CHEMISTRY

GRADE 12

SLOs for Assessment Key:

1.Assessible / Attainable - (Not included in drop down list)
2. Ambiguous (assessable in longer run) - (BOLD White)
3. Not assessable in Summitive - (Grey)
4. Repetitive (with in same grade) - (Grey)
5. Repetitive (with in same learning level) - (Grey)

Domains	Standards	Benchmarks	Topic/Title	NC SLO #	NCP (2022) - SLO	Status of SLOs	SLOs for Assessment	Cognitive Domain	Comments
Nature of Science in Chemistry	Students should be able to explain and evaluate, with examples, what philosophical assumptions underpin the practice of science	Benchmark I: Students should be able to: - explain the role of thought experiments in chemical theory - consider the ethical aspects of developing and using chemical substances and processes	**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: ● 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)	New SLO	**Ambiguous**	Understand	New SLO'S not present in current 2006 SLO'S and it takes longer for accessability
				[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).	New SLO	**Ambiguous**	Understand	New SLO'S not present in current 2006 SLO'S and it takes longer for accessability
			Electrochemistry	**[SLO: C-11-A-03]**	Explain and apply the following terms to deconstruct the structure of a scientific argument in a variety of formats such as speeches, written articles and advertisement brochures: ● claims ● counterclaims ● rebuttals ● premises ● conclusions ● assumptions	New SLO	**Not assessable in summative**	Apply	New SLO'S Not seem as assessable for summative exam .

Physical Chemistry	Describe the principles of electrochemistry, including the movement of electrons in terms of oxidation and reduction in a chemical reaction. Explain the concept of oxidation and reduction, including the role of electrons in these processes. Describe the process of electrolysis and its applications. Discuss the relationship between electricity and chemical reactions, including the use of electrodes and electrolytes. Apply the principles of electrochemistry to explain the behavior of batteries,	Students should be able to describe the principles of electricity and electrochemistry, including redox reactions, oxidation and reduction, and the behavior of electrolytes.		**[SLO: C-12-B-01]**	Apply the concept of oxidation numbers in identifying oxidation and reduction reactions	Grade 11 SLO		Apply	This SLO'S already present in current XI syllabus chapter electrochemistry
				[SLO: C-12-B-02]	Apply the concept of changes in oxidation numbers to balance chemical equations	Grade 11 SLO		Apply	This SLO'S already present in current XI syllabus chapter electrochemistry
				[SLO: C-12-B-03]	Define the terms redox, oxidation, reduction, and disproportionation (in terms of electron transfer and changes in oxidation number)	Grade 11 SLO		Understand	This SLO'S already present in current XI syllabus chapter electrochemistry
				[SLO: C-12-B-04]	Identify the oxidizing and reducing agents in a redox reaction.	New SLO		Understand	This SLO'S already present in current XI syllabus chapter electrochemistry
				[SLO: C-12-B-05]	Describe the role of oxidizing and reducing agents in the redox reaction	Matched SLO		Understand	This SLO'S already present in current XI syllabus chapter electrochemistry
				[SLO: C-12-B-06]	Explain the concept of the activity series of metals and how it relates to the ease of oxidation	Grade 11 SLO		Understand	This SLO'S already present in current XI syllabus chapter electrochemistry
				[SLO: C-12-B-07]	Deduce the feasibility of redox reactions from activity series or reaction data.	New SLO		Analyse	New SLO'S not mentioned in previous XI 2006 SLO'S
				[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	New SLO		Understand	New SLO'S not mentioned in previous XI 2006 SLO'S
				[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.	Grade 11 SLO		Understand	This SLO'S already present in current XI syllabus chapter electrochemistry
				[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	Grade 11 SLO		Analyse	New SLO'S But some related information is mentioned in current XI SLO's electrochemistry chapter
				[SLO: C-12-B-11]	Apply the relationship between the Faraday constant, Avogadro constant, and the charge on the electron to solve problems	Grade 11 SLO		Apply	This SLO'S already present in current XI syllabus chapter electrochemistry
				[SLO: C-12-B-12]	Calculate the quantity of charge passed during electrolysis and the mass or volume of substance liberated during electrolysis.	Grade 11 SLO		Apply	New SLO'S
				[SLO: C-12-B-13]	Deduce the Avogadro constant by an electrolytic method.	New SLO		Analyse	New SLO'S
				[SLO: C-12-B-14]	Define the terms standard electrode potential and standard cell potential	Grade 11 SLO		Understand	This SLO'S already present in current XI syllabus chapter electrochemistry
				[SLO: C-12-B-15]	Describe the standard hydrogen electrode and methods used to measure standard electrode potentials.	Grade 11 SLO		Understand	This SLO'S already present in current XI syllabus chapter electrochemistry
				[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.	Grade 11 SLO		Apply	This SLO'S already present in current XI syllabus chapter electrochemistry

				[SLO: C-12-B-17]	Deduce the relative reactivity of elements, compounds, and ions as oxidizing agents or reducing agents from their electrode potential values.	Grade 11 SLO		Analyse	This SLO'S already present in current XI syllabus chapter electrochemistry
				[SLO: C-12-B-18]	construct redox equations using relevant half-equations.	Grade 11 SLO		Apply	This SLO'S already present in current XI syllabus chapter electrochemistry
				[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.	New SLO		Understand	New SLO'S but attainable
		Benchmark 2: Students should be able to explain how voltaic or galvanic cells convert chemical energy into electrical energy		**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	Grade 11 SLO		Understand	This SLO'S already present in current XI syllabus chapter electrochemistry
				[SLO: C-10-B-21]	Explain how voltaic cells convert chemical energy from redox reactions to electrical energy using Cu-Zn galvanic cell as an example	Grade 11 SLO		Understand	This SLO'S already present in current XI syllabus chapter electrochemistry
	Describe the concept of chemical equilibrium and the dynamic nature of chemical reactions. Explain the relationship between concentration of reactants or products and the position of equilibrium. Apply the law of mass action to predict the position of chemical equilibrium. Discuss the effect of temperature and pressure on chemical equilibria. Describe the concept of Le Chatelier's principle and its application in predicting the effect of changes on chemical equilibria.	Benchmark 1: Students can apply the principles of chemical equilibrium to analyze and predict the position and extent of chemical reactions, and to gauge the extent of dissociation of solutes into solvents based on adjustment of physical parameters	**Equilibria**	**SLO: C-12-B-22]**	explain common ion effects giving suitable examples.	Grade 11 SLO		Understand	Already present in XI SLO'S 2006 of chapter chemical equilibria
				[SLO: C-12-B-23]	Use the extent of ionization and the acid dissociation constant, K_a, to distinguish between strong and weak acids.	Grade 11 SLO		Apply	Already present in XI SLO'S 2006 of chapter acid base and salt
				[SLO: C-12-B-24]	Use the extent of ionization and the base dissociation constant, K_b, to distinguish between strong and weak bases.	Grade 11 SLO		Apply	Already present in XI SLO'S 2006 of chapter acid base and salt
				[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 a 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 HCO3- in controlling pH in blood)	Grade 11 SLO		Understand	Already present in XI SLO'S 2006 of chapter acid base and salt
				[SLO: C-12-B-26]	Calculate concentrations of ions of slightly soluble salts.	Grade 11 SLO		Apply	Already present in XI SLO'S 2006 of chapter acid base and salt
				[SLO: C-12-B-27]	state what is meant by the term partition coefficient, K_{pc}	New SLO		Remember	New SLO'S
				[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	New SLO		Apply	New SLO'S

