



**Ministry of Higher
Education and Scientific
Research
Mustansiriyah University
College of Science
Chemistry Department**



Organic Identification Laboratory

Fourth Stage / Evening Study

**Designed By
Dr. Nazar Sattar Harb
Malik Musa Sultan**

ORGANIC IDENTIFICATION LABORATORY

- An organic identification laboratory is defined as the identification of unknown organic compounds by determining the chemical structure and composition of organic compounds.

- There are two main approaches for the identification of organic compounds:

I. Classical method: This method uses classical techniques for identifying unknown organic compounds, such as physical properties assessment, ignition test, solubility test, acidity and basicity test, and functional groups test.

II. Instrumental method: This method is based on a powerful suite of instrumental devices to deduce the exact structure of an unknown molecule. Ultraviolet-Visible (UV-Vis) Spectroscopy, Infrared (IR) Spectroscopy, Nuclear Magnetic Resonance (NMR) Spectroscopy, and Mass Spectrometry (MS) are the main instrumental methods for identifying unknown organic compounds.

❖ Classical Method for Identifying Unknown Organic Compounds

Although modern chemistry relies on a powerful suite of instrumental methods to deduce the exact structure of an unknown molecule, classical techniques are still used for initial screening. The main steps of the follow-up included the identification of unknown organic compounds by classical methods:

A. Physical properties assessment

B. Solubility test

C. Ignition test

D. Acidity and Basicity test

E. Primary classification functional group test

F. Secondary classification functional group test

1. Physical Properties Assessment

I. Basic observations that offer immediate clues for an unknown compound are:

a) State of matter: Is it a solid, liquid, or gas at room temperature?

In general, compounds with low molecular weight ($C \leq 5$) are often liquids or gases, while compounds with high molecular weight ($C \geq 6$) are often solids.

b) Color of matter: Is it colored or colorless?

Many pure organic compounds are colorless or white. Moreover, distinct colors point to specific structural features.

c) Odor of matter: Is it acceptable or unacceptable?

Odor can be informative. Esters often smell fruity, carboxylic acids smell sour or like vinegar/sweat, and amines frequently have a fishy smell.

II. Temperature (Melting Point and Boiling Point)

Melting point (for solid matter) and boiling point (for liquid matter) are the most informative physical properties for an unknown organic compound, where each compound has its own melting or boiling points that differ from those of another compound in the same family or other families.

➤ Melting Point (MP)

Physical Definition: The temperature at which a substance transitions from a solid state to a liquid state.

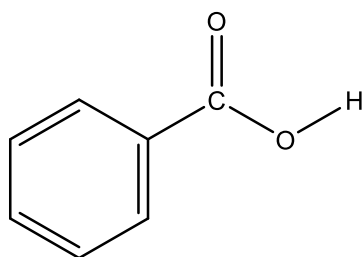
Chemical Definition: The exact temperature at which the solid and liquid forms of a pure substance can exist in equilibrium, or the exact temperature at which the thermal energy (kinetic energy) of a solid substance becomes strong enough

ORGANIC IDENTIFICATION LABORATORY

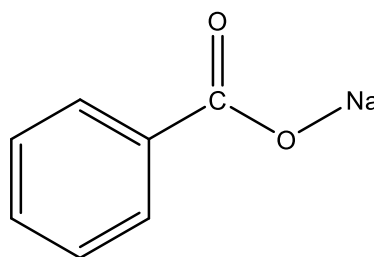
to overcome the intermolecular forces holding it in a fixed, rigid crystalline lattice under 1 atmospheric pressure.

• Factors That Affect Melting Point

- 1) Presence of Impurities:** Solid impurities cause decreased MP because they interfere with the crystalline lattice and weaken the lattice, requiring less energy to break down, while liquid impurities (like H₂O) cause raised MP because they increase the number of bonds (H-bonding) and require high energy to break down.
- 2) Molecular weight:** Solid compounds with low molecular weight have low MP, while compounds with high molecular weight have high MP (**MP $\propto$ molecular weight**). Polarizability increases with molecular weight and causes increased London dispersion forces (distortion of the electron cloud in a molecule or atom), which in turn increase MP.
- 3) Nature of chemical bonding within the compound:** The stronger the forces holding the particles together, the more energy is required to break them apart, resulting in a higher MP.



Benzoic acid
MP = 123 °C

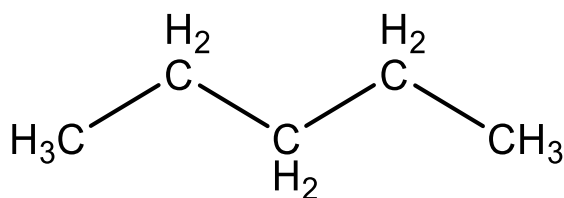


Sodium Benzoate
MP = 410 °C

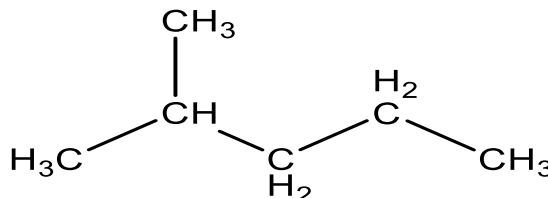
- 4) Branching in the chain:** Linear chains have a large surface area and can easily stack closely together due to maximizing Van der Waals forces, and thus high energy is required to break the structure apart, resulting in a higher MP. On the

ORGANIC IDENTIFICATION LABORATORY

other hand, branched molecules have a lower surface area (being bulkier and irregularly shaped), thereby minimizing Van der Waals forces and thus requiring less energy to disrupt the structure, resulting in a lower MP.



