آغا خان یونیورسٹی ایگزامینیشن بورڈ

AGA KHAN UNIVERSITY EXAMINATION BOARD

Pacing Guide for Teachers

CHEMISTRY

Grade XII

Theory

Number of weeks: 28

Number of periods per week: 5

Key Textbook: Grade XI Chemistry by Punjab Curriculum and Textbook Board & Grade XI Chemistry by National Book Foundation

Teacher Developer(s): Dr. Saira Erum and Syeda Khadija Hasan

Institution(s): Aga Khan Higher Secondary School, Karimabad, Karachi and Habib Public High School, Karachi

Topic	Total Periods
13. S & P Block Elements	14

Sub-Topic	Range of SLOs	Periods (40 mins)
13.1. Elements and periodicity	13.1.1-13.1.2	1
	13.1.3,13.3.1, 13.4.1,13.5.1	3
13.2 Periods 3 (Na to Ar)	13.2.1-13.2.4	3
13.3 Group 1	13.3.2-13. 3.4	2
13.4 Group 2	13.4.2-13.4.5	2
13.5 Group 4	13.5.2-13.5.5	2
13.6 Group 7	13.6.2-13.6.4	1

Learning Resource

- A-level Chemistry by E.N. Ramsden

Web Resources

- https://www.ausetute.com.au/index.html
- https://chemistrytalk.org/how-to-read-the-periodic-table/

Suggested Activities and/ or Formative Assessment

Activity 1:

Icebreaker activity: Ask students to demarcate a classroom/ Laboratory and ask them why they have demarcated it in this manner.

Activity 2:

a) Show students videos regarding different elements and ask them why they differ from one another and if there is any trend that each group is following related to a certain property.
b) Assign each SLO to different groups of students and they will present their findings.

Activity 3:

A hands-on activity in groups: Give students salt and ask them to fill out a worksheet regarding the solubility of each salt.

Activity 4:

Assign students some ed-puzzle videos and ask them to submit their responses.

Activity 5:

Get to know the Element Character: Assign each group of the periodic table to a group of students. Ask each group to present the characteristic properties of the elements in the assigned group.

Activity 6:

Chemical Reaction Challenges: Students can be challenged to create chemical reactions using only elements from a particular group. They can then discuss the trends they observe in the reactivity and properties of the group's elements.

Activity 7:

Element Research Project: Students can be assigned an element from a particular group and conduct research on its properties, reactivity, and common uses. They can then present their findings to the class and discuss the trends they observe in the group's behaviour.

Activity 8:

Element Bingo: Students can play a game of bingo where they mark off elements from a particular group. They can then discuss the trends they observe in the group's properties and reactivity.

Activity 9:

Element Debate: Students can be assigned to debate the importance of a particular group of elements in everyday life. They can then discuss the trends they observe in the group's behaviour and importance.

Further Resources

For additional resources related to teaching, learning and formative assessments, please refer to: **Learn Smart Classroom by Knowledge Platform:**

https://akueb.knowledgeplatform.com/login

Topic	Total Periods
14. d & f Block Elements	8

Sub-Topic	Range of SLOs	Periods (40 mins)
14.1 General Features of Transition Elements	14.1.1	1
14.2 Electronic Structure	14.2.1-14.2.2	1
14.3 Chemistry of some Specific Transition Elements	14.3.1-14.3.4	2
14.4 Coordination Compounds	14.4.1-14.4.4	4

Learning Resources

- Philips Mathew, Advanced Chemistry (Cambridge University Press)
- Worksheet: https://chem.libretexts.org/Ancillary_Materials/Worksheets/Worksheets%3A_General_Chemistry/Worksheets%3A_General_Chemistry_(Traditional)/Coordination_Nomenclature_(Worksheet)

Suggested Activities and/ or Formative Assessment

Activity 1:

Transition Element Lab: Students can conduct a lab experiment to observe the properties and behavior of transition elements. For example, they can observe the colour changes in solutions of different transition metal ions or the formation of coordination compounds.

Activity 2:

Transition Element Case Study: Students can be given a case study of a real-world application of a transition element, such as the use of iron in the production of steel. They can then discuss the unique properties of the transition element that make it suitable for the application and the trends they observe in the behaviour of transition elements.

Activity 3:

Transition Element Debate: Students can be assigned to debate the importance of a particular transition element in everyday life. They can then discuss the unique properties of the transition element that make it important and the trends they observe in the behaviour of transition elements.