				[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	New SLO		Understand	New SLO'S
	Define acids and bases and describe their properties. Explain the concept of pH and describe the relationship between pH and the concentration of hydrogen ions in a solution. Describe the different types of acid-base reactions, including neutralization and proton transfer. Discuss the use of buffers to control pH, including the relationship between buffer capacity and the concentration of buffer components.	Benchmark 1: Students will be able to calculate pH values for dissolved acids and alkalis, including in titration experiments	**Acid-Base Chemistry and pH**	**[SLO: C-12-B-30]**	State that pH = − log[H^+(aq)] and [H^+] = 10(to the power)−pH.	Grade 11 SLO		Remember	Already present in XI SLO'S 2006 of chapter acid base and salt
				[SLO: C-12-B-31]	State that change of one pH unit represents a 10-fold change in the hydrogen ion concentration [H^+].	Grade 11 SLO		Remember	Already present in XI SLO'S 2006 of chapter acid base and salt
				[SLO: C-12-B-32]	Use the ionic product constant, k = [H^+][OH^-] = 10^{-14} at 298 K to solve problems	Grade 11 SLO		Apply	Already present in XI SLO'S 2006 of chapter acid base and salt
				SLO: C-12-B-33]	sketch the pH titration curves of titrations using combinations of strong and weak acids with strong and weak alkalis	New SLO		Apply	Already present in XI SLO'S 2006 of chapter acid base and salt
Inorganic Chemistry	Identify and classify Group 2 elements based on their position in the periodic table Explain the reactivity trends of Group 2 elements based on their electron configuration and oxidation state Describe the industrial and everyday uses of Group 2 elements, such as magnesium in alloys, calcium in construction, and barium in flame retardants Explain the methods for extraction and purification of Group 2 elements, such as thermal reduction and electrolysis Discuss the solubility and	Benchmark 1: Describe the trend of atomic properties in Group and their chemical reactivity with the other elements. These include the trends of reactivity and solubility, and reactions to form oxides and carbonates.	**(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	Matched SLO		Understand	Already present in XII SLO'S 2006
				[SLO: C-12-C-02]	Explain the chemical reactivity of Group 2 elements, including their reactions with oxygen, water, and acids (Be, Mg, Ca).	Matched SLO		Understand	Already present in XII SLO'S 2006
				[SLO: C-12-C-03]	Explain the reactivity of Group 2 elements in terms of their electron configuration and valence electrons.	Matched SLO		Understand	Already present in XII SLO'S 2006
				[SLO: C-12-C-04]	Describe the industrial and everyday uses of Group 2 compounds, including their role in medicine and agriculture.	Matched SLO		Remember	Already present in XII SLO'S 2006
				[SLO: C-12-C-05]	Explain the term reactivity series and its application in predicting the outcome of chemical reactions.	New SLO		Understand	Not included in the current SLO's
				[SLO: C-12-C-06]	use the term reactivity series and its application in predicting the outcome of chemical reactions.	New SLO		Apply	Not included in the current SLO's

				[SLO: C-12-C-07]	Explain the extraction and purification process of Group II elements and their compounds.	New SLO		Understand	Not included in the current SLO's
				[SLO: C-12-C-08]	Understand the term thermal decomposition and its application in the analysis of Group 2 compounds especially carbonates and nitrates.	Matched SLO		Understand	Already present in XII SLO'S 2006
				[SLO: C-12-C-09]	use the term thermal decomposition and its application in the analysis of Group 2 compounds especially carbonates and nitrates.	Matched SLO		Apply	Already present in XII SLO'S 2006
				[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	Matched SLO		Understand	Already present in XII SLO'S 2006
				[SLO: C-12-C-11]	Compare the properties and reactivity of Group 2 elements with group 1 in the periodic table.	New SLO		Analyse	Not included in the current SLO's 2006 of XII
				[SLO: C-12-C-12]	Explain the term complex ion and its application in the formation of Group2 compounds.	New SLO		Understand	Not included in the current SLO's 2006 of XII
				[SLO: C-12-C-13]	Explain the term basic oxide and its application in the formation of Group 2 compounds.	New SLO		Understand	Not included in the current SLO's 2006 of XII
				[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 polarisation of the large anion	Matched SLO		Understand	Present in current 2006 SLO'S of 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	New SLO		Understand	Not included in the current SLO's 2006 of XII
	Describe the general physical properties of transition elements Describe the pattern in electronic configuration of transition elements and its implications for chemical bonding , reactions and for physical properties	Benchmark 1: Identify the elements in the d-block of the periodic table and understand their general properties.	**Transition Metals**	**[SLO: C-12-C-16]**	Identify the general physical and chemical properties of the first row of transition elements, titanium to copper	Matched SLO		Understand	Present in current 2006 SLO'S of XII
				[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	New SLO		Understand	Not included in the current SLO's 2006 of XII
				[SLO: C-12-C-18]	sketch the shape of a $3d_{xy}$ orbital and $3d_{z2}$ orbital	New SLO		Create	Not included in the current SLO's 2006 of XII
				[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)	Matched SLO		Understand	Present in current 2006 SLO'S of XII
				[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	Matched SLO		Understand	Present in current 2006 SLO'S of XII
				[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	Matched SLO		Understand	Present in current 2006 SLO'S of XII
				[SLO: C-12-C-22]	explain why transition elements form complex ions in terms of vacant d orbitals that are energetically accessible	Matched SLO		Understand	Present in current 2006 SLO'S of XII

[SLO: C-12-C-23]	Explain the reactions of transition elements with ligands to form complexes, including the complexes of copper(II) and cobalt(II) ions with water and ammonia molecules and hydroxide and chloride ions	New SLO		Understand	Just Copper complexs are present in current XII 2006 SLO's
[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	Matched SLO		Understand	Already present in current 2006 XII SLO's
[SLO: C-12-C-25]	Use the term monodentate ligand including as examples H_2O, NH_3, Cl^- and CN^-	Matched SLO		Apply	Already present in current 2006 XII SLO's
[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	Matched SLO		Apply	Already present in current 2006 XII SLO's
[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	Matched SLO		Understand	Already present in current 2006 XII SLO's
[SLO: C-12-C-28]	Describe the geometry (shape and bond angles) of transition element complexes which are linear, square planar, tetrahedral or octahedral	Matched SLO		Understand	Already present in current 2006 XII SLO's
[SLO: C-12-C-29]	state what is meant by coordination number	Matched SLO		Remember	Already present in current 2006 XII SLO's
[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	Matched SLO		Analyse	Already present in current 2006 XII SLO's
[SLO: C-12-C-31]	explain qualitatively that ligand exchange can occur, including the complexes of copper(II) ions and cobalt(II) ions with water and ammonia molecules and hydroxide and chloride ions	New SLO		Understand	Just Copper complexs are present in current XII 2006 SLO's
[SLO: C-12-C-32]	predict, using E^0 values, the feasibility of redox reactions involving transition elements and their ions	New SLO		Analyse	Not included in the current SLO's 2006 of XII
[SLO: C-12-C-33]	Analyse reactions involving MnO_4^- / $C_2O_4^-$ in acid solution given suitable data (including describing the reaction and doing calculations)	New SLO		Analyse	Not included in the current SLO's 2006 of XII
[SLO: C-12-C-34]	Analyse reactions involving MnO_4^- / Fe^{2+} in acid solution given suitable data ((including describing the reaction and doing calculations)	New SLO		Analyse	Not included in the current SLO's 2006 of XII
[SLO: C-12-C-35]	Analyse reactions involving Cu^{2+} / I– given suitable data (including describing the reaction and doing calculations)	New SLO		Analyse	Not included in the current SLO's 2006 of XII
[SLO: C-12-C-36]	perform calculations involving other redox systems given suitable data	New SLO		Apply	Not included in the current SLO's 2006 of XII
[SLO: C-12-C-37]	use the terms degenerate and non-degenerate d orbitals	Matched SLO		Apply	Already present in current 2006 XII SLO's
[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 Δ E in: (a) octahedral complexes, two higher and three lower d orbitalss (b) tetrahedral complexes, three higher and two lower d orbitals	New SLO		Understand	Not included in the current SLO's 2006 of XII
[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	New SLO		Understand	Not included in the current SLO's 2006 of XII
[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	New SLO		Understand	Not included in the current SLO's 2006 of XII

