Organic chemistry

Organic chemistry is the scientific study of the structure, properties, composition, reactions, and synthesis of organic compounds that by definition contain carbon.

Organic compounds

Organic compounds are molecules composed of carbon and hydrogen, and may contain any number of other elements . Many organic compounds contain nitrogen, oxygen, halogens, and more rarely phosphorus or sulphur

Identification of Organic compounds

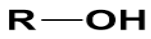
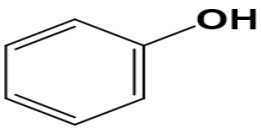
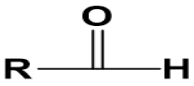
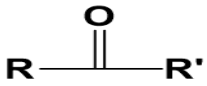
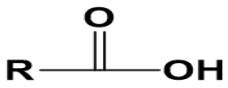
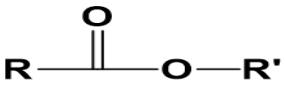
Physical properties

Physical properties of organic compounds typically of interest include both quantitative and qualitative features. Quantitative information includes melting point, boiling point, and index of refraction. Qualitative properties include odor, solubility, and color.

Melting point refers to the temperature at which a compound changes states from a solid to a liquid. Boiling point is the temperature at which a compound changes states from a liquid to gas.

Chemical properties

The effect of the compound on the litmus paper , if the compound is acid the color of the litmus paper changes to red , while if the compound is base the color of the litmus paper changes to blue and if the compound is neutral the color of the litmus paper does not change Determination of functional group and to which chemical class compounds it belong , special test for

Name	Functional Group	IUPAC Ending
Alcohols		-ol
Phenols		phenol
Ethers		ether
Aldehydes		-al
Ketones		-one
Carboxylic Acids		-oic acid
Esters		-ate

Experiment (13)

Alcohols

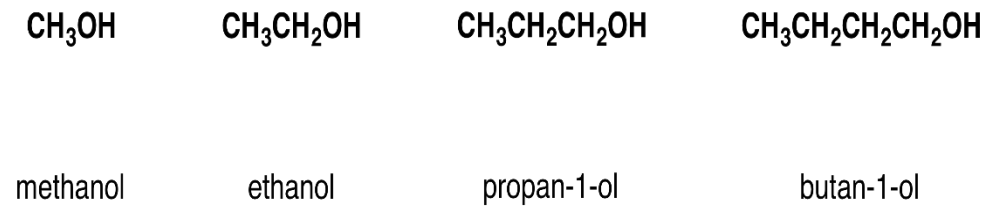
Alcohols are organic compounds in which the hydroxyl functional group (-OH) is bound to a carbon atom. Alcohols are an important class of molecules with many scientific, medical, and industrial uses. Alcohols are classified according to their chemical composition into aliphatic and aromatic .

General formula of alcohols is R-OH in which R= alkyl group , OH = hydroxyl group

Types of alcohols

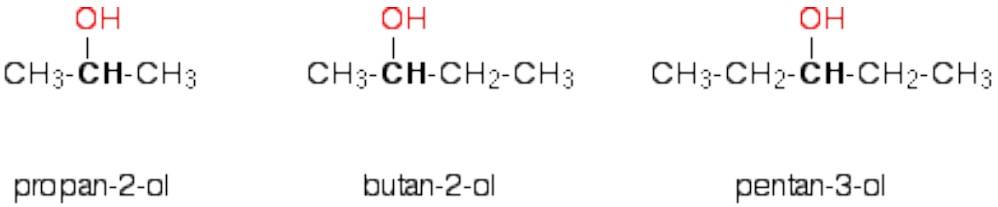
1- Primary alcohols (1º)

Primary alcohols are those alcohols where the carbon atom of the hydroxyl group (OH) is attached to only one single alkyl group.



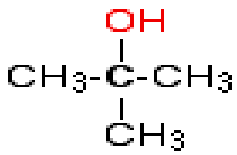
2- Secondary alcohols (2º)

Secondary alcohols are those where the carbon atom of the hydroxyl group is attached to two alkyl groups on either side.