Activity 4:

Naming Practice Worksheets: Students can be given practice worksheets with examples of transition metal complexes and asked to name them using the IUPAC naming conventions.

Activity 5:

Naming Games: Students can play games such as "IUPAC Bingo" or "IUPAC Hangman" to practice naming transition metal complexes.

Activity 6:

Element Flashcards: Students can create flashcards with information about elements, including their group and period. They can then quiz each other on the information and discuss the trends they observe in the organization of the periodic table.

Activity 7:

Redox titrations could be done to understand the role of transition elements as reducing and oxidizing agents.

Activity 8:

Colour Exploration: Distribute worksheet handouts to students. Instruct students to choose five transition elements and write down their electronic configurations. Using the periodic table as a reference, students should identify the corresponding colours of each transition element and record them on the worksheet.

Activity 9:

Electronic Configurations: Review the electronic configurations of the transition elements with the students. Emphasize the relationship between the number of unpaired electrons in the d orbitals and the colour observed.

Further Resources

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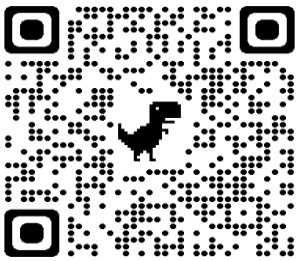

Topic	Total Periods
15. Organic Compounds	9

Sub-Topic	Range of SLOs	Periods (40 mins)
5.1 Coal as a Source of Organic Compound	15.1.1-15.1.2	1
15.2 Classification of Organic Compound	15.2.1-15.2.2	3
5.3 Isomerism	15.3.1-15.3.5	5

Learning Resources

Organic Chemistry by Solomons

Organic Chemistry by L.G. Wade

https://wisegot.com/download-l-g-wade-jr-organic-book-and-solution-in-pdf/

Essential Chemistry by Raymond Chang

https://aisyahfitrirusianijisman.files.wordpress.com/2018/03/raymond_chang_general_chemistry_the_essential_cbookos-org.pdf

https://chemistrytalk.org/isomers/

https://chemistrytalk.org/functional-groups-organic-chemistry/

Suggested Activities and/or Formative Assessment

Activity 1:

Use Real-life Examples: Connect the concept of functional groups to real-life applications, such as pharmaceuticals, polymers, and natural products. Show students how functional groups play a crucial role in determining the properties and functions of these compounds.

Activity 2:

Provide Practice Problems: Offer a variety of practice problems that involve identifying functional groups in different organic compounds. Start with simple examples and gradually increase the complexity. Encourage students to draw the structures and write the names of the functional groups present.

Activity 3:

Analyze Molecular Structures: Teach students to analyze the structure of a molecule and identify functional groups based on the presence of specific atoms or groups of atoms. Emphasize the importance of recognizing characteristic functional group patterns within the molecule.

Activity 4

Structural Isomerism

a. **Ball-and-Stick Models:** Provide students with a molecular model kit and ask them to create different structural isomers of a given molecule. They can explore chain isomerism, position isomerism, and functional group isomerism.
b. **Drawing Exercises:** Give students a set of molecules and ask them to draw all possible structural isomers for each compound.

Activity 5:

Geometrical Isomerism

a. **Molecular Models:** Use molecular models to demonstrate cis-trans isomerism in compounds with double bonds. Students can physically manipulate the models to understand the differences between the isomers.
b. **Molecular Visualization Software:** Utilize molecular visualization software or online tools to display various molecules and allow students to explore the differences between cis and trans isomers.

Activity 6:

Optical Isomerism

a. **Chiral Molecule Modeling:** Provide students with chiral molecules in a model kit and ask them to identify the chiral centres and determine the number of possible stereoisomers.
b. **Hands-on Activities:** Demonstrate optical isomerism using simple objects, such as gloves or scissors, to represent chiral molecules. Show how these objects cannot be superimposed on their mirror images.

Activity 7:

Concept Maps: Ask students to create concept maps illustrating the different types of isomerism, such as structural isomerism, stereoisomerism (including geometric and optical isomerism), and tautomeric isomerism. They can label each type, provide examples, and show the relationships between them.

Activity 8:

Sorting Activity: Prepare a set of cards or images representing different molecules exhibiting various types of isomerism. Ask students to sort and categorize them into different groups based on the type of isomerism. Encourage them to discuss their reasoning behind each classification.