				[SLO: C-12-C-41]	use the complexes of copper(II) ions and cobalt(II) ions with water and ammonia molecules and hydroxide, chloride ions as examples of ligand exchange affecting the colour observed	Matched SLO		Apply	Already present in current 2006 XII SLO's
				[SLO: C-12-C-42]	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(NH3)2Cl2] and octahedral such as [Co(NH3)4(H2O)2]2+ and [Ni(H2NCH2CH2NH2)2(H2O)2]2+ (b) optical isomerism, e.g. [Ni(H2NCH2CH2NH2)3]2+ and [Ni(H2NCH2CH2NH2)2(H2O)2]2+	New SLO		Understand	Not included in the current SLO's 2006 of XII
				[SLO: C-12-C-43]	deduce the overall polarity of complexes	New SLO		Analyse	Not included in the current SLO's 2006 of XII
				[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)	New SLO		Understand	Not included in the current SLO's 2006 of XII
				[SLO: C-12-C-45]	write an expression for a K_{stab} of a complex ($[H_2O]$ should not be included)	New SLO		Apply	Not included in the current SLO's 2006 of XII
				[SLO: C-12-C-46]	use K_{stab} expressions to perform calculations	New SLO		Apply	Not included in the current SLO's 2006 of XII
				[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	New SLO		Understand	Not included in the current SLO's 2006 of XII
Organic Chemistry	Basics of organic chemistry (catenation, isomerism, nomenclature, functional groups, homologous series) Students should be able to: Describe the concept of catenation, including the ability of carbon atoms to bond with each other to form complex structures. Explain the concept of isomerism in organic compounds, including structural and stereoisomers. Discuss the systematic nomenclature of organic compounds, including IUPAC rules. Describe the functional groups in organic compounds, including alcohols, carboxylic acids	Benchmark 1: Analyze the chemical and physical properties of organic compounds based on their functional groups and be acquainted with the structures and terminology of different compounds and organic mechanisms.	**Basics of organic chemistry**	**[SLO: C-12-E-01]**	Explain stereoisomerism and its division into geometrical (cis/trans) and optical isomerism	New SLO		Understand	Not included in the current SLO's 2006 of XII
				[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	New SLO		Understand	Not included in the current SLO's 2006 of XII
				[SLO: C-12-E-03]	Describe the shape of benzene and other aromatic molecules, including sp^2 hybridisation, in terms of σ bonds and a delocalised π system	Matched SLO		Understand	Already present in current 2006 XII SLO's
				[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)	Matched SLO		Understand	Already present in current 2006 XII SLO's
				[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.	Matched SLO		Understand	Already present in current 2006 XII SLO's
				[SLO: C-12-E-06]	apply the terms optically active, racemic mixture and mesocompunds on given structure.	Matched SLO		Apply	Already present in current 2006 XII SLO's

			[SLO: C-12-E-07]	Describe the effect of two optical isomers of a single substance on a plane polarized light.	Matched SLO		Understand	Already present in current 2006 XII SLO's
			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 exam	New SLO		Understand	Not included in the current SLO's 2006 of XII
Describe the structures and properties of alkanes, alkenes, and alkynes, including their classification as saturated and unsaturated hydrocarbons. Explain the reaction mechanisms and products of alkane, alkene, and alkyne reactions, including combustion, addition, and substitution reactions. Discuss the applications of hydrocarbons, including their use as fuels and starting materials for the synthesis of other organic compounds. Apply the concepts of chemical bonding and reactivity to predict the products of hydrocarbon reactions (including	Benchmark 1: Demonstrate an understanding of the formation and reactions of hydrocarbons (including aromatic compounds), their nomenclature, shapes and properties.	**Hydrocarbons**	[SLO: C-12-E-09]	Explain the shape of the benzene molecule (molecular orbital aspect).	Matched SLO		Understand	Already present in current 2006 XII SLO's
			[SLO: C-12-E-10]	Define resonance, resonance energy and relative stability of benzene.	Matched SLO		Understand	Already present in current 2006 XII SLO's
			[SLO: C-12-E-11]	Compare the reactivity of benzene with alkanes and alkenes.	Matched SLO		Analyse	Already present in current 2006 XII SLO's
			[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.	Matched SLO		Understand	Already present in current 2006 XII SLO's
			[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.	Matched SLO		Understand	Already present in current 2006 XII SLO's
			[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.	Matched SLO		Understand	Already present in current 2006 XII SLO's
			[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.	Matched SLO		Understand	Already present in current 2006 XII SLO's
			[SLO: 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.	Matched SLO		Understand	Already present in current 2006 XII SLO's
			[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.	Matched SLO		Understand	Already present in current 2006 XII SLO's

	Explain the Synthesis of halogenoalkanes and their classifications based on their molecular structure. Describe the common reactions of halogenoalkanes, including elimination reactions and substitutions, with a focus on SN1 and SN2 substitution mechanisms. Predict the reactivity of halogenoalkanes based on their molecular structure and the reaction conditions. Describe simple halogenoalkane syntheses and explain the organic functional groups involved in the reactions. Analyze the mechanisms and products of	Benchmark 1: Explain the reactions by which Halogenoalkanc and halogenoarenes are produced and the chemical reactions of these compounds.	**Halogenoalkanes**	**[SLO: C-12-E-18]**	Describe production of halogenoarenes i.e. reaction of benzene with Cl2 and Br2 in the presence of catalyst	Matched SLO		Understand	Already present in current 2006 XII SLO's
				[SLO: C-12-E-19]	compare the reactivity of halogenoalkane and halogenoarene using chloroethane and chlorobenzene as examples	New SLO		Analyse	Not included in the current SLO's 2006 of XII
				[SLO: C-12-E-20]	predict the major product(s) based on the reaction conditions and the molecular structure of the halogenoalkane.	Matched SLO		Analyse	Already present in current 2006 XII SLO's
				[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.	New SLO	**Ambiguous**	Analyse	Not included in the current SLO's 2006 of XII
		Benchmark 2: Identify various substitution reactions and how different halogenoalkanes undergo substitution reactions and the compounds they produce.		**[SLO: C-11-E-22]**	describe the SN1 and SN2 mechanisms of nucleophilic substitution in halogenoalkanes including the inductive effects of alkyl groups	Matched SLO		Understand	Already present in current 2006 XII SLO's
				[SLO: C-11-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	Matched SLO		Understand	Already present in current 2006 XII SLO's
				[SLO: C-11-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)	New SLO		Understand	Not included in the current SLO's 2006 of XII (distinguish test)

