CBSE Class 12 Chemistry Notes Chapter 11: CBSE Class 12 Chemistry Notes for Chapter 11 Alcohols, Phenols, and Ethers provide a detailed overview of these important organic compounds. Alcohols are characterized by the presence of one or more hydroxyl (-OH) groups attached to a carbon atom, affecting their physical and chemical properties. Phenols, on the other hand, have hydroxyl groups bonded directly to an aromatic ring, influencing their acidity and reactivity.

Ethers consist of an oxygen atom connected to two alkyl or aryl groups, making them valuable as solvents and in synthesis. These notes detail the nomenclature, preparation methods, reactions, and uses of alcohols, phenols, and ethers, ensuring a clear understanding of their roles in organic chemistry.

CBSE Class 12 Chemistry Notes Chapter 11 Alcohols, Phenols and Ethers Overview

CBSE Class 12 Chemistry Notes for Chapter 11 Alcohols, Phenols, and Ethers are prepared by the subject experts of Physics Wallah.

By breaking down complex concepts into understandable segments, these notes aim to facilitate better comprehension and retention for students. This well-structured material is designed to help students grasp the key ideas effectively and perform confidently in their exams.

CBSE Class 12 Chemistry Notes Chapter 11 Alcohols, Phenols and Ethers PDF

The PDF link for CBSE Class 12 Chemistry Notes Chapter 11 Alcohols, Phenols, and Ethers is provided below. This PDF provide a detailed guide to understanding the important concepts of alcohols, phenols, and ethers, including their nomenclature, preparation, properties, and reactions.

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Here we have provided CBSE Class 12 Chemistry Notes Chapter 11 Alcohols, Phenols and Ethers-

Introduction

Alcohols are organic compounds characterized by the presence of a hydroxyl group (-OH) attached to a saturated carbon atom. This category includes various types of carbon, such as alkyl, alkynyl, alkenyl, cycloalkyl, or benzyl. Enols, a related class, feature a hydroxyl group linked to an unsaturated carbon within a double bond. When the hydroxyl group is attached directly to a benzene ring, the compound is known as a phenol.

Alcohols are versatile in both industrial and daily applications. For instance, ethanol is commonly used for polishing wooden furniture. Additionally, essential compounds like sugar, cotton, and paper contain hydroxyl groups. Phenols are significant in the production of polymers such as Bakelite and pharmaceuticals like aspirin. Ethers, another class of compounds, are primarily utilized as anesthetics and solvents.

In alcohols, the hydroxyl group's oxygen is bonded to the carbon via a sigma bond, which results from the overlap of sp hybridized orbitals of carbon and oxygen. The structural aspects of alcohols, phenols, and ethers are illustrated in the following figure, highlighting their different bonding and structural features.

Classification of Alcohol Phenol and Ether

1. Alcohols

Alcohols are classified based on the number of hydroxyl groups (-OH) they contain, and the type of carbon atom to which the -OH group is attached:

Based on the Number of Hydroxyl Groups:

- **Monohydric Alcohols**: Contain one -OH group. Example: Ethanol (CH_3CH_2OH).
- **Dihydric Alcohols**: Contain two -OH groups. Example: Ethylene glycol (1,2-ethanediol).
- **Trihydric Alcohols**: Contain three -OH groups. Example: Glycerol (1,2,3-propanetriol).
- **Polyhydric Alcohols**: Contain more than three -OH groups. Example: Sorbitol.

Based on the Carbon Atom Bonded with the -OH Group:

- **Primary Alcohols**: The -OH group is attached to a carbon that is bonded to only one other carbon. Example: Ethanol.
- **Secondary Alcohols**: The -OH group is attached to a carbon bonded to two other carbons. Example: Isopropanol (2-propanol).
- **Tertiary Alcohols**: The -OH group is attached to a carbon bonded to three other carbons. Example: tert-Butanol.

Based on the Position Relative to Double Bonds or Rings:

- **Allylic Alcohols**: The -OH group is attached to a carbon adjacent to a C=C double bond. Example: 3-Buten-1-ol.
- **Benzylic Alcohols**: The -OH group is attached to a carbon directly bonded to a benzene ring. Example: Benzyl alcohol.