Activity 9:

Peer Teaching: Divide students into small groups and assign each group a specific type of isomerism. Ask each group to prepare a short presentation explaining their assigned type of isomerism, providing examples, and highlighting key differences from other types. Afterwards, have the groups present their findings to the class.

Activity 10:

Conceptual Questions: Pose conceptual questions that require students to apply their knowledge of isomerism. For example, ask them to explain why cis-trans isomerism occurs only in compounds with restricted rotation around a double bond, or how optical isomerism is related to chirality.

Further Resources

For additional resources related to teaching, learning and formative assessments, please refer to:

Learn Smart Classroom by Knowledge Platform:

https://akueb.knowledgeplatform.com/login

Topic	Total Periods
16. Hydrocarbons	22

Sub-Topic	Range of SLOs	Periods (40 mins)
16.1 Nomenclature, Shape of Molecules and Resonance	16.1.1, 16.1.2	2
16.2 Types of Organic Reactions	16.2.1	1
16.3 Alkanes	16.3.1-16.3.2	2
16.4 Alkene	16.4.1-16.4.2	4
16.5 Alkyne	16.5.1-16.5.5	6
16.6 Benzene Substituted Benzene	16.6.1-16.6.2	2
	16.6.3-16.6.4	5

Learning Resources

- Organic chemistry by Clayden, Greeves and Warren

https://www.rachidscience.com/2020/07/book-organic-chemistry-second-edition.html

- Organic Chemistry by L.G. Wade
- Essential Chemistry By Raymond Chang

Web Resource

https://chemistrytalk.org/grignard-reagents/

Suggested Activities and/or Formative Assessment

Activity 1:

Lecture and Note-Taking: Start by delivering a comprehensive lecture on the rules and guidelines for hydrocarbon nomenclature. Provide clear explanations and examples, emphasizing key concepts and patterns.

Activity 2:

Visual Aids: Utilise visual aids such as charts, diagrams, and molecular models to illustrate the structures of hydrocarbons and how their names are derived. This will help them connect the structural features of hydrocarbons to their names.

Activity 3:

Practice Exercises: Provide students with a variety of practice exercises to reinforce their understanding of hydrocarbon nomenclature.

Activity 4:

Online Resources and Interactive tools: Take advantage of online resources and interactive tools that provide additional practice and reinforcement. There are websites, mobile apps, and computer programs available that offer interactive quizzes, naming games, and tutorials on hydrocarbon nomenclature and their reactions.

Activity 5:

Chemical Reactions Sorting: Prepare a set of reaction cards with different hydrocarbons and the corresponding reaction they undergo (e.g., combustion, substitution, addition). Ask students to sort the cards into appropriate categories, discussing the specific reaction types and their characteristics.

Activity 6:

Addition Reactions: Demonstrate an addition reaction using an unsaturated hydrocarbon, such as ethene or propene. Show the addition of bromine water to the hydrocarbon and discuss the disappearance of the red-brown color of bromine due to the formation of a colorless dibromo compound.

Activity 7:

Organic Reactions Matching Game: Create a matching game with cards containing reactants, reagents, and products of various organic reactions. Students can work in pairs or groups to match the correct combinations, reinforcing their understanding of different reaction types.

Activity 8:

Research and Presentation: Assign students specific hydrocarbon reactions to research and present to the class. Encourage them to explore real-life applications of these reactions, such as in the petrochemical industry or environmental contexts.

Activity 9:

Interactive Models: Utilise physical or virtual models of benzene to demonstrate the concept of resonance. Physical models such as molecular model kits allow students to manipulate atoms and bonds, illustrating the delocalization of electrons. Alternatively, interactive software or websites can provide virtual models for students to explore benzene's resonance.

Activity 10:

One possible interactive activity for discussing the directing effect of benzene substitution is a role-playing exercise where students act as different substituents and their respective directing effects.

Further Resources

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Topic	Total Periods
17. Alkyl halides and Amines	19

Sub-Topic	Range of SLOs	Periods (40 mins)
17.1 Alkyl Halides	17.1.1-17.1.4	4
17.2 Nucleophilic Substitution Reaction	17.2.5	1
	17.2.1-17.2.4	3
17.3 Elimination Reaction	17.3.1-17.3.4	4
17.4 Organo-Metallic Compounds (Grignard Reagent)	17.4.1-17.4.2	2
17.5 Amines	17.5.1-17.5.7	5

Suggested Activities and/or Formative Assessment

Activity 1:

Reaction Mechanism Sorting: Prepare a set of reaction mechanism cards that include the different steps involved in both S_N1 and S_N2 reactions. Shuffle the cards and distribute them among the students. In groups or individually, students must sort the cards into the correct order for each reaction mechanism. This activity will help them visualize and understand the step-by-step processes involved in both reactions.