	Describe the structure and properties of alcohols, including primary, secondary, and tertiary alcohols. Explain the reaction mechanisms and products of alcohol reactions, including oxidation, esterification, and dehydration. Discuss the applications of alcohols, including their use as solvents, fuels, and starting materials for organic synthesis. Apply the concepts of chemical bonding and reactivity to predict the products of alcohol reactions. Describe the importance of	Benchmark 1: Analyze the different reactions through which different hydroxy compounds can be produced and the physical and chemical properties of corresponding alcohols.	**Hydroxy Compounds**	**[SLO: C-12-E-25]**	describe the reaction with acyl chlorides to form esters using ethyl ethanoate	Matched SLO		Understand	Already present in current 2006 XII SLO's
				[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_2O to give phenol	Matched SLO		Remember	Already present in current 2006 XII SLO's
				[SLO: C-12-E-27]	recall the chemistry of phenol, as exemplified by the following reactions: with bases, for example NaOH (aq) to produce sodium phenoxide with Na(s) to produce sodium phenoxide and H2(g) in NaOH(aq) with diazonium salts, to give azo compounds nitration of the aromatic ring with dilute HNO3(aq) at room temperature to give a mixture of 2-nitrophenol and 4-nitrophenol bromination of the aromatic ring with Br2(aq) to form 2,4,6-tribromophenol	Matched SLO		Remember	Already present in current 2006 XII SLO's
				[SLO: C-12-E-28]	explain the acidity of phenol	Matched SLO		Understand	Already present in current 2006 XII SLO's
				[SLO: C-12-E-29]	describe the relative acidities of water, phenol and ethanol	Matched SLO		Understand	Already present in current 2006 XII SLO's
				[SLO: C-12-E-30]	explain why the reagents and conditions for the nitration and bromination of phenol are different from those for benzene	Matched SLO		Understand	Already present in current 2006 XII SLO's
				[SLO: C-12-E-31]	recall that the hydroxyl group of a phenol directs to the 2-, 4- and 6-positions	Matched SLO		Understand	Already present in current 2006 XII SLO's
				[SLO: C-12-E-32]	apply knowledge of the reactions of phenol to those of other phenolic compounds, e.g. naphthol	New SLO		Apply	Not included in the current SLO's 2006 of XII (new SLO's)

	Describe the structure and properties of carbonyl Compounds , including their characteristic functional groups. Explain the reaction mechanisms and products of carboxylic acid reactions, including decarboxylation, esterification, and acid-base reactions. Discuss the applications of carboxylic acids and esters, including their use as fragrances, flavors, and starting materials for organic synthesis. Apply the concepts of chemical bonding and reactivity to predict the products of carboxylic acid reactions.	Benchmark 1: Explain the reactions by which carboxylic acids are produced and the nature, reactions and uses of these aldehydes and ketones.	**Carbonyl Compounds**	**[SLO: C-12-E-33]**	state the reaction by which benzoic acid can be produced: reaction of an alkylbenzene with hot alkaline $KMnO_4$ and then dilute acid, exemplified by methylbenzene	Matched SLO		Remember	Already present in current 2006 XII SLO's
				[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	New SLO		Understand	Not included in the current SLO's 2006 of XII (new SLO's)
				[SLO: C-12-E-35]	recognise that some carboxylic acids can be further oxidised: a. the oxidation of methanoic acid, HCOOH, with Fehling's reagent or Tollens' reagent or acidified KMnO4 or acidified K2Cr2O7 to carbon dioxide and water B. the oxidation of ethanedioic acid, HOOCCOOH, with warm acidified KMnO4 to carbon dioxide	New SLO		Understand	Not included in the current SLO's 2006 of XII (new SLO's)
				[SLO: C-12-E-36]	explain the relative acidities of carboxylic acids, phenols and alcohols	Matched SLO		Understand	Already present in current 2006 XII SLO's
				[SLO: C-12-E-37]	explain the relative acidities of chlorine-substituted carboxylic acids	Matched SLO		Understand	Already present in current 2006 XII SLO's
				[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	Matched SLO		Remember	Already present in current 2006 XII SLO's
				[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 $SOCl_2$	New SLO		Remember	Already present in current 2006 XII SLO's
				[SLO: C-12-E-40]	describe the following reactions of acyl chlorides: (check either bullets or add a,b,c,d) 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 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 an amide and HCl	New SLO		Understand	Not included in the current SLO's 2006 of XII (new SLO's)

				[SLO: C-12-E-41]	describe the addition–elimination mechanism of acyl chlorides in reactions	New SLO		Understand	Not included in the current SLO's 2006 of XII (new SLO's)
				[SLO: C-12-E-42]	explain the relative ease of hydrolysis of acyl chlorides, alkyl chlorides and halogenoarenes (aryl chlorides)	New SLO		Understand	Not included in the current SLO's 2006 of XII (new SLO's)
	Describe the structure and properties of nitrogen compounds, including their characteristic functional groups. Explain the reaction mechanisms and products of reactions with nitrogen containing compounds Discuss the formation of amide bonds to form amino acids	Benchmark 1: Explain the classification and reactions of aliphatic and aromatic amines including their conversion to amides, forming amino acids.	**Nitrogen Compounds**	**[SLO: C-12-E-43]**	recall the reactions (reagents and conditions) by which primary and secondary amines are produced: (a) reaction of halogenoalkanes with NH3 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 LiAlH4 (d) the reduction of nitriles with LiAlH4 or H2/ Ni	Matched SLO		Remember	Already present in current 2006 XII SLO's
				SLO: C-12-E-44]	Describe the reactions by which nitriles can be produced: reaction of a halogenoalkane with KCN in ethanol and heat	New SLO		Understand	Not included in the current SLO's 2006 of XII (new SLO's)
				[SLO: C-12-E-45]	recall the reactions by which hydroxy nitriles can be produced: the reaction of aldehydes and ketones with HCN, KCN as catalyst, and heat	New SLO		Remember	Not included in the current SLO's 2006 of XII (new SLO's)
				[SLO: C-12-E-46]	describe the hydrolysis of nitriles with dilute acid or dilute alkali followed by acidification	New SLO		Understand	Not included in the current SLO's 2006 of XII (new SLO's)
				[SLO: C-12-E-47]	describe the basicity of aqueous solutions of amines	Matched SLO		Understand	Already present in current 2006 XII SLO's
				[SLO: C-12-E-48]	describe the reaction of phenylamine with Br_2(aq) at room temperature	Matched SLO		Understand	Already present in current 2006 XII SLO's
				[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_2O to give phenol	New SLO		Understand	Already present in current 2006 XII SLO's
				[SLO: C-12-E-50]	explain the relative basicities of aqueous ammonia, ethylamine and phenylamine	Matched SLO		Understand	Already present in current 2006 XII SLO's
				[SLO: C-12-E-51]	identify the properties of azo compounds 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 (d) Recognize that other azo dyes can be formed via a similar route)	New SLO		Understand	Not included in the current SLO's 2006 of XII (new SLO's)
				[SLO: C-12-E-52]	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)	Matched SLO		Understand	Already present in current 2006 XII SLO's

