₆ H ₅ OH + C ₆ H ₅ N ₂ Cl ⁻ → D + E C ₆ H ₅ OH + HNO ₃ → F + G	07
Q.6	Following data represents the mass spectrum of organic compound X: • Molecular ion peak (M ⁺) at m/z = 122 with intensity 100% • M ⁺ +1 peak at m/z = 4.4% • Fragment peaks at m/z = 107, 81, 79 and 51		OR	(a) Write balanced chemical equations for the reaction of: i) Strontium with oxygen ii) Strontium oxide with hydrochloric acid	03

	<ul style="list-style-type: none"> • A characteristic peak pattern with a 1:1 intensity ratio at $m/z = 122$ and 124 			(b) Describe the different carbon environments in butanone ($\text{CH}_3\text{COCH}_2\text{CH}_3$) based on its ^{13}C -NMR spectrum.	02
	(a) Calculate the number of carbon atoms (n) in the compound.	02		(c) Predict the number of peaks and justify your answer.	02
	(b) Identify the halogen present in the compound based on the given mass spectral data.	02			
	(c) Suggest a possible structure for organic compound X by analyzing the given fragment peaks.	03			

Federal Board HSSC-II Examination
Chemistry Model Question Paper

(Curriculum 2022-23)

Alignment of Questions with Student Learning Outcomes

Section-A (1x 17 = 17 Marks)

Q1.	SLO's	Domain	Cognitive level	Marks
i.	[SLO: C-12-B-01] Apply the concept of oxidation numbers in identifying oxidation and reduction reactions	B	A	1
ii.	[SLO: C-12-B-24] Use the extent of ionization and the base dissociation constant, K_b to distinguish between strong and weak bases.	B	A	1
iii.	[SLO: C-12-C-30] Predict the formula and charge of a complex ion, given the metal ion, its charge or oxidation state, the ligand and its coordination number or, Geometry.	C	A	1
iv.	[SLO: C-12-C-04] Describe the industrial and everyday uses of Group 2 compounds, including their role in medicine and agriculture.	C	K	1
v.	[SLO: C-12-E-13] Explain the mechanism of nitration, including the formation of a nitronium ion, and predict the major product(s) of the reaction.	E	U	1
vi.	[SLO: C-12-C-28] Describe the geometry (shape and bond angles) of transition element complexes which are linear, square planar, tetrahedral or octahedral.	C	U	1
vii.	[SLO: C-12-E-04] Explain what is meant by a chiral center and that such a center gives rise to two optical isomers (enantiomers).	E	U	1
viii.	[SLO: C-12-E-17] Describe the mechanism of electrophilic aromatic substitution, including the role of the electrophile and the formation of a sigma complex, and predict the major product(s) of the reaction based on the directing effects of substituents on the aromatic ring.	E	U	1
ix.	[SLO: C-12-E-23] Identify that primary halogenoalkanes tend to react via the SN_2 mechanism; tertiary halogenoalkanes via the SN_1 mechanism; and secondary halogenoalkanes by a mixture of the two, depending on structure.	E	K	1
x.	[SLO: C-12-E-49] Describe the reaction of phenylamine with HNO_2 or $NaNO_2$ and dilute acid below $1^\circ C$ to produce the diazonium salt; further warming of the diazonium salt with H_2O to give phenol.	E	U	1
xi.	[SLO: C-12-E-29] Describe the relative acidities of water, phenol and ethanol.	E	U	1
xii.	[SLO: C-12-C-26] Use the term bidentate ligand including as examples 1,2-Diaminoethane, $H_2NCH_2CH_2NH_2$, and the ethanedioate ion, $C_2O_4^{2-}$, polydentate ligand including as an example EDTA	C	A	1
xiii.	[SLO: C-12-E-82] Differentiate between the structures of DNA polymer (double strand) and RNA (single strand).	E	U	1
xiv.	[SLO: C-12-E-33] State the reaction by which benzoic acid can be produced: reaction of an alkyl benzene with hot alkaline $KMnO_4$ and then dilute acid, exemplified by methylbenzene.	E	K	1

xv.	[SLO: C-12-F-32] Explain the principles and applications of thin layer chromatography in colorless forensic chemistry and analysis of unknown materials.	E	U	1
xvi.	[SLO: C-12-E-63] Deduce the repeating unit of a polymer obtained from a given monomer or pair of monomers and identify the monomers present in a given section of; a polymer molecule.	E	U	1
xvii.	[SLO: C-12-B-06] Explain the concept of the activity series of metals and how it relates to the ease of oxidation	B	U	1