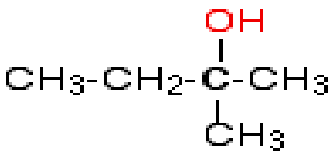


3- Tertiary alcohols (3º)

Tertiary alcohols are those which feature hydroxyl group attached to the carbon atom which is connected to 3- alkyl groups.



2-methylpropan-2-ol



2-methylbutan-2-ol

Physical properties of alcohols

1- Colorless liquids at room temperature.

2- Methyl alcohol, ethyl alcohol, and isopropyl alcohol are free-flowing liquids with fruity odors. The higher alcohols those containing 4 to 10 carbon atoms are somewhat viscous or oily, and they have heavier fruity odors. Some of the highly branched alcohols which containing more than 12 carbon atoms are solids at room temperature.

3 - Alcohols have a low boiling point

4 – Miscible in water except 2- butyl alcohol and benzyl alcohols (white gelatinous material with conc. H_2SO_4)

5 – Ignition: aliphatic alcohols ignite with blue non smoky flame. While aromatic alcohols ignite with yellow smoky flame.

Chemical properties of alcohols

1 - They are neutral compounds because they don't change the color of litmus paper

2- General test for alcohols is ceric ammonium nitrate $(NH_4)_2Ce(NO_3)_6$.

Ceric ammonium nitrate (yellow solution) is an oxidizing agent that reacts with alcohols to give a red complex

a- Alcohol miscible with water

Add 2 drops of alcohol + 5 drops of ceric ammonium nitrate to a test tube and observe the red coloration due to the oxidation

b- Alcohols immiscible with water

Add 2 drops of alcohols + 2 drops of dioxan mix very well and add 5 drops of ceric ammonium nitrate and observe the red coloration due to the oxidation

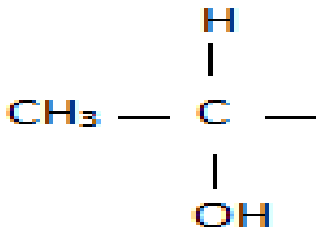
$$\underset{\text{Alcohol}}{2R\text{—}OH} + \underset{\text{Ceric ammonium nitrate}}{(NH_4)_2Ce(NO_3)_6} \longrightarrow \underset{\text{Pink or red complex}}{[(ROH)_2Ce(NO_3)_4]} + 2NH_4NO_3$$

This red color disappears after a reason-able time due to completing the oxidation of this complex

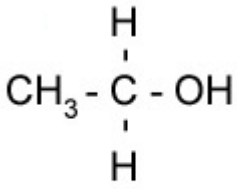
$$-\overset{|}{C}H\text{-}OH + 2Ce\ (IV) \longrightarrow -\overset{|}{C}=O + 2Ce\ (III) + 2H^+$$

3- Iodoform (Haloform) test

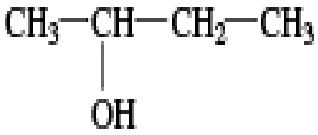
This test is specific for alcohols which have a free methyl group (- CH3) and a hydrogen attached to the carbon bearing the hydroxyl group