				[SLO: C-12-E-53]	describe the reactions of amides (Some examples include: (a) hydrolysis with aqueous alkali or aqueous acid (b) the reduction of the CO group in amides with LiAlH4 to form an amine)	Matched SLO		Understand	Already present in current 2006 XII SLO's
				[SLO: C-12-E-54]	explain why amides are much weaker bases than amines	New SLO		Understand	Not included in the current SLO's 2006 of XII (new SLO's)
				[SLO: C-12-E-55]	describe the acid/ base properties of amino acids and the formation of zwitterions,	New SLO		Understand	Not included in the current SLO's 2006 of XII (new SLO's)
				[SLO: C-12-E-56]	describe the formation of amide (peptide) bonds between amino acids to give di- and tripeptides	New SLO		Understand	Not included in the current SLO's 2006 of XII (new SLO's)
				[SLO: C-12-E-57]	predict the results of electrophoresis on mixtures of amino acids and dipeptides at varying pHs	New SLO		Apply	Not included in the current SLO's 2006 of XII (new SLO's)
	Describe the structure and properties of polymers, including homopolymers and copolymers. Explain the formation and synthesis of polymers, including addition polymerization and condensation polymerization. Discuss the applications of polymers, including their use in various industries such as plastics, textiles, and biomedicine. Apply the concepts of chemical bonding and reactivity to predict the properties and reactivity of polymers. Describe the importance of polymers in materials	Benchmark 1: Describe the polymerization process and factors that affect polymer properties and performance.	**Polymer**	**[SLO: C-12-E-58]**	Explain the chemical processes and properties of PVC and nylon, and the applications of these polymers in the industry.	Matched SLO		Understand	Already present in current 2006 XII SLO's
				[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	Matched SLO		Understand	Already present in current 2006 XII SLO's
				[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.	Matched SLO		Understand	Already present in current 2006 XII SLO's
				[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), c. polyamides (from reactions of a diamine and a dicarboxylic acid or dioyl chloride, of an aminocarboxylic acid, or between amino acids)	Matched SLO		Understand	Already present in current 2006 XII SLO's
				[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.	Matched SLO		Understand	Already present in current 2006 XII SLO's

			[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.	New SLO		Analyse	Not included in the current SLO's 2006 of XII (new SLO's)
			[SLO: C-12-E-64]	Predict the type of polymerization reaction for a given monomer or pair of monomers.	New SLO		Analyse	Not included in the current SLO's 2006 of XII (new SLO's)
			[SLO: C-12-E-65]	explain the challenges associated with the disposal of non-biodegradable polymers.	New SLO		Analyse	Not included in the current SLO's 2006 of XII (new SLO's)
			[SLO: C-12-E-66]	recognise that poly(alkenes) are chemically inert and can therefore be difficult to biodegrade	New SLO		Understand	Not included in the current SLO's 2006 of XII (new SLO's)
			[SLO: C-12-E-67]	recognise that some polymers can be degraded by the action of light	New SLO		Understand	Not included in the current SLO's 2006 of XII (new SLO's)
			[SLO: C-12-E-68]	recognise that polyesters and polyamides are biodegradable by acidic and alkaline hydrolysis	New SLO		Understand	Not included in the current SLO's 2006 of XII (new SLO's)
			[SLO: C-12-E-69]	Outline the use of polymers to create artificial organs in biomedical science.	New SLO		Understand	Not included in the current SLO's 2006 of XII (new SLO's)
Identify and name common organic functional groups and their physical and chemical properties. Demonstrate understanding of the basic mechanisms of common organic reactions of functional groups. Design a synthetic route for simple organic compounds using reagents and reaction conditions. Perform basic retro-synthetic analysis to deduce the starting materials for the synthesis of a target molecule. Evaluate the feasibility and efficiency of synthetic routes for the preparation of target molecules.	Benchmark 1: Understand that function groups have distinct and varied reactions and how to synthesize one organic compound of a functional group from another.	**Organic Synthesis**	**[SLO: C-12-E-70]**	Describe the use of Artificial Intelligence tools in designing organic molecules which may have the potential to be used as medicine. (Halicin can be used as an example)	New SLO		Understand	Not included in the current SLO's 2006 of XII (new SLO's)
Describe the structure and properties of carbohydrates, proteins, and lipids, including their classification as monosaccharides, disaccharides, polysaccharides, amino acids, peptides, and fatty acids. Explain the metabolic pathways and functions of carbohydrates, proteins, and lipids in living organisms, including energy storage and transfer, structural support, and regulatory roles. Describe the structure and function of DNA and RNA, including the role of DNA in genetics and the mechanism of transcription	Benchmark 1: Explain the structures of different biochemical compounds, their reactions and role inside living organisms.	**Biochemistry**	**[SLO: C-12-E-71]**	Explain the basis of classification and structure–function relationship of carbohydrates	Matched SLO		Understand	Already present in current 2006 XII SLO's
			[SLO: C-12-E-72]	Explain the role of various carbohydrates in health and diseases	Matched SLO		Understand	Already present in current 2006 XII SLO's
			[SLO: C-12-E-73]	Identify the nutritional importance of carbohydrates and their role as energy storage	Matched SLO		Understand	Already present in current 2006 XII SLO's