Pentane
MP = -130 °C



2-Methyl Pentane
MP = -154 °C

• Boiling Point (PB)

Physical Definition: The temperature at which a substance transitions from a liquid state to a gas state.

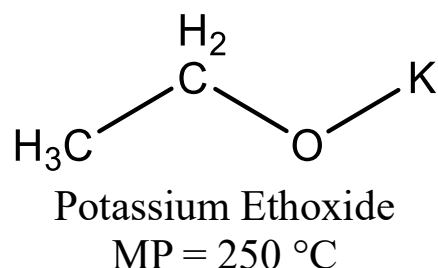
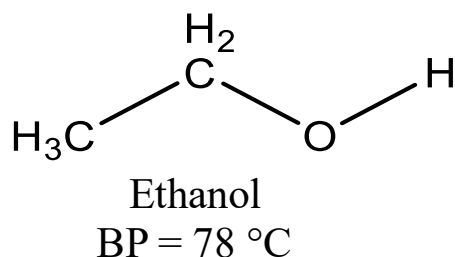
Chemical Definition: The exact temperature at which a liquid's vapor pressure equals the surrounding atmospheric pressure.

• Factors That Affect Boiling Point

- 1) Presence of Impurities:** Impurities cause increased BP because they interfere with the intermolecular bonds of liquid matter, increasing the number of bonds and requiring high energy to break down.
- 2) Molecular weight:** Liquid compounds with low molecular weight have low BP, while compounds with high molecular weight have high BP (**BP $\propto$ molecular weight**). Polarizability increases with molecular weight and causes increased London dispersion forces (distortion of the electron cloud in a molecule or atom), which in turn increase BP.

ORGANIC IDENTIFICATION LABORATORY

3) Nature of chemical bonding within the compound: The stronger the forces holding the particles together, the more energy is required to break them apart, resulting in a higher BP.



4) Branching in the chain: Linear chains have a large surface area and can easily stack closely together due to maximizing Van der Waals forces, and thus high energy is required to break the structure apart, resulting in a higher BP. On the other hand, branched molecules have a lower surface area (being bulkier and irregularly shaped), which minimizes Van der Waals forces and thus requires less energy to disrupt the structure, resulting in a lower BP.

•Notes for Measuring Melting Point or Boiling Point

- 1) When measuring MP, the solid matter should be ground thoroughly because the aggregation of solid matter affects the MP.
- 2) MP depends on the quantity of the compound; therefore, the smallest amount of solid matter inside the capillary tube should be taken.
- 3) It is best to dry the solid matter before measuring its MP to ensure it is moisture-free, especially in the winter.
- 4) When measuring the MP of a solid matter, the range (± 5 , ± 10 , ± 15) must be taken to ensure that the solid unknown compound is obtained.

ORGANIC IDENTIFICATION LABORATORY

- 5) BP depends on the speed of heating; therefore, the speed of heating should be gentle.
- 6) The thermometer must be connected in parallel to the test tube containing the unknown liquid to measure the exact BP.
- 7) When measuring the BP of a liquid matter, the range (± 3 , ± 5 , ± 10) must be taken to ensure that the liquid unknown compound is obtained.
- 8) When measuring the BP of a liquid matter, an oil bath should be used rather than a water bath for safety.
- 9) The test tube containing the unknown liquid must be immersed in an oil bath to ensure that heat is distributed evenly across all walls of the test tube.

