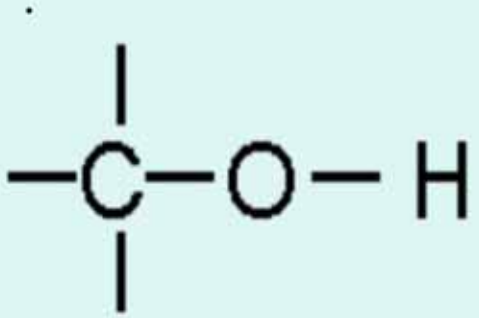
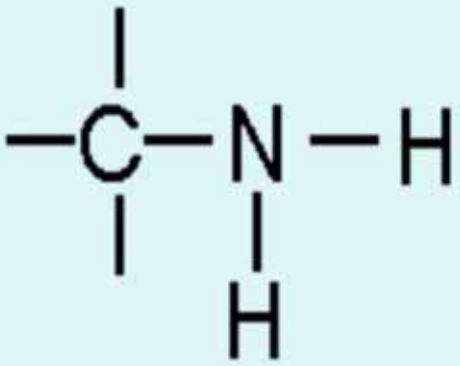
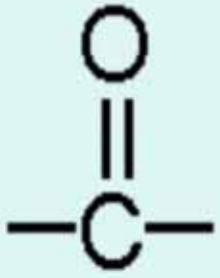
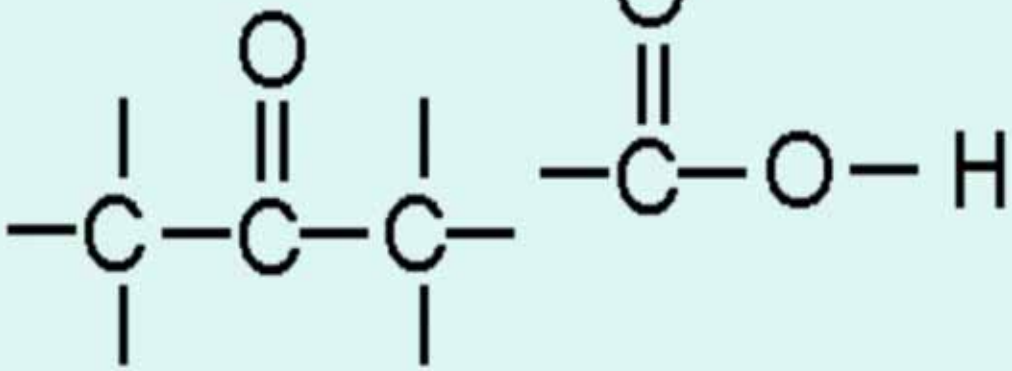




Organic Functional Groups





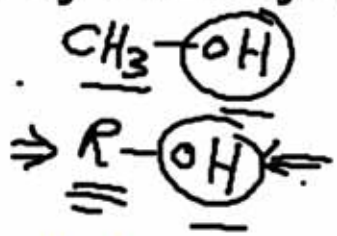
Learning Outcomes:

Students will be able to:

1. define a functional group;
2. differentiate among various organic compounds on the basis of their functional groups;
3. identify the functional groups of a molecule.
4. identify the tests carried out in the laboratory for carboxylic acids, phenols, amines, aldehydes and ketones in terms of their functional groups.

Functional group:

In organic chemistry the compounds other than hydrocarbons are derived by replacing one or more hydrogen atoms of a hydrocarbon by another atom or group of atoms. The chemical properties of the derived compound depend upon that atom or group of atoms, while the physical properties are governed by the alkyl group of the derived compound.



Definition:

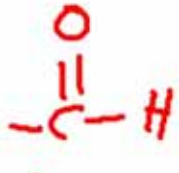
"An atom or group of atoms or a multiple bond that gives specific properties to an organic compound is called a functional group".

Differentiation of organic compounds on the basis of their functional groups:

As we know functional groups can have major influence on the chemical and physical properties of organic compounds. All the organic compounds can be easily differentiated from one another on the basis of their functional groups. *For example*, all alcohols have the sub-unit -C-OH, while ethers have -O- and the carboxylic acids possess -COOH etc.