Such as ethanol and 2-butyl alcohol

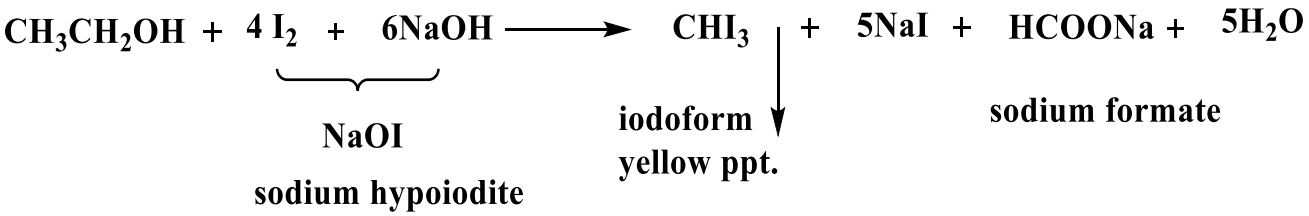


ethanol



sec-butyl alcohol
2-butanol

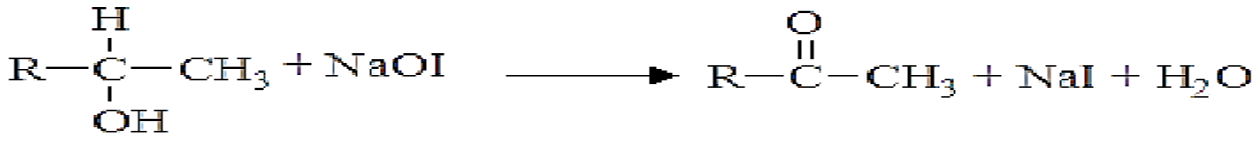
The overall reaction is :



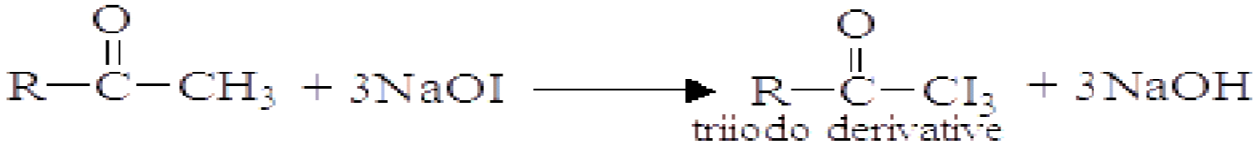
The alcohol is oxidized to the corresponding aldehyde or ketone by the action of the produced oxidizing agent sodium hypoiodite which also causes the aldehyde or ketone to be tri-iodinated on the terminal methyl group producing iodoform as a yellow precipitate

The mechanism of this reaction involves many steps, the first of which is the formation of the oxidizing agent sodium hypoiodate (NaOI)

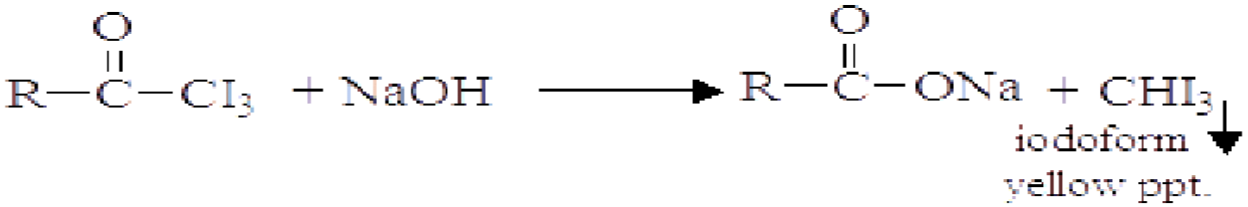
The next steps are : Oxidation of the alcohol to the corresponding aldehyde or ketone by sodium hypoiodate



Halogenation of the produced aldehyde or ketone with three moles of sodium hypoiodate to form the triiodo derivative



Cleavage of the triiodo derivative by NaOH to an acid containing one less carbon atom than the starting alcohol



Procedure

- Place 3 drops of alcohol +1 mL of D.W (or 1mL of dioxane for water insoluble compounds in a test tube -

-Add 1 ml of 10% NaOH solution.

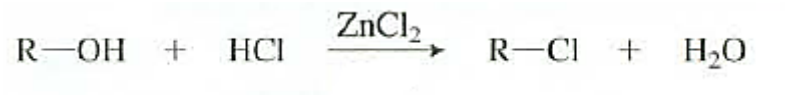
- Add 1 drop of iodine solution (I_2) wise with shaking until either a yellow iodoform precipitate is formed

- Allow the solution to stand for 3 minutes during which period check for the appearance of the yellow precipitate at the bottom of the test tube

4- Lucas test

This test to distinguish between the different types of alcohols (primary, secondary and tertiary) .

Lucas reagent is a solution of anhydrous $ZnCl_2$ and conc. HCl



Add one drop of alcohols and 6 drops of Lucas reagent shake well and observe after 5 minute

3° immediately separation into 2 layers

2° turbidity after 5 minute (one layer)

1° requires heat (clear solution) (one layer)