SECTION- B (14 x 3 = 42)

Q. 2. Attempt the following questions.

Q No	SLO	Marks	Cognitive level	Domain		SLO	Marks	Cognitive level	Domain
(i)	[SLO: C-12-C-29] State what is meant by coordination number?	1 + 2	K	C	OR	[SLO: C-12-E-38] Recall the reaction by which esters can be produced: reaction of alcohols with acyl chlorides using the formation of ethyl ethanoate and phenyl benzoate as examples.	3	K	E
(ii)	[SLO: C-12-E-61] Describe the chemical processes of addition and condensation polymerization and the differences between them. Examples include, polyamides (from reactions of a diamine and a dicarboxylic acid or diolchloride, of an amino carboxylic acid, or between amino acids).	03	U	E	OR	[SLO: C-12-F-17] Deduce possible structures for organic compounds using IR spectrum and molecular formula (Examples: phenol, acetone, ethanol)	03	U	F
(iii)	Identify the chemical reactions that occur when acid rain falls on crops and soil and explain the effects it has on crop, growth, including nutrient uptake and crop yield.	3	A	E	OR	[SLO: C-12-C-37] Explain why transition elements form coloured compounds in terms of the frequency of light absorbed as an electron is promoted between two non- degenerate d, orbitals	03	A	C
(iv)	[SLO: C-12-F-24] Analyze the different environments of protons	03	U	F	OR	[SLO: C-12-E-29]	03	U	E

	present in a simple molecule using a ^1H (proton) NMR spectrum.					Describe the relative acidities of water, phenol and ethanol.			
(v)	(a) [SLO: C-12-E-39] Recall the reactions (reagents and conditions) by which acyl chlorides can be produced: reaction of carboxylic acids with PCl_3 and heat, PCl_5 , or SOCl_2 .	03	K	E	OR	[SLO: C-12-E-45] Recall the reactions by which hydroxy nitriles can be produced: the reaction of aldehydes and ketones with HCN , and heat.	03	K	E
(vi)	[SLO: C-12-E-09] and [SLO: C-12-E-10] Explain the shape of the benzene molecule (molecular/orbital aspect). Define resonance, resonance energy and relative stability of benzene.	03	U	E	OR	[SLO: C-12-E-14] Explain the mechanism of Friedel-Crafts alkylation and acylation, respectively, including the role of the Lewis acid catalyst, and predict the major product(s) of the reaction.	03	U	E
(vii)	[SLO: C-12-B-18] Construct redox equations using relevant half- equations. [SLO: C-12-B-16] Calculate the standard cell potentials by combining the potentials of two standard electrodes and then use these to predict the feasibility of a reaction and the direction of electron flow in a simple cell.	03	A	B	OR	[SLO: C-12-B-33] Sketch the pH titration curves of titrations using combinations of strong and weak acids with strong and weak alkalis	03	A	B
(viii)	[SLO: C-12-E-78] Explain the role of inhibitors of enzyme-catalyzed reactions.	3	U	E	OR	[SLO: C-12-F-38] Explain the mechanism of catalysts and how they increase the rate of a reaction while remaining unchanged at the end.	03	U	F
(ix)	SLO: C-12-E-02 Describe geometrical (cis/trans) isomerism in alkenes, and explain its origin in terms of restricted rotation due to the presence of π bonds.	3	U	E	OR	[SLO: C-12-E-63] Deduce the repeating unit of a polymer obtained from a given monomer or pair of monomers and identify the monomers	2	U	E