Activity 2:

Reaction Role-Play: Divide the students into groups and assign each group a specific S_N1 or S_N2 reaction scenario. Ask them to act out the reaction, considering the different aspects of the reaction, such as the attack of the nucleophile, the formation of a transition state, and the departure of the leaving group. This activity can help students grasp the concepts of reactants, nucleophiles, leaving groups, and the overall mechanism.

Activity 3:

Study Groups or Partners: Collaborate with classmates or study partners to create a set of practice problems or quiz each other on alkyl halide and amine naming.

Activity 4:

Reaction Puzzle: Create a puzzle or crossword related to S_N1 and S_N2, or E1 and E2 reactions. Include clues that describe the reactants, products, nucleophiles, leaving groups, and conditions for each reaction. Students must solve the puzzle by correctly filling in the blanks with the appropriate terms. This activity encourages critical thinking and helps students reinforce their knowledge of the reactions and their key components.

Activity 5:

Virtual Lab Simulation: Use virtual lab simulations or interactive software that allows students to perform S_N1 and S_N2 reactions virtually. These simulations provide a hands-on experience, allowing students to choose different reactants, change reaction conditions, and observe the outcomes. They can explore how different factors affect the reaction rate, stereochemistry, and product formation.

Activity 6:

Reaction Mapping: Create a reaction mapping activity where students are given a starting amine compound and must predict the products and mechanisms of various reactions. Provide them with a set of reagents and conditions commonly used in amine reactions, Students can work individually or in pairs to complete the reaction maps and then compare their answers with the rest of the class. This activity will help them develop a deeper understanding of the reactions and mechanisms involved.

Activity 7:

Flashcards: Create flashcards with the names of various alkyl halides and amines on one side and their corresponding structures on the other side. Practice matching the names with the structures and vice versa. This activity will help you familiarize yourself with the common naming conventions.

Activity 8:

Naming Exercises: Take a set of structures and try to name them using the common naming system for alkyl halides and amines. You can find examples in textbooks, online resources, or create your own. Practice regularly to improve your naming skills.

Activity 9:

a. **Structure-to-Name Conversion**

Given a structural formula, try to convert it into a common name. Start with simple examples and gradually move to more complex structures. This activity will help you reinforce the relationship between the structure and the name. (Some samples of this activity are given in Grade X PG)

b. **Name-to-Structure Conversion**

Given a common name, try to draw the corresponding structure. Begin with simple examples and gradually increase the complexity. This exercise will enhance your ability to translate the name into a structural formula. (Some samples of this activity are given in Grade X PG)

Further Resources

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Topic	Total Periods
18. Alcohols, Phenols and Ethers	13

Sub-Topic	Range of SLOs	Periods (40 mins)
18.1 Alcohols	18.1.1-18.1.9	6
18.2 Phenols	18.2.1-18.2.5	5
18.3 Ethers	18.3.1-18.3.4	2

Suggested Activities and/or Formative Assessment

Activity 1:

Interactive Activities: Organize interactive activities to reinforce the concepts. You can prepare flashcards with different alcohols and their corresponding reactions. Divide the students into groups and have them match the alcohol with the correct reaction. This activity promotes active learning and enhances students' retention of the material.

Activity 2:

Problem-solving exercises: Solve practice problems or work on sample questions related to alcohol reactions. This will help reinforce your understanding of the concepts and their applications.

Activity 3:

Visual aids and simulations: Utilise interactive simulations or visual aids available online or in software applications. These tools can help you visualize the reactions and better understand the mechanisms involved.

Activity 4:

Practical demonstration to compare acidity of alcohol with phenol: prepare a list of chemical tests like, litmus test, $NaHCO_3$ test, PH measurements, dissolution in NaOH.

Ask students to perform these tests and explain the reactivity based on their observations. (Virtual lab simulation can also be done)

Activity 5:

Reaction Identification: Provide students with a list of reactions involving alcohol and phenols. They can work in pairs or groups to identify the type of reaction (e.g., oxidation, esterification, substitution) and write the balanced chemical equation for each reaction.