2. Phenols

Phenols are aromatic compounds where one or more hydroxyl groups are directly bonded to a benzene ring:

Based on the Number of Hydroxyl Groups:

- **Monohydroxy Phenols**: Contain one -OH group attached to the benzene ring. Example: Phenol (C_6H_5OH).
- **Dihydroxy Phenols**: Contain two -OH groups. They can be further classified based on the positions of -OH groups:
- **Ortho- (o-)**: Hydroxyl groups are adjacent. Example: Catechol.
- **Meta- (m-)**: Hydroxyl groups are separated by one carbon. Example: Resorcinol.
- **Para- (p-)**: Hydroxyl groups are opposite each other. Example: Hydroquinone.
- **Trihydroxy Phenols**: Contain three -OH groups. Example: Phloroglucinol.

3. Ethers

Ethers are characterized by an oxygen atom connected to two alkyl or aryl groups:

Based on the Nature of Substituents:

- **Simple Ethers**: Both substituents are the same or similar alkyl/aryl groups. Example: Dimethyl ether (CH_3OCH_3).
- **Mixed Ethers**: Contain different alkyl or aryl groups. Example: Ethyl methyl ether ($CH_3OCH_2CH_3$).
- **Cyclic Ethers**: The oxygen atom is part of a ring structure. Example: Tetrahydrofuran (THF).

Nomenclature and Preparation of Alcohols, Phenols, and Ethers

Nomenclature:

Alcohols:

- **Common Name:** Derived from the alkyl group followed by "alcohol." For example, CH_3OH is named methyl alcohol.
- **IUPAC Name:** Derived from the name of the parent alkane with the suffix ‘-ol.’ For example, CH_3OH is named methanol (from methane).
- **Cyclic Alcohols:** Named by prefixing "cyclo-" and considering the hydroxyl group attached to the first carbon. Example: Cyclohexanol.

Phenol:

- **Common Name:** Phenol is the common and IUPAC name for the simplest hydroxy derivative of benzene.

- **Dihydroxy Benzene Derivatives:** Named based on the positions of the hydroxyl groups on the benzene ring as 1,2- (ortho), 1,3- (meta), and 1,4- (para) benzenediol. Example: 1,2-Benzenediol is catechol.

Ethers:

- **General Names:** Derived from the names of the alkyl or aryl groups connected to the oxygen atom, listed in alphabetical order, followed by "ether." Example: $CH_3OC_2H_5$ is ethyl methyl ether.

Preparation:

Alcohols:

- **Hydrolysis of Halides:** Alkyl halides react with an aqueous alkali hydroxide to yield alcohols through nucleophilic substitution. Example: R-X + KOH → R-OH + KX.
- **Hydration of Alkenes:** Alcohols can be prepared directly by adding water in the presence of a catalyst or indirectly by adding sulfuric acid followed by hydrolysis. Example: $CH_2=CH_2 + H_2O \rightarrow CH_3CH_2OH$.
- **Reduction of Aldehydes and Ketones:** Aldehydes and ketones are reduced using reducing agents like $LiAlH_4$ to form alcohols. Example: $CH_3CHO + H_2 \rightarrow CH_3CH_2OH$.
- **Reduction of Carboxylic Acids:** Carboxylic acids are reduced with hydrogen to yield alcohols. Example: $CH_3COOH + H_2 \rightarrow CH_3CH_2OH$.
- **Hydroboration of Alkenes:** Alkenes react with diborane to form alkyl boranes, which on oxidation yield alcohols, typically leading to anti-Markovnikov addition. Example: $R\text{-}CH=CH_2 + BH_3 \rightarrow R\text{-}CH(OH)\text{-}CH_3$.
- **Grignard Synthesis:** Grignard reagents react with carbonyl compounds to form alcohols. For instance, formaldehyde gives primary alcohols, while ketones yield tertiary alcohols.

Phenols:

- **From Sulfonic Acids:** Sodium benzene sulfonate is fused with sodium hydroxide to produce sodium phenoxide, which is acidified to yield phenol. Example: $C_6H_5SO_3Na + NaOH \rightarrow C_6H_5ONa + Na_2SO_4$; $C_6H_5ONa + HCl \rightarrow C_6H_5OH + NaCl$.
- **From Diazonium Salts:** Diazonium salts hydrolyzed under steam or boiling sulfuric acid produce phenol. Example: $C_6H_5\text{-}N_2^+Cl^- + H_2O \rightarrow C_6H_5OH + N_2 + HCl$.
- **From Cumene:** Cumene (isopropylbenzene) is oxidized to cumene hydroperoxide, which is then reacted with acid to yield phenol and acetone. Example: $C_6H_5\text{-}CH(CH_3)_2 + O_2 \rightarrow C_6H_5\text{-}C(CH_3)_2\text{-}OOH \rightarrow C_6H_5OH + (CH_3)_2CO$.