				[SLO: C-12-E-74]	Explain the basis of classification and structure–function relationship of proteins	Matched SLO		Understand	Already present in current 2006 XII SLO's
				[SLO: C-12-E-75]	Describe the role of various proteins in maintaining body functions and their nutritional importance	Matched SLO		Understand	Already present in current 2006 XII SLO's
				[SLO: C-12-E-76]	Describe the role of enzyme as biocatalyst and relate this role to various functions such as digestion of food	Matched SLO		Understand	Already present in current 2006 XII SLO's
				[SLO: C-12-E-77]	Identify factors that affect enzyme activity such as the effect of temperature and pH.	Matched SLO		Understand	Already present in current 2006 XII SLO's
				[SLO: C-12-E-78]	Explain the role of inhibitors of enzyme catalyzed reactions	Matched SLO		Understand	Already present in current 2006 XII SLO's
				[SLO: C-12-E-79]	Describe the basis of classification and structure–function relationship of lipids	Matched SLO		Understand	Already present in current 2006 XII SLO's
				[SLO: C-12-E-80]	Identify the nutritional and biological importance of lipids	Matched SLO		Understand	Already present in current 2006 XII SLO's
				[SLO: C-12-E-81] repetition	Identify the structural components of DNA and RNA	Matched SLO		Understand	Already present in current 2006 XII SLO's
				[SLO: C-12-E-82]	Differentiate between the structures of DNA polymer (double strand) and RNA (single strand)	Matched SLO		Understand	Already present in current 2006 XII SLO's
				[SLO: C-12-E-83]	Relate DNA sequences to its function as storage of genetic information	Matched SLO		Analyse	Already present in current 2006 XII SLO's
				[SLO: C-12-E-84]	Relate RNA sequence (transcript) to its role in transfer of information to protein (translation)	Matched SLO		Analyse	Already present in current 2006 XII SLO's
				[SLO: C-12-E-85]	Identify the sources of minerals such as iron, calcium, phosphorus and zinc	Matched SLO		Understand	Already present in current 2006 XII SLO's
				[SLO: C-12-E-86]	Describe the role of iron, calcium, phoshorous and zinc in nutrition	Matched SLO		Understand	Already present in current 2006 XII SLO's
				[SLO: C-12-E-87]	Explain why animals and humans have large glycogen deposits for sustainable muscular activities. Hibernating animals (polar bear, reptiles and amphibians) accumulate fat to meet energy resources during hibernation	Matched SLO		Understand	Already present in current 2006 XII SLO's
				[SLO: C-12-E-88]	Identify complex carbohydrates which provide lubrication to the elbow and knee.	Matched SLO		Understand	Already present in current 2006 XII SLO's
				[SLO: C-12-E-89]	Describe fibrous proteins from hair and silk	Matched SLO		Understand	Already present in current 2006 XII SLO's
				[SLO: C-12-E-90]	Explain how cholesterol and amino acid serve as hormones	Matched SLO		Understand	Already present in current 2006 XII SLO's
				[SLO: C-12-E-91]	Identify insulin as a protein hormone whose deficiency leads to diabetes mellitus	Matched SLO		Understand	Already present in current 2006 XII SLO's
				[SLO: C-12-E-92]	Explain the role of minerals in structure and function	Matched SLO		Understand	Already present in current 2006 XII SLO's
				[SLO: C-12-E-93]	Identify calcium as a requirement for coagulation	New SLO		Understand	Not included in the current SLO's 2006 of XII (new SLO's)
				[SLO: C-12-E-94]	Identify how milk proteins can be precipitated by lowering the pH using lemon juice	New SLO		Understand	Not included in the current SLO's 2006 of XII (new SLO's)
Empirical Data Collection and Analysis	Analyze and interpret data from experiments, using mathematical and statistical tools as needed. Evaluate the accuracy and precision of data, and identify sources of error in experimental results. Communicate experimental results clearly and effectively, using appropriate graphical and written formats.	Benchmark 2: Students can apply the scientific units and measurements used in chemistry, explain the kind of errors that can appear in such measurements, and use different graphical techniques to present the collected data.	**Empirical Data Collection and Analysis**	**[SLO: C-12-F-01]**	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.)	New SLO	**Ambiguous**	Analyse	Not included in the current SLO's 2006 of XII (new SLO's)

				[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: - 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. -. This information is critical in scientific research as it helps us assess the reliability of our data and draw valid conclusions from our experiments.)	New SLO	**Ambiguous**	Understand	Not included in the current SLO's 2006 of XII (new SLO's)
				[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.	New SLO	**Ambiguous**	Analyse	Not included in the current SLO's 2006 of XII (new SLO's)
				[SLO: C-12-F-04]	Justify that repeat trials and measurements will reduce random errors but not systematic errors	New SLO	**Ambiguous**	Understand	Not included in the current SLO's 2006 of XII (new SLO's)
				[SLO: C-12-F-05]	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.	New SLO	**Ambiguous**	Understand	Not included in the current SLO's 2006 of XII (new SLO's)
				[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.	New SLO	**Ambiguous**	Understand	Not included in the current SLO's 2006 of XII (new SLO's)
				[SLO: C-12-F-07]	Discuss that drawn graphs have labelled and scaled axes, and are used in quantitative measurements	New SLO		Understand	Not included in the current SLO's 2006 of XII (new SLO's)
	Understand the principles of qualitative analysis, including the use of reagents and reaction tests to identify unknown substances. Perform experimental procedures and techniques accurately and safely, using appropriate equipment and instruments. Analyze and interpret data from experiments, using logical reasoning and inferential thinking to deduce the identity of unknown substances. Evaluate the reliability and validity of experimental results, and identify sources of error and uncertainty in the analysis.	Benchmark 1: Understand how mass spectrometers can help analyse different atoms including isotopes based on their e/m values and identify molecules based on their masses while looking at their mass spectra.	**Qualitative Analysis**	**[SLO: C-12-F-08]**	analyse mass spectra in terms of m/e values and isotopic abundances (knowledge of the working of the mass spectrometer is not required)	New SLO		Analyse	Not included in the current SLO's 2006 of XII (new SLO's)
				[SLO: C-12-F-09]	calculate the relative atomic mass of an element given the relative abundances of its isotopes, or its mass spectrum	New SLO		Apply	Not included in the current SLO's 2006 of XII (new SLO's)
				[SLO: C-12-F-10]	deduce the molecular mass of an organic molecule from the molecular ion peak in a mass spectrum	New SLO		Apply	Not included in the current SLO's 2006 of XII (new SLO's)
				[SLO: C-12-F-11]	suggest the identity of molecules formed by simple fragmentation in a given mass spectrum	New SLO		Analyse	Not included in the current SLO's 2006 of XII (new SLO's)

				[SLO: C-12-F-12]	deduce the number of carbon atoms, n, in a compound using the M +peak and the formula n=/(1.1 × abundance of M + ion) =	New SLO		Analyse	Not included in the current SLO's 2006 of XII (new SLO's)
				[SLO: C-12-F-13]	deduce the presence of bromine and chlorine atoms in a compound using the Mpeak	New SLO		Analyse	Not included in the current SLO's 2006 of XII (new SLO's)
	Describe the principles of spectroscopy and relate it to the interaction of electromagnetic radiation with matter. Analyze spectra to determine the presence and concentration of chemical species. Explain the relationship between the absorption/emission spectrum (from mass spectroscopy) of a substance and its electronic structure. Compare and contrast different types of spectroscopy (e.g. infrared, ultraviolet-visible, nuclear magnetic resonance). Use spectroscopic	Benchmark 1: Understand how spectroscopy works and can be used to identify different functional groups and structures of compounds and explain how emission and absorption spectra work.	**Spectroscopy**	**[SLO: C-12-F-14]**	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.	New SLO		Understand	Not included in the current SLO's 2006 of XII (new SLO's)
				[SLO: C-12-F-15]	Explore how Mass spectrometry (MS), proton nuclear magnetic resonance spectroscopy (1H NMR) and infrared spectroscopy (IR) are techniques that can be used to help identify compounds and to determine their structure	Matched SLO		Analyse	Already present in current 2006 XII SLO's
				[SLO: C-12-F-16]	Interpret an infrared (IR) spectrum of a simple molecule to identify functional groups	Matched SLO		Analyse	Already present in current 2006 XII SLO's
				[SLO: C-12-F-17]	Deduce possible structures for organic compounds using IR spectrum and molecular formula (Examples: phenol, acetone, ethanol)	Matched SLO		Analyse	Already present in current 2006 XII SLO's
				[SLO: C-12-F-18]	Predict whether a given molecule will absorb in the UV/visible region.	Matched SLO		Apply	Already present in current 2006 XII SLO's
				[SLO: C-12-F-19]	Predict the color of a transition metal complex from its UV/visible spectrum.	New SLO		Apply	Not included in the current SLO's 2006 of XII (new SLO's)
				[SLO: C-12-F-20]	explain atomic emission and atomic absorption spectrum.	Matched SLO		Understand	Already present in current 2006 XII SLO's
	Describe the basic principles of NMR spectroscopy and explain how it is used to determine the structure of organic molecules Distinguish between the different types of NMR spectra and interpret the information they provide Use NMR spectra to determine the number and type of carbon atoms in an organic molecule Explain how carbon-13 NMR spectra provide unique information about the structure of organic molecules. Analyze carbon-13 NMR spectra to deduce the structure of simple organic	Benchmark 1: Explain how NMR can be used to identify the compounds present and help ascertain its structure in addition to deducing the relative number of different types of protons present inside a molecule.	**NMR**	**[SLO: C-12-F-21]**	analyze the different environments of carbon atoms present in a simple molecule using a 13C NMR spectrum.	Matched SLO		Analyse	Already present in current 2006 XII SLO's