Further Resources

For additional resources related to teaching, learning and formative assessments, please refer to: **Learn Smart Classroom by Knowledge Platform:**

https://akueb.knowledgeplatform.com/login

Topic	Total Periods
19. Carbonyl Compound I: Aldehyde & Ketones	11

Sub-Topic	Range of SLOs	Periods (40 mins)
19.1 Nomenclature and Structure	19.1.1-19.1.3	1
19.2 Physical Properties 19.3 Preparation of Aldehydes and Ketones	19.2.1,19.3.1	1
19.4 Reactions of Aldehydes and Ketones	19.4.1-19.4.4	8
19.5 Uses and Effect	19.5.1,19.5.2	1

Suggested Activities and/or Formative Assessment

Activity 1:

To enhance understanding, provide hands-on experience with molecular model kits. Students can build and visualise the different isomers, helping them grasp the spatial arrangements.

Activity 2:

Hands on activity: Models and kits can be given to students to analyse different isomers from the formula of given aldehyde and ketones.

Activity 3:

Reaction Mechanism Diagrams: Create reaction mechanism diagrams for the selected acid-catalyzed reactions of aldehydes. Illustrate the steps involved, including protonation, nucleophilic attack, intermediate formation, and product formation. Use arrows and appropriate symbols to represent electron movements.

Activity 4:

Mechanism Discussion Sessions: Organise group discussions or seminar sessions where participants can present and discuss different aspects of the acid and base-catalyzed reactions of aldehydes and ketones. Encourage questions, debates, and critical analysis of the proposed mechanisms.

Activity 5:

Reaction Mechanisms: Present students with different aldehyde reactions and ask them to explain the reaction mechanisms involved. For example, they could analyze the nucleophilic addition of aldehydes with various reagents like water, alcohols, or amines.

Activity 6:

Synthesis of Aldehydes: Provide starting material and ask students to propose a synthetic route to obtain a specific aldehyde/ ketone. They will need to consider appropriate reagents, reaction conditions, and possible side reactions that might occur.

Activity 7:

Matching Exercise: Create a list of ammonia derivatives and a separate list of aldehyde derivatives. Ask students to match the appropriate derivative from one list with its corresponding reaction or product from the other list.

Activity 8:

Synthesis Challenge: Provide a target molecule and ask students to design a multi-step synthesis using ammonia derivatives and aldehydes as key starting materials. Evaluate their understanding of reaction sequences, reactivity, and selectivity.

Further Resources

For additional resources related to teaching, learning and formative assessments, please refer to: **Learn Smart Classroom by Knowledge Platform:**

https://akueb.knowledgeplatform.com/login

Topic	Total Periods
20. Carbonyl Compound II: Carboxylic Acids & Derivative	15

Sub-Topic	Range of SLOs	Periods (40 mins)
20.1 Nomenclature	20.1.1-20.2.2	2
20.2 Structure and Physical Properties	20.2.1	1
20.3 Acidity	20.3.1	1
20.4 Preparation of Carboxylic Acid	20.4.1	1
20.5 Reactivity	20.5.1-20.5.2	4
20.6 Reactions of Carboxylic acid	20.6.1-20.6.3	5
20.7 Uses	20.7.1-20.7.2	1

Suggested Activities and/or Formative Assessment

Activity 1:

Comparative Analysis: Provide students with a list of different carboxylic acids, such as acetic acid, formic acid, and benzoic acid. Ask them to compare the physical properties (melting point, boiling point, solubility) and chemical reactivity of these

acids. Encourage them to discuss the underlying factors that influence these properties.

Activity 2:

Reaction Pathways: Select a specific carboxylic acid, such as ethanoic acid (acetic acid), and present a series of reactions involving this compound. Ask students to identify the reactants, products, and intermediates, as well as the conditions required for each reaction. Encourage them to discuss the mechanisms and factors influencing the reaction outcomes.

Activity 3:

Derivative Shuffle: To engage students in a hands-on activity to explore the interconversion of carboxylic acid derivatives. Assign each group a set of index cards and Instruct each group to write one type of carboxylic acid derivative on each card, including the specific compound name or formula. Once the cards are prepared, have each group shuffle their cards and distribute them equally among group members. Discuss the mechanisms of key reactions, emphasizing the role of nucleophiles, electrophiles, and leaving groups.

Activity 4:

Mechanism Analysis: Students can be provided with a set of acid derivative reactions and asked to propose plausible reaction mechanisms. This activity assesses their understanding of the reaction pathways involved in carboxylic acid interconversion.