Physical Properties and Chemical Reactions of Alcohols, Phenols, and Ethers

Physical Properties:

- **Solubility:** Alcohols and phenols are soluble in water due to the formation of hydrogen bonds between their -OH groups and water molecules. However, this solubility decreases as the size of the hydrophobic (non-polar) group increases. Consequently, alcohols and phenols generally have higher boiling points compared to similar molecular mass hydrocarbons, except for carboxylic acids. This is attributed to their polar and protic nature.

Chemical Reactions:

Reaction with Metals:

- Alcohols and phenols react with active metals such as sodium (Na), potassium (K), and aluminum (Al) to form corresponding alkoxides, phenoxides, and hydrogen gas. This reaction demonstrates their acidic properties, though they are less acidic than water.

Acidity of Alcohols:

- The acidity of alcohols is influenced by the polarity of the -OH bond. Electron-releasing groups increase the electron density on oxygen, decreasing the bond's polarity and thereby reducing acidity. The general acidity order of alcohols is Primary > Secondary > Tertiary. Alcohols are weaker acids compared to water.

Acidity of Phenols:

- Phenols are more acidic than alcohols due to the stabilization of the phenoxide ion through resonance. Electron-withdrawing groups enhance phenol's acidity by stabilizing the phenoxide ion, while electron-releasing groups decrease acidity by destabilizing it.

Esterification:

- Alcohols and phenols react with carboxylic acids, acid chlorides, and anhydrides to form esters. Esterification with carboxylic acids is typically conducted using concentrated sulfuric acid to facilitate the reaction.

Reaction with Hydrogen Halides:

- Alcohols react with hydrogen halides (HX) to produce alkyl halides and water. For example: $CH_3OH + HCl \rightarrow CH_3Cl + H_2O$.

Reaction with PCl_3 and PCl_5:

- Alcohols react with phosphorus trichloride (PCl_3) and phosphorus pentachloride (PCl_5) to yield alkyl chlorides.
- For example: $3\ ROH + PCl_3 \rightarrow 3\ RCl + H_3PO_3$ and $ROH + PCl_5 \rightarrow RCl + HCl + POCl_3$

Reaction with $SOCl_2$:

- Alcohols react with thionyl chloride ($SOCl_2$) to form alkyl chlorides, sulfur dioxide, and hydrochloric acid. For example: $ROH + SOCl_2 \rightarrow RCl + SO_2 + HCl$.

Dehydration:

- Alcohols undergo dehydration (removal of water) to form alkenes when treated with protic acids such as concentrated sulfuric acid (H_2SO_4), phosphoric acid (H_3PO_4), or aluminum oxide (Al_2O_3).

Oxidation:

- Alcohols can be oxidized to aldehydes (oxidation state 0) and carboxylic acids (oxidation state +2) depending on the reagents used.

Reactions of Phenol:

Halogenation: Phenol reacts with bromine in non-polar solvents like chloroform or carbon disulfide at low temperatures to form monobromo phenols. In the presence of bromine water, phenol yields 2,4,6-tribromophenol as a white precipitate.

Nitration: Phenol reacts with dilute nitric acid at low temperatures to produce a mixture of ortho and para nitrophenols.

Reimer-Tiemann Reaction: Phenol reacts with chloroform and sodium hydroxide (NaOH) to form salicylaldehyde, with the -CHO group attached at the ortho position of the benzene ring.

Benefits of CBSE Class 12 Chemistry Notes Chapter 11 Alcohols, Phenols and Ethers

Comprehensive Coverage: Provides an detailed overview of alcohols, phenols, and ethers, including their classification, bonding, and chemical reactions.

Clarity and Simplicity: Written in simple language to make complex chemical concepts easier to understand.

Detailed Reaction Mechanisms: Includes thorough explanations of various reactions, such as oxidation, esterification, and the behavior of alcohols, phenols, and ethers in different contexts.

Enhanced Understanding: Detailed explanations and organized content aid in better understanding of the material which is important for tackling exam questions effectively.