						present in a given section of; a polymer molecule. [SLO:C-12-E-64] Predict the type of polymerization reaction for a given monomer or pair of monomers.	01	U	U
(x)	[SLO: C-12-E-04] Explain what is meant by a chiral center and that such a center gives rise to two optical isomers (enantiomers).	3	U	E	OR	[SLO: C-12-E-37] Explain the relative acidities of chlorine substituted carboxylic acids.	3	U	E
(xi)	[SLO: C-12-C-14] Describe qualitatively the trend in the thermal stability of the nitrates and carbonates including the effect of ionic radius on the polarization of the large anion.	1+ 2	U	C	OR	[SLO: C-12-F-47] Identify the chemical reactions that occur when acid rain falls on crops and soil and explain the effects it has on crop, growth, including nutrient uptake and crop yield.	3	U	F
(xii)	[SLO: C-12-C-15] Describe qualitatively the variation in solubility and of enthalpy change of solution, ΔH_{sol} , of the hydroxides and sulfates in terms of relative magnitudes of the enthalpy change of hydration and the lattice energy.	1+ 2	U	C	OR	[SLO: C-12-E-42] Explain the relative ease of hydrolysis of acyl chlorides, alkyl chlorides and halogenoarenes (aryl chlorides).	3	U	E
(xiii)	[SLO: C-12-B-28] Calculate a partition coefficient for a system in which the solute is in the same physical state in the two solvents.	3	A	B	OR	[SLO: C-12-B-02] Apply the concept of changes in oxidation numbers to balance chemical equations	03	A	B
(xiv)	[SLO: C-12-C-04] Describe the industrial and everyday uses of Group 2 compounds, including their role in medicine and agriculture.	03	K	C	OR	[SLO: C-12-B-10] Predict the identities of substances liberated during electrolysis based on the state of the electrolyte, position in the redox series, and concentration.	3	K	B

SECTION – C (Marks 26)

Note: Attempt the following questions

Q No	SLO	Marks	Cognitive level	Domain		SLO	Marks	Cognitive level	Domain
Q:3	(a) [SLO: C-12-C-45] Write an expression for K_{stab} of a complex	02	A	C	OR	[SLO: C-12-B-16] Calculate the standard cell potentials by combining the potentials of two standard electrodes and then use these to predict the feasibility of a reaction and the direction of electron flow in a simple cell.	2	A	B
	(b) [SLO: C-12-C-46] Use K_{stab} expressions to perform calculations.	04	A	C		[SLO: C-12-B-18] Construct redox equations using relevant half-equations.	+ 2 + 2		
Q:4	[SLO: C-12-B-25] Explain what is meant by a chemical buffer and how a buffer system works. (For context this should include: a. Defining what is a buffer solution b. Explaining how buffer solution can be made c. Explaining how buffer solutions control pH; use chemical equations in these explanations d. Describe and explain the uses of buffer solutions including the role of HCO_3^{1-} in controlling PH in blood.	06	U	B	OR	[SLO: C-12-E-22] Describe the SN1 and SN2 mechanisms of nucleophilic substitution in halogenoalkanes including the inductive effects of alkyl groups.	3+ 3	U	E

Q:5	<p>[SLO: C-12-E-43]</p> <p>Primary and secondary amines, recall the reactions (reagents and conditions) by which primary and secondary amines are produced:</p> <p>a. reaction of halogenoalkanes with NH_3 in ethanol heated under pressure</p> <p>b. reaction of halogenoalkanes with primary amines in ethanol, heated in a sealed tube / under pressure.</p> <p>c. the reduction of amides with LiAlH_4,</p> <p>d. the reduction of nitriles with LiAlH_4 or H_2/Ni.</p>	7	K	E	OR	<p>[SLO: C-12-E-27]</p> <p>Recall the chemistry of phenol, as exemplified by the following reactions:</p> <p>a. with bases, for example NaOH (aq) to produce sodium phenoxide</p> <p>b. with Na(s) to produce sodium phenoxide and $\text{H}_2(\text{g})$</p> <p>c. in NaOH(aq) with diazonium salts to give azo compounds.</p> <p>d. nitration of the aromatic ring with dilute $\text{HNO}_3(\text{aq})$ at room temperature to give a mixture of 2-nitrophenol and 4-nitrophenol</p>	07	K	E
Q6	<p>(a) [SLO: C-12-F-11]</p> <p>Suggest the identity of molecules formed by simple fragmentation in a given mass spectrum.</p> <p>(b) [SLO: C-12-F-12]</p> <p>Deduce the number of carbon atoms, n, in a compound using the M^+ peak and the formula,</p> <p>(c) [SLO: C-12-F-13]</p> <p>Deduce the presence of bromine and chlorine atoms in a compound using the M^+ peak.</p>	2	U	F	OR	<p>(a) [SLO: C-12-C-02]</p> <p>Explain the chemical reactivity, of Group 2 elements, including their reactions with oxygen, water, and acids (Be, Mg, Ca).</p> <p>(b) [SLO: C-12-F-21]</p> <p>Analyze the different environments of carbon atoms present in a simple molecule using a ^{13}C-NMR spectrum.</p> <p>(c) [SLO: C-12-F-23]</p> <p>Predict the number of peaks in a ^{13}C NMR spectrum for a given molecule.</p>	3	U	C
		2	U	F			02	U	F
		3	U	F			02	A	F