Activity 5:

Problem-Solving Exercises: Students can be given a series of problems or questions related to carboxylic acid interconversion reactions. These exercises can involve predicting the products of specific reactions, determining the starting material required to synthesize a given acid derivative, or identifying the reagents and conditions needed to convert one acid derivative into another. This type of assessment tests students' knowledge of the reactions, their ability to apply concepts, and their problem-solving skills.

Assessment 6:

Naming Practice: Given a set of carboxylic acid derivatives, write their systematic IUPAC names. Start with simple derivatives like acid chlorides, esters, and amides, and gradually progress to more complex compounds such as anhydrides and acid halides.

Activity 7:

Structure-to-Name Matching: Provide a series of carboxylic acid derivative structures and ask the students to match them with their corresponding IUPAC names. This activity helps reinforce the relationship between structural features and nomenclature.

Activity 8:

Name-to-Structure Drawing: Give students the systematic names of carboxylic acid derivatives and ask them to draw the corresponding structures. This activity tests their ability to interpret the nomenclature rules and apply them to generate the correct chemical structures.

Activity 9:

Problem-Solving Scenarios: Present students with complex scenarios involving the synthesis or interconversion of carboxylic acid derivatives. Ask them to propose the appropriate IUPAC names for the starting materials, intermediates, and final products. This type of activity evaluates their overall comprehension of the nomenclature and their ability to apply it in practical situations.

Further Resources

For additional resources related to teaching, learning and formative assessments, please refer to: **Learn Smart Classroom by Knowledge Platform:**

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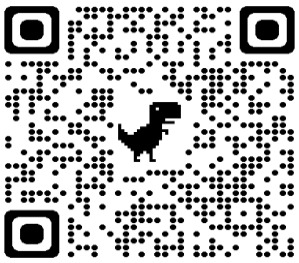

Topic	Total Periods
21. Biochemistry	7

Sub-Topic	Range of SLOs	Periods (40 mins)
21.1 Carbohydrates, Proteins and Lipids	21.1.1-21.1.7	5
21.2 Enzymes	21.2.1	1
21.3 Nucleic Acids 21.4 Minerals of Biological significance	21.3.1-21.3.2, 21.4.1	1

Learning Resources

- Organic Chemistry by Clayden, Greeves and Warren
- Organic Chemistry by L.G. Wade

https://chemistrytalk.org/nucleic-acids/

https://chemistrytalk.org/what-are-enzymes/

https://chemistrytalk.org/proteins-and-amino-acids/

https://chemistrytalk.org/protein-denaturation/

https://www.youtube.com/watch?v=yk14dOOvwMk

Suggested Activities and/or Formative Assessment

Activity 1:

Protein Structure Puzzle: Distribute printed copies of protein structure diagrams to each student or group. Instruct the students to cut out the protein structure diagrams along the lines, separating the different levels of protein structure. Each level should be cut into separate pieces. Then ask students or groups to reconstruct the protein structure puzzles by arranging the cut-out pieces according to their respective levels of structure.

Activity 2:

Analyse carbohydrate diagrams: Look for carbohydrate structure diagrams in textbooks or scientific articles. Analyse these diagrams to identify the types of sugars involved, the linkage positions, and the overall structure of the molecule. This will help you understand how the different components of a carbohydrate are connected.

Activity 3:

Explore online Resources: Utilise online resources such as interactive tutorials, quizzes, and virtual laboratories. Many educational websites offer interactive tools and simulations that allow you to explore carbohydrate structures and their properties in a dynamic and engaging way.

Activity 4:

Classification Exercise: Provide students with a handout or worksheet that includes different types of lipids such as triglycerides, phospholipids, steroids, and waxes. Ask them to classify each lipid based on its structural and functional characteristics.

Activity 5:

Protein Model Building: Provide students with different materials such as beads, pipe cleaners, and foam balls to create physical models of various protein structures. You can assign different protein types to groups of students and have them build models to represent their assigned protein.

Activity 6:

Protein Sorting Game: Prepare a deck of cards or flashcards, each featuring a different protein type. Divide the class into small groups and distribute the cards. Students should then categorize the proteins into groups based on their structures or functions. This activity encourages critical thinking and collaboration.

