

## Chapter: 08

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# AIM: TO CARRY OUT THE QUALITATIVE TEST OF ALCOHOL

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## **Materials Required**

### **Chemicals**

1. Na metal
2. Acetic acid
3. Ceric ammonium nitrate
4. Acetyl chloride
5.  $\text{NH}_4\text{OH}$
6. Iodine
7. NaOH
8. Calcium sulfate
9. Lucas reagent ( $\text{ZnCl}_2$  and Con. HCl)

### **Glass wares**

1. Test-tube
2. Stands
3. Brush
4. Holder
5. Glass rod
6. Beakers

**Theory:** In organic chemistry, functional groups play a very important role. Alcohols are compounds in the periodic table that have an OH functional group inside their structure. Compounds are considered to be alcohols if they include an OH-group that is covalently bonded to a tetrahedral carbon atom. R-OH is the

chemical formula for alcohol in its most common form. Where R denotes the presence of an alkyl group.

### Preparation of Reagents

- **Ceric Ammonium Nitrate:** Mix twenty grammes of orange crystals of ceric ammonium nitrate with two hundred ml of warm, dil.  $\text{HNO}_3$ .
- **Lucas Reagent:** To prepare the solution, dissolve 135g of anhydrous  $\text{ZnCl}_2$  in 100ml of conc. HCl.
- **Iodine Solution:** Dissolve 5 grammes of KI in 40 ml of water. Add one gramme of solid iodine to the solution, and make sure it is thoroughly dissolved.

### Functional Group Test for Alcohols

S. No.	Identification Test	Observation	Inference
1	<p><b>Sodium metal test:</b> It is based on the release of <math>\text{H}_2</math> gas when alcohol combines with active metals such as sodium, causing the appearance of vigorous fizzing.</p> <p>Utilize a dry test tube to examine the organic component. Add 1g of anhydrous calcium sulphate and shake vigorously to eliminate excess water. Transfer the solution to another test tube that is clean. Add a minute amount of Na metal.</p> <p>Listed below is the chemical reaction.</p>	Brisk effervescence	Acidic compound may be present

	$2R-OH + 2Na \rightarrow 2R-O-Na + H_2\uparrow$ $2CH_3-OH + 2Na \rightarrow 2CH_3-O-Na + H_2\uparrow$ <p>Because water also reacts with sodium, the alcohol to be examined must be dry. Na must be handled with care; unreacted Na must be eliminated by the addition of sufficient alcohol. This test is positive if neither phenyl nor carboxyl groups are present.</p>		
2	<p><b>Ester Test:</b> After reacting with alcohols, carboxylic acids produce an ester that has a smell reminiscent of fruit. The reaction that takes place between an alcohol and a carboxylic acid is known as esterification. This is a slow process that is catalysed by conc. <math>H_2SO_4</math>.</p> <p>Take 1 ml of the organic liquid to be analysed and place it in a dry, clean test tube. Add 1 ml of glacial acetic acid and two to three drops of conc. <math>H_2SO_4</math>. The mixture was heated in a water bath for ten minutes. In a beaker containing cold water, the hot mixture is poured. Examine the aroma of the water in the beaker.</p> <p>The chemical reaction is shown below.</p> $R-OH + R-COOH \rightarrow R-COOR + H_2O$ $CH_3OH + CH_3-COOH \rightarrow CH_3-COOCH_3 + H_2O$	Sweet smell	Alcohol is confirmed

<p><b>3</b></p>	<p><b>Ceric Ammonium Nitrate Test:</b> A pink or red precipitate is produced when alcohol or its combination with ceric ammonium nitrate is used. This is because both of these processes result in the synthesis of a complex chemical and ammonium nitrate.</p> <p>In a dry test tube, place 1 mL of the supplied substance. Add a few drops of the ceric ammonium nitrate reagent and vigorously shake the mixture. Consider the remedy. The appearance of a wine-red precipitate indicates the existence of an alcoholic group.</p> <p>The chemical reaction is shown below.</p> $(NH_4)_2 [Ce(NO_3)_6] + 3ROH \rightarrow [Ce(NO_3)_4(ROH)_3] + 2NH_4NO_3$ $(NH_4)_2 [Ce(NO_3)_6] + 3CH_3OH \rightarrow [Ce(NO_3)_4(CH_3OH)_3] + 2NH_4NO_3$	<p>Wine-red colour ppt</p>	<p>Alcohol is confirmed</p>
<p><b>4</b></p>	<p><b>Acetyl Chloride Test:</b> When alcohol interacts with <math>CH_3COCl</math>, ester and <math>HCl</math> are produced. When <math>HCl</math> reacts with <math>NH_4OH</math>, white vapours of <math>NH_4Cl</math> and <math>H_2O</math> are produced.</p> <p>Take 2ml of provided organic substance in a clean test tube. Add 1g of anhydrous calcium sulphate and vigorously shake. Filter the answer. Add three to four drops of <math>CH_3COCl</math> to the filtrate and mix</p>	<p>White fumes</p>	<p>Alcohol is confirmed</p>