$R-CH_2-OH$ $R-OH$ $R-O-R$

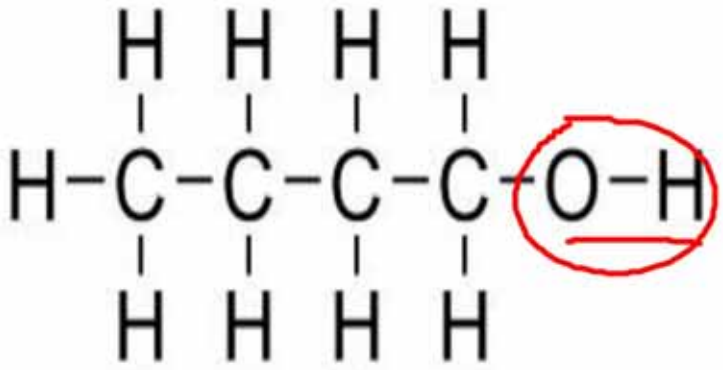
Different organic compounds, on the basis of their functional groups, have been classified as under:

Chemical Class	Functional Group	Formula
Alkanes	C-C	$R\text{-}H_2C\text{-}CH_2\text{-}R$
Alkenes	C=C	R-HC=CH-R
Alkynes	C≡ C	R-C≡C-R
Alkyl halides	-X (Cl,Br,I)	R-X
Alcohols	-OH	R-OH
Amines	$-NH_2$	$R\text{-}NH_2$
Aldehydes	-CHO 	R-CHO

Chemical Class	Functional Group	Formula
Ketones	-CO- 	R-CO-R
Carboxylic acids	-COOH	R-COOH
Esters	-COOR	R-COOR
Acid Amides	$-CONH_2$	$R-CONH_2$
Acid Halides	-COX	R-COX

Identify A Molecule's Functional Groups:

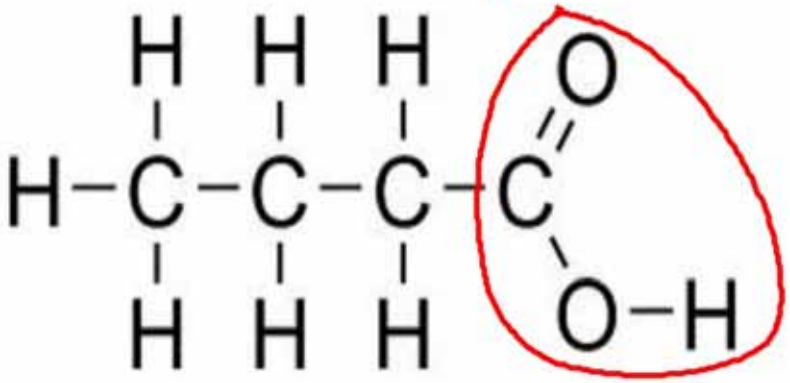
The class of an organic compound can easily be identified on the basis of the functional group present in it. Take the following compound as an example:



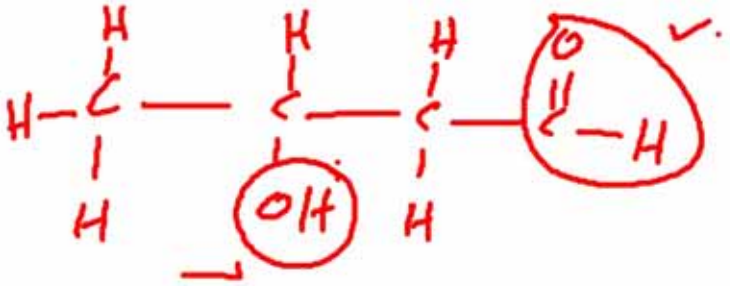
After having a closer look at the given structure, it is observed that the compound possess an -OH group, which is the functional group of alcohols. Thus, it indicates that the given compound is an

alcohol which is named as 1-butanol.