Activity 7:

Demonstrate Protein Denaturation

a) **Denaturation by pH**: Proteins can be denatured by extreme pH conditions. Take two test tubes and add an equal amount of protein solution to each. Adjust the pH of one test tube to an extreme acidic or alkaline value (pH 2 or pH 12, for example) using appropriate acids or bases. Observe how the protein denatures, resulting in a change in its physical properties, such as precipitation or a change in color.
b) **Egg White Cooking:** This is a classic demonstration of protein denaturation. Take two containers, and in one container, place raw egg white. In the other container, heat some water until it boils. Carefully pour the boiling water into the container with raw egg white. Observe how the egg white changes from a transparent liquid to a solid white mass due to the denaturation and coagulation of proteins.

Activity 8:

Enzyme quizzes and games: Organise quizzes or educational games that focus on enzyme-related concepts. This can help reinforce knowledge and make learning enjoyable.

Activity 9:

Venn Diagram: Provide students with a Venn diagram template or draw one on the board. Ask them to write characteristics or properties of DNA in one circle and those of RNA in the other circle. Then, in the overlapping section, have them write the shared characteristics of both DNA and RNA.

Activity 10:

Building Blocks: Provide students with a set of nucleotides building blocks paper based (adenine, guanine, cytosine, thymine/uracil, and a sugar-phosphate backbone). In pairs or small groups, ask them to assemble both a DNA strand and an RNA strand using the provided building blocks. This activity helps demonstrate the structural differences between DNA and RNA.

Further Resources

For additional resources related to teaching, learning and formative assessments, please refer to: **Learn Smart Classroom by Knowledge Platform:**

https://akueb.knowledgeplatform.com/login

Topic	Total Periods
22. Industrial Chemistry	8

Sub-Topic	Range of SLOs	Periods (40 mins)
22.1 Introduction	22.1.1-22.1.2	1
22.2 Safety Measurements	22.2.1	0.5
22.3 Dyes and Pigments	22.3.1-22.3.2	1.5
22.4 Petro-chemicals	22.4.1-22.4.4	2
22.5 Synthetic Polymers (PVC and Nylon)	22.5.1-22.5.2	1
22.6 Synthetic Adhesives	22.6.1	1
22.7 Pesticides	22.7.1-22.7.3	1

Learning Resource

- Organic Chemistry by Clayden, Greeves and Warren

Suggested Activities and/or Formative Assessment

Activity 1:

Interactive Simulations: Look for online interactive simulations or virtual laboratory experiments that demonstrate the fractional distillation process. These simulations allow you to observe and manipulate the various components involved in the process.

Activity 2:

Polymerisation Role Play: Divide the class into groups and assign each group a specific type of polymerisation (e.g., addition, condensation, or co-polymerisation). Ask each group to prepare a short skit or role play demonstrating the process and characteristics of their assigned polymerisation type. Encourage creativity and accuracy in portraying the steps and concepts involved.

Activity 3:

Polymerisation Stations: Set up different stations in the classroom, each representing a different type of polymerisation. For example, one station could demonstrate addition polymerisation using modeling clay, another station could simulate condensation polymerisation with a DIY reaction involving two different chemicals, and a third station could showcase co-polymerisation through a hands-on activity using various colored beads. Rotate students through the stations, allowing them to experience and observe the different polymerisation processes firsthand.

Activity 4:

Polymerisation Puzzle: Create a puzzle activity where students are given pieces that represent monomers and must assemble them correctly to form a polymer chain. Provide different sets of monomer pieces representing different polymerisation types, such as addition and condensation. This activity will help students understand the connectivity and structure of polymers formed through different polymerisation processes.

Activity 5:

Experimental Videos: Watch educational videos or documentaries that showcase the fractional distillation process in action. Visualising the process and seeing the equipment used can enhance your students' understanding.

Further Resources

For additional resources related to teaching, learning and formative assessments, please refer to: **Learn Smart Classroom by Knowledge Platform:**

https://akueb.knowledgeplatform.com/login

Topic	Total Periods
23. Environmental Chemistry	8

Sub-Topic	Range of SLOs	Periods (40 mins)
22.1 Introduction	22.1.1-22.1.2	1
22.2 Safety Measurements	22.2.1	0.5
22.3 Dyes and Pigments	22.3.1- 22.3.2	1.5
22.4 Petrochemicals	22.4.1-22.4.4	2
22.5 Synthetic Polymers (PVC and Nylon)	22.5.1- 22.5.2	1
22.6 Synthetic Adhesives	22.6.1	1
22.7 Pesticides	22.7.1- 22.7.3	1

Suggested Activities and/or Formative Assessment

Activity 1:

Group Presentation: Divide the participants into smaller groups and assign each group one of the three oxides (CO_x, NO_x, or SO_x). Ask each group to research and prepare a short presentation on the following points:

•Sources of the oxide (e.g., industrial processes, transportation, power plants).