				[SLO: C-12-F-22]	Use a C13 NMR spectrum to deduce possible structures of a simple molecule.	Matched SLO		Apply	Already present in current 2006 XII SLO's
				[SLO: C-12-F-23]	Predict the number of peaks in a 13C NMR spectrum for a given molecule.	Matched SLO		Analyse	Already present in current 2006 XII SLO's
				[SLO: C-12-F-24]	analyze the different environments of protons present in a simple molecule using a 1H (proton) NMR spectrum.	Matched SLO		Analyse	Already present in current 2006 XII SLO's
				[SLO: C-12-F-25]	Use a H 1(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	Matched SLO		Apply	Already present in current 2006 XII SLO's
				[SLO: C-12-F-26]	Deduce possible structures for the molecule	Matched SLO		Apply	Already present in current 2006 XII SLO's
				[SLO: C-12-F-27]	predict the chemical shifts and splitting patterns of the protons in a given molecule	Matched SLO		Analyse	Already present in current 2006 XII SLO's
				[SLO: C-12-F-28]	explain the use of tetramethylsilane, TMS, as the standard for chemical shift measurement	Matched SLO		Understand	Already present in current 2006 XII SLO's
				[SLO: C-12-F-29]	Recognize the need for deuterated solvents, e.g. $CDCl_3$, when obtaining a proton NMR spectrum	New SLO		Understand	Not included in the current SLO's 2006 of XII (new SLO's)
				[SLO: C-12-F-30]	describe the identification of O–H and N–H protons by proton exchange using D_2O	New SLO		Understand	Not included in the current SLO's 2006 of XII (new SLO's)
	Define chromatography and explain the principles of its different types including paper chromatography, column chromatography, thin layer chromatography, and gas chromatography. Analyze the results of a chromatography experiment, including identifying spots or peaks and determining their relative sizes and positions. Design and execute chromatography experiments to separate mixtures of compounds based on their physical and chemical properties including the interpretation of Rf values. Identify any unknown	Benchmark 1: Understand how chromatography works and how one can separate different components of a mixture.	**Chromatography**	**[SLO: C-12-F-31]**	Describe the terms stationary phase, mobile phase, R_f value, baseline and solvent front.	New SLO		Understand	some part is present in current SLO'S like stationary and mobile phase
				[SLO: C-12-F-32]	Explain the principles and applications of thin-layer chromatography in forensic chemistry and analysis of unknown materials.	New SLO		Understand	simple chromatography explaination is present in current SLO's
				[SLO: C-12-F-33]	interpret R_f values and retention times in chromatograms to determine the composition of a mixture	New SLO		Analyse	Not included in the current SLO's 2006 of XII (new SLO's)
				[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	New SLO		Understand	Not included in the current SLO's 2006 of XII (new SLO's)
				[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.	Matched SLO		Understand	Already present in current 2006 XII SLO's

	Describe the properties of various materials, including metals, polymers, ceramics, and composites, and explain how these properties are related to the structure of the material. Discuss the extraction of materials from natural sources and the environmental impact of these processes. Predict the outcome of chemical reactions involving materials, including oxidation-reduction reactions, precipitation reactions, and acid-base reactions. Evaluate the sustainability of recycling processes for various materials,	Benchmark 1: Explain the properties of different materials, their extraction techniques, uses and effects in the world around us	**Materials**	**[SLO: C-12-F-36]**	Explain the properties of different materials and how they can be applied to desired structures.	New SLO		Understand	Not included in the current SLO's 2006 of XII (new SLO's)
				[SLO: C-12-F-37]	Explain the process of extracting metals from ores and alloying them to achieve desired characteristics.	Matched SLO		Understand	Already present in current 2006 XII SLO's
				[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.	Grade 11 SLO		Understand	Already present in current 2006 XII SLO's
				[SLO: C-12-F-39]	Explain the challenges associated with recycling and toxicity of some materials produced through materials science.	New SLO	**Ambiguous**	Understand	Not included in the current SLO's 2006 of XII (new SLO's)
				[SLO: C-12-F-40]	Explain the use of X-ray crystallography in analyzing structures.	New SLO	**Ambiguous**	Understand	Not included in the current SLO's 2006 of XII (new SLO's)
	Explain the concept of therapeutic index and therapeutic window, and how it affects drug efficacy and safety. Analyze the mechanisms of action of commonly used medications such as aspirin, penicillin, and opiates. Evaluate the pH regulation of the stomach and its impact on drug absorption. Evaluate the uses and limitations of antiviral medications. Analyze the trade-off between the benefits and potential side effects of different medications.	Benchmark 1: Identify common drugs used in medicines and their reactivity inside the bodies of living organisms. Understand how these drugs bind to different receptors and affect their performance.	**Medicine**	**[SLO: C-12-F-40]**	Recognize the concept of therapeutic index and therapeutic window in relation to drug administration	New SLO	**Ambiguous**	Understand	Not included in the current SLO's 2006 of XII (new SLO's)
				[SLO: C-12-F-41]	Explain the mechanism of action and uses of aspirin and penicillin and explain the chemical structure of the same	New SLO	**Ambiguous**	Understand	Not included in the current SLO's 2006 of XII (new SLO's)
				[SLO: C-12-F-42]	Describe the mechanism of action of opiates and the concept of opioid receptors in the brain	New SLO	**Ambiguous**	Understand	Not included in the current SLO's 2006 of XII (new SLO's)
				[SLO: C-12-F-43]	Describe the pH regulation of stomach and its relation to the concept of non-specific reactions and active metabolites	New SLO	**Ambiguous**	Understand	Not included in the current SLO's 2006 of XII (new SLO's)
				[SLO: C-12-F-44]	Recognize the challenges in treating viral infections with drugs and the concept of antiviral medications.	New SLO	**Ambiguous**	Understand	Not included in the current SLO's 2006 of XII (new SLO's)

	Describe the chemistry of fertilizers and its impact on plant growth and soil health. Evaluate the benefits and risks of using pesticides in agriculture, including their effects on the environment and human health. Analyze the impact of acid rain on soil and plant growth, and explain ways to mitigate its effects. Describe the basic principles and applications of genetic engineering in agriculture, including the use of transgenic crops. Assess the role of temperature in crop growth and development, and explain how changes in	Benchmark 1: Identify the chemical nature of majorly used compounds in agriculture including those in fertilizers and pesticides, their positive and negative effects on crops and their reactivity based on external conditions like temperature and moisture.	**Agriculture**	**[SLO: C-12-F-45]**	Explain the chemical composition and function of different types of fertilizers, including their role in providing essential nutrients to crops and the impact of their application on soil health.	New SLO		Understand	Not included in the current SLO's 2006 of XII (new SLO's) some part of fertilizer is present in current SLO'S of environmental chemistry
				[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.	New SLO		Understand	Not included in the current SLO's 2006 of XII (new SLO's) some part of fertilizer is present in current SLO'S of environmental chemistry
				[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.	Matched SLO		Understand	Already present in current 2006 XII SLO's environmental chmeistry
				[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.	New SLO		Understand	Not included in the current SLO's 2006 of XII (new SLO's)
				[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.	New SLO		Understand	Not included in the current SLO's 2006 of XII (new SLO's)
	Analyze the impact of industrial processes on the environment and human health Evaluate the sustainability of different industrial processes based on energy consumption, waste generation and material use. Describe the role of chemistry in key industrial sectors such as petrochemical, pharmaceutical and materials manufacturing. Analyze the use of catalysts and reaction optimization in industrial processes. Discuss the challenges and opportunities in using	Benchmark 1: Describe industrial use of chemical compounds for manufacturing, and elaborate on the reactions of various industrially used chemicals.	**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.	New SLO		Understand	Not included in the current SLO's 2006 of XII (new SLO's)