Another example is:



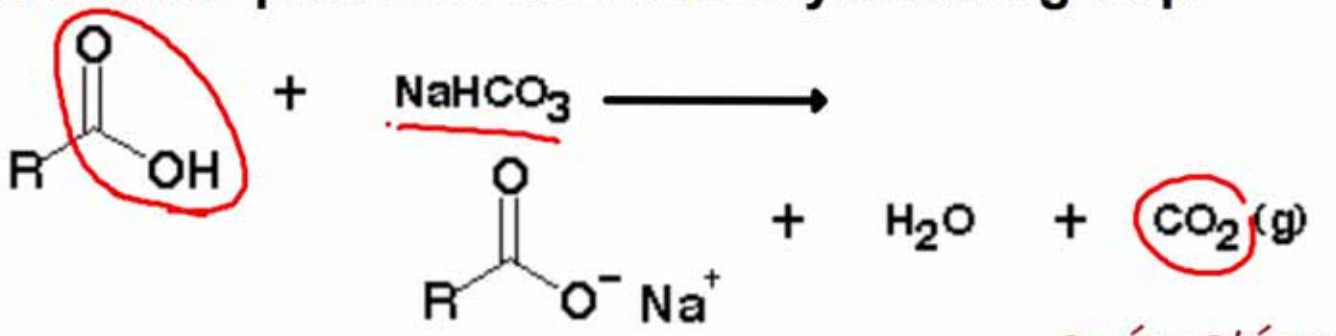
At a glance, one can observe that the structure possess a -COOH group, which is the functional group of carboxylic acids. It means that the given compound is an organic acid and is named as butyric acid.


H
H
H
H
H
H
H
H
O
H
OH

Laboratory Tests for Different Functional Groups:

1. Carboxylic group:

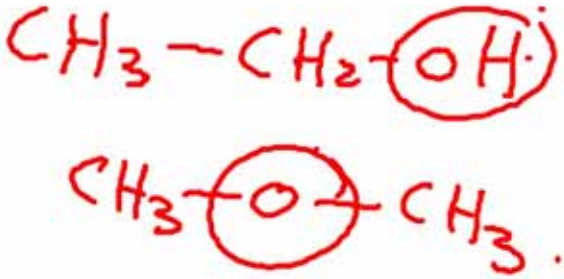
- When a carboxylic acid dissolves in an aqueous solution of sodium bicarbonate, the reaction results in the release of carbon dioxide gas with effervescence. Because of the visibility of the CO_2 bubbles, this is one of the tests used as to check the presence of a carboxylic acid group.



animation

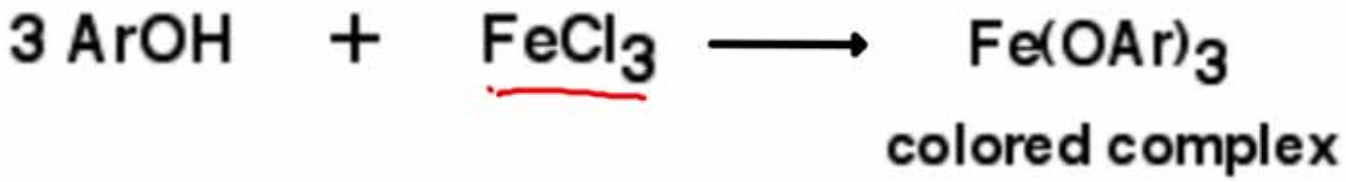
ethyl alcohol C_2H_6O (C_2H_5OH)

dimethyl ether C_2H_6O



2. Tests for Phenols:

When $FeCl_3$ solution is added to phenols, a red, blue, green or purple colour is obtained. This gives indication about the presence of a phenolic i.e -OH group.



Animation

3. Tests for Amines:

When a given solution of organic compound is tested with a red litmus paper, its colour changes to blue. This indicates the presence of amines ($-NH_2$).

4. Tests for Aldehydes:

Aldehydes react with ammoniacal silver nitrate solution (Tollen's reagent) and form a silver mirror on the test tube, while the ketones will not react.

$$R\text{-}CHO + 2[Ag(NH_3)_2]^+ + 2OH^- \rightarrow R\text{-}COONH_4 + 2Ag + 2NH_3 + H_2O$$

Animation

Mutiple Choice Questions

1. Which of the following is a Ketone?

A. H_3CCH_2CHO
B. $H_3CCH_2CH_2OH$
C. H_3CCOCH_3
D. H_3CCH_2COOH

2. Which of the following is the functional group of Esters?

A. -COOH
B. -COOR
C. $-CONH_2$
D. -COX

3. Which of the following functional groups contain nitrogen?

A. Carboxylic acids
B. Acid halides
C. Acid amides
D. Ethers