•Environmental impacts (e.g., contribution to air pollution, climate change, acid rain).

•Health effects on humans and other organisms.
•Current regulations or initiatives aimed at reducing emissions of the specific oxide.
•Any other relevant information or case studies.

Activity 2:

Interactive Presentations: Create visually appealing presentations using images, diagrams, and animations to explain the greenhouse effect. Encourage students to ask questions and participate in discussions throughout the presentation.

Activity 3:

Multimedia Projects: Allow students to work individually or in groups to create multimedia projects, such as videos, infographics, or podcasts, to explain the greenhouse effect. Encourage creativity and emphasize the importance of communicating scientific concepts effectively.

Activity 4:

Process Flow Diagram: Create a process flow diagram of a typical wastewater treatment plant on a whiteboard or using a digital presentation tool. Engage students in a discussion about each step of the treatment process, including preliminary treatment, primary treatment, secondary treatment, and tertiary treatment.

Activity 5:

Group Discussion: Divide students into small groups and provide them with specific wastewater treatment scenarios or challenges. Ask each group to brainstorm and discuss potential solutions, considering factors such as the level of pollution, available resources, and community needs. Encourage them to think critically and come up with innovative ideas.

Activity 6:

Field Trip or Guest Speaker: Arrange a field trip to a local wastewater treatment plant or invite a guest speaker who has experience in the field of wastewater treatment. This will provide students with practical insights and allow them to ask questions directly to professionals working in the industry.

Further Resources

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Topic	Total Periods
24. Analytical Chemistry	6

Sub-Topic	Range of SLOs	Periods (40 mins)
24.1 Classical and Modern Methods of Analysis	24.1.1-24.1.12	6

Learning Resources

- Essential Chemistry By Raymond Chang
- Foundation of College Chemistry by Morris Hein
- Basic Chemistry by Leo J.Malone, Theodore Dolter
- Chemistry: The Science in Context by Thomas R. Gilbert
- Advanced Chemistry an Enquiry-based approach by James Maple

Web Resources

https://www.khanacademy.org/science/ap-chemistry-beta/x2eef969c74e0d802:atomic-structure-and-properties/x2eef969c74e0d802:mass-spectrometry-of-elements/v/mass-spectrometry

https://chemistrytalk.org/naming-alkanes/

https://chemistrytalk.org/iupac-naming-organic-compounds/

https://chemistrytalk.org/what-is-ir-spectroscopy/

https://chemistrytalk.org/mass-spectrometry/

https://chemistrytalk.org/emission-absorption-spectrum/

Suggested Activities and/or Formative Assessment

Activity 1:

Case Studies: Introduce real-life case studies where spectroscopy played a vital role in scientific discoveries or forensic investigations. Engage students in discussions about the significance and limitations of spectroscopic techniques in those scenarios.

Activity 2:

Interactive Simulations: Utilise interactive software or online simulations that allow students to virtually operate spectroscopic instruments and analyze spectra. These simulations can be highly effective in reinforcing concepts and developing practical skills.

Activity 3:

Guest Speakers and Field Trips: Invite experts from academia or industry to deliver lectures or demonstrations on spectroscopy. Organize field trips to laboratories or industrial settings where students can observe spectroscopic techniques in action.

Activity 4:

Group Discussions: Organise group discussions where students can present and discuss their interpretations of IR spectra. Encourage them to explain their reasoning, share different approaches, and engage in critical thinking. This activity fosters collaboration and helps students refine their interpretation skills through peer feedback.

Activity 5:

Isotope Abundance Calculation: Provide students with a simple molecular formula and ask them to calculate the isotopic abundance for each element in the compound. They can then compare their calculated values with the actual isotopic abundance data and discuss the implications of isotopic patterns in mass spectrometry.

Further Resources

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Note: This teacher-led pacing guide has been developed for AKU-EB affiliated schools to facilitate them by

- ensuring smooth transition of a school's academic year.
- ensuring curricular continuity in schools.
- predicting the time and pace of syllabi implementation.

This document also contains **suggested activities and/or formative assessments** that may enhance the learning experience. Please note that these activities are meant to serve as suggestions. As educators, you have the flexibility and autonomy to adapt and modify them to best suit the needs of your students and the dynamics of your classroom.

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