Lab and Practical Skills				[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.	Matched SLO		Understand	Already present in current 2006 XII SLO's
				[SLO: C-12-F-52]	Identify the raw materials and resources used in industrial chemistry, including those readily available in the context of Pakistan.	Matched SLO		Understand	Already present in current 2006 XII SLO's Industrial chemstry
				[SLO: C-12-F-53]	Explain the applications of industrial chemistry in industries such as petrochemical, cosmetics, cement, food production and more.	Matched SLO		Understand	Already present in current 2006 XII SLO's Industrial chemstry
				[SLO: C-12-F-54]	Elaborate on the safety measures and precautions necessary in industrial chemical processes and facilities.	Matched SLO		Understand	Already present in current 2006 XII SLO's Industrial chemstry
	Students should be able to demonstrate knowledge of how to select and safely use techniques, apparatus and materials	Benchmark 1: Students should be able to identify hazards and design safe experiments.	**Lab and Practical Skills**	[SLO: C-12-G-01]	Analyse risks associated with experiments in the lab and suggest strategies to minimize hazards	New SLO	**Not assessable in summative**	Analyse	instruction of lab work
				[SLO: C-12-G-02]	Develop guidelines for lab experiments that incorporate appropriate safety measures.	New SLO	**Not assessable in summative**	Understand	Instruction for lab saftey
				[SLO: C-12-G-03]	Communicate laboratory safety protocols to their peers and colleagues.	New SLO	**Not assessable in summative**	Apply	Instruction for lab saftey
				[SLO: C-12-G-04]	Analyse chemical hazards in terms of impact on the environment.	New SLO		Analyse	Chemical hazards and environmental saftey SLO'S
	to plan and carry out experiments and investigations. to make and record observations and measurements.	Benchmark: Accurately carry out titration experiments ensuring quality of observation and tabulation of results		[SLO: C-12-G-05]	Explain the principle behind titration (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)	Grade 11 SLO		Understand	Already present in current 2006 XI SLO's Titration
				[SLO: C-12-G-06]	understand how to correctly set up a burette in order to carry out titrations.	Grade 11 SLO	**Not assessable in summative**	Understand	Already present in current 2006 XI SLO's Titration
				[SLO: C-12-G-07]	Identify the importance of carrying out a rough titration before	Grade 11 SLO	**Not assessable in summative**	Understand	Already present in current 2006 XI SLO's Titration
				[SLO: C-12-G-08]	Carry out titrations until concordant results are obtained.	Grade 11 SLO	**Not assessable in summative**	Apply	Already present in current 2006 XI SLO's Titration
				[SLO: C-12-G-09]	Identify and use appropriate indicators in the titration.	Grade 11 SLO	**Not assessable in summative**	Understand	Already present in current 2006 XI SLO's Titration
		Benchmark: Accurately carry out rate experiments ensuring quality of observation and appropriate presentation of results.		[SLO: C-12-G-10]	Carry out rate investigation by mixing reagents and recording the time for an observation to occur.	New SLO		Apply	New SLO'S according to reaction kinetics but Rate of diffusion of gases present in current SLO'S OF XI 2006
				[SLO: C-12-G-11]	Suggest experimental designs to measure the rate of a reaction.	New SLO	**Not assessable in summative**	Understand	NEW SLO'S
		Benchmark: Accurately carry out gravimetric experiments ensuring quality of observation and appropriate presentation of results.		[SLO: C-12-G-12]	prepare a sample for gravimetric analysis	Grade 11 SLO	**Not assessable in summative**	Apply	Already present in current 2006 XI SLO's STOICHIMETRY
				[SLO: C-12-G-13]	Perform a gravimetric analysis using appropriate techniques (may include precipitation and filtration)	Grade 11 SLO		Apply	Already present in current 2006 XI SLO's STOICHIMETRY
				[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)	Grade 11 SLO	**Not assessable in summative**	Understand	Method of agravimetric
		Benchmark: Accurately carry out thermometric experiments ensuring quality of observation and appropriate results.		SLO: C-12-G-15]	prepare and set up a sample for a thermometric analysis, including appropriate mixing and stirring techniques	Grade 11 SLO	**Not assessable in summative**	Apply	experimental technique
				[SLO: C-12-G-16]	accurately use and take readings from thermometers	Grade 11 SLO	**Not assessable in summative**	Apply	experimental technique

		Benchmark: Accurately carry out gas volume experiments ensuring quality of observation and tabulation of results.		**[SLO: C-12-G-17]**	Set up and prepare a gas volume experiment, including appropriate apparatus selection and assembly techniques	Grade 11 SLO	**Not assessable in summative**	Apply	experimental technique
				[SLO: C-12-G-18]	use a gas syringe, gas burette, or other appropriate equipment to measure gas volume	Grade 11 SLO	**Not assessable in summative**	Apply	experimental technique
		Benchmark: Accurately carry out qualitative analysis tests while taking necessary safety precautions and demonstrate knowledge and skill required for the respective experiment.		**[SLO: C-12-G-19]**	Understand the appropriate methods to be used when carrying out qualitative analysis tests: · to treat all unknown materials with caution · to use an appropriate quantity of the material under test · to add only the specified amount · to work safely, e.g. 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 · to identify a gas whose formation is shown by effervescence.	Grade 11 SLO	**Not assessable in summative**	Understand	experimental handling procdure
				[SLO: C-12-G-20]	Perform the following organic analysis tests and interpret the positive test result to identify the functional group present:· 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 colourless to indicate the presence of a compound that can be oxidised.	New SLO		Apply	some part is present in current SLO'S of differnet boards
	Interpret mass spectra and identify isotopes based on their m/e values and relative abundances Determine the atomic mass of an element from its isotopic composition and mass spectrum Analyze the molecular mass of organic compounds by analyzing the molecular ion peak in a mass spectrum Predict the identity of fragmented molecules in a given mass spectrum Determine the number of carbon atoms in a compound using the M 1 peak and the formula n=/(1.1 × abundance of M + ion)	Benchmark I: should be able to analyse the presented data and identify sources of error.		**[SLO: C-12-G-21]**	Identify the best way to present collected and transformed data based on the experiment being performed	New SLO	**Not assessable in summative**	Understand	data handling in experimental work
				[SLO: C-12-G-22]	Interpret the collected data to draw conclusions based on the experiment being performed	New SLO	**Not assessable in summative**	Analyse	data handling in experimental work