	<p>thoroughly. Dip a glass rod in a solution of <math>\text{NH}_4\text{OH}</math>. Bring the glass rod close to the test tube's opening. White vaporisation indicates the presence of alcohol.</p> <p>The chemical reaction is shown below.</p> $\text{R-OH} + \text{CH}_3\text{-CO-Cl} \rightarrow \text{CH}_3\text{-COOR} + \text{HCl}$ $\text{HCl} + \text{NH}_4\text{OH} \rightarrow \text{NH}_4\text{Cl} + \text{H}_2\text{O}$		
5	<p><b>Iodoform test:</b> The secondary alcohols, ketones, and acetaldehyde present this test. First, the chemical is heated with a solution of <math>\text{NaOH}</math> and <math>\text{I}_2</math>. A precipitate of yellow iodoform indicates the presence of alcohol.</p> <p>Place 1 ml of the provided organic substance in a dry, clean test tube. Add 1 ml of a 1 percent <math>\text{I}_2</math> solution. Add dil. <math>\text{NaOH}</math> solution drop by drop until the iodine becomes brown. The mixture is heated slowly in a water bath. Yellow precipitate indicates the presence of alcohol.</p> <p>The chemical reactions are described as follows:</p> $\text{CH}_3\text{-CH(OH)-CH}_3 + \text{I}_2 + 2\text{NaOH} \rightarrow \text{CH}_3\text{-CO-CH}_3 + 2\text{NaI} + 2\text{H}_2\text{O}$ $\text{CH}_3\text{-CO-CH}_3 + 3\text{I}_2 + 4\text{NaOH} \rightarrow \text{CHI}_3(\text{Iodoform}) + \text{CH}_3\text{COONa} + 3\text{NaI} + 3\text{H}_2\text{O}$	Yellow precipitate	Alcohol is confirmed
6	<p><b>Lucas Test:</b> The combination of <math>\text{ZnCl}_2</math> and conc. <math>\text{HCl}</math> is referred to as the Lucas reagent. It interacts at</p>	Cloudiness	Alcohol is confirmed

	<p>varying rates with 1°, 2°, and 3° alcohols. This reagent produces a cloudy substance when it reacts with alcohols. 3° alcohols react instantly and produce cloudiness, 2° alcohols react gradually and after 5 to 10 minutes produce cloudiness, and 1° alcohols do not react.</p> $\begin{array}{ccc} \text{CH}_3\text{CH}_2\text{OH} & \xrightarrow{\text{ZnCl}_2 + \text{HCl}} & \text{No reaction} \\ \text{(Ethyl alcohol)} & & \end{array}$ $\begin{array}{ccc} \begin{array}{c} \text{OH} \\   \\ \text{CH}_3 - \text{CH} - \text{CH}_3 \end{array} & \xrightarrow{\text{ZnCl}_2 + \text{HCl}} & \begin{array}{c} \text{Cl} \\   \\ \text{CH}_3 - \text{CH} - \text{CH}_2 - \text{CH}_3 \end{array} \\ \text{(Sec-butyl alcohol)} & & \text{(Sec-butyl chloride)} \end{array}$ $\begin{array}{ccc} \begin{array}{c} \text{CH}_3 \\   \\ \text{CH}_3 - \text{C} - \text{OH} \\   \\ \text{CH}_3 \end{array} & \xrightarrow{\text{ZnCl}_2 + \text{HCl}} & \begin{array}{c} \text{CH}_3 \\   \\ \text{CH}_3 - \text{C} - \text{Cl} \\   \\ \text{CH}_3 \end{array} \\ \text{(Tert-butyl alcohol)} & & \text{(Tert-butyl chloride)} \end{array}$	
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### Precautions

- Since it interacts aggressively with water, sodium metal should be handled with care.
- I<sub>2</sub> solution should not be breathed since it might irritate the nasal passages.

**Result:** The results of the systemic qualitative tests performed and alcohol was found and reported.