Table of Specification of the Model Paper Grade - XII, (HSSC-II)

Domain	A	B			C		E					
Cognitive Levels	Ethics and Values in Chemistry	Electrochemistry	Chemical Equilibrium	Acid and bases	Group II	Transition metals	Organic Chemistry	Hydrocarbon	Halogeno Alkane	Hydroxy Compound	Carbonyl Compounds	Nitrogen compounds
Knowledge	Formative	Q2(xiv/s)(3)			Q1(iv)(1) Q2(xiv/f)(3)	Q2(i/f)(3)			Q1(ix)(1)	Q5(s)(7)	Q1(xiv)(1) Q2(i/s)(3) Q2(v/f)(3)	Q2(v/s)(3) Q5(f)(7)
Understanding	Formative	Q1(xvii)(1)	Q4(f)(6)		Q2(xi/f)(3) Q2(xii/f)(3) Q6(a)(s)(3)	Q1(vi)(1)	Q1(vii)(1) Q2(ix/f)(3) Q2(x/f)(3)	Q1(v)(1) Q1(viii)(1) Q2(vi/f)(3) Q2(vi/s)(3)	Q4(s)(6)	Q1(xi)(1) Q2(iv/s)(3)	Q2(x/s)(3) Q2(xii/s)(3)	Q1(x)(1)
Application	Formative	Q1(i)(1) Q2(vii/f)(3) Q2(xiii/s)(3) Q3 (s) (6)	Q1(ii)(1) Q2(xiii/f)(3)	Q2(vii/s)(3)		Q1(iii)(1) Q1(xii)(1) Q2(iii/s)(3) Q3 (f)(6)						Q2(iii/f)(3)
Total	0	17	10	3	13	15	7	8	7	11	13	14
Content %	0	11.1%	6.5%	2%	8.5%	9.8%	4.6%	5.2%	4.6%	7.2%	8.5%	9.2%

Domain	E			F									Total	%age
Cognitive Levels	Polymers	Organic Synthesis	Biochemistry	Uncertainties and errors in measurement and results	Qualitative analysis (Mass Spectrometry)	Spectroscopy	NMR	Chromatography	Material	Medicine	Agriculture	Industry		
Knowledge		Formative		Formative									35	23%
Understanding	Q1(xvi)(1) Q2(ii/f)(3) Q2(ix/s)(3)	Formative	Q1(xiii)(1) Q2(viii/f)(3)		Q6(f)(7)	Q2(ii/s)(3)	Q2(iv/f)(3) Q6(b)(s)(2)	Q1(xv)(1)	Q2(viii/s)(3)		Q2(xi/s)(3)		82	53.5%
Application		Formative					Q6(c)(s)(2)						36	23.5%
Total	7		4		7	3	7	1	3		3		153	100
Content %	4.6%		2.6%		4.6%	2%	4.6%	0.65%	2%		2%			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 domain is 20%, 50%, and 30% for knowledge, understanding, and application, respectively with $\pm 5\%$ variation.
- 4 While selecting alternative questions for SRQs and ERQs, it must be kept in mind that:

- Difficulty levels of both questions should also be same
- SLOs of both the alternative questions must be different

Key: Question Number (part/ first choice) marks example: **Q2 (i / f) 4**
Question Number (part/ second choice) marks example: **Q2 (i / s) 4**



111 032 473

For more information, please visit
www.fbise.edu.pk



/ Federal.BISE.Official



/ FBISEOfficial



/ fbise.official