➤ Characteristics of Oil Bath

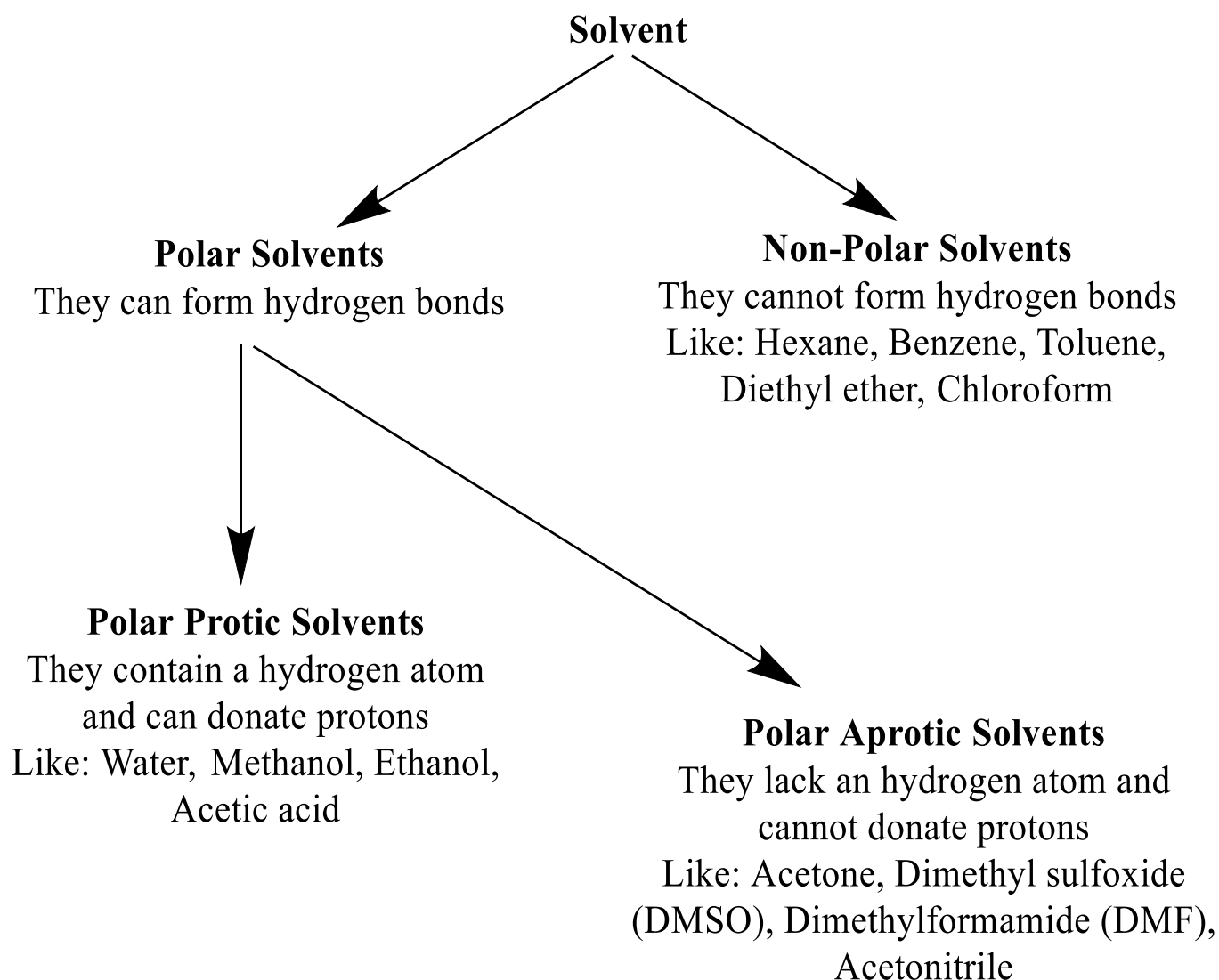
- a) Lower heat capacity
- b) High thermal stability: could be heated to a higher temperature (250 °C) without decomposition
- c) Excellent heat distribution
- d) No phase change
- e) Transparency
- f) Preventing contamination
- g) It is inflammable
- h) Safety limits: does not cause corrosion and does not cause severe burns

2. Solubility Test

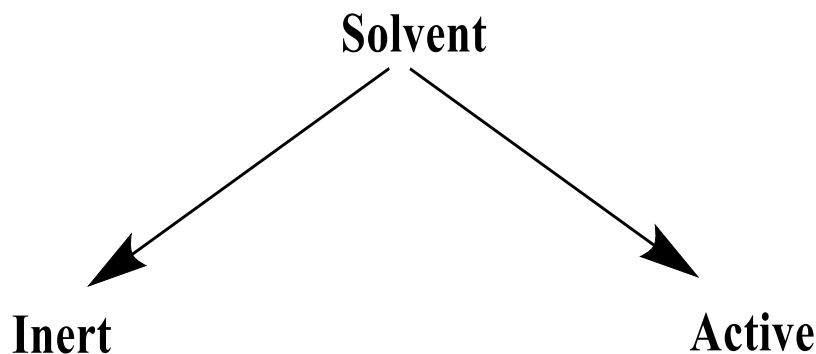
Solubility is defined as the breaking down and dispersing of solute throughout a solvent to create a solution or the ability of a substance (solute) to dissolve and become a part of another substance (solvent). The solubility test is one of the most powerful preliminary tests for identifying unknown organic compounds because it serves as a functional-group family prediction.

➤ **Solvents can be classified according to:**

A. Polarity



B. Activity with solute



They does not chemically react with the solute and remains exactly the same

Like: Water, Benzene, Hexane, Acetone, Toluene, Ethanol

They chemically react with solute and cannot get the original solute back

Like: HCL (aq), NaOH (aq), Sulfuric acid, Phosphoric acid

- The general principle of solubility is **like dissolves like**, where polar solvents dissolve polar compounds and non-polar solvents dissolve non-polar compounds.
- The energy required to break the bonds between the solute molecules can be obtained from the energy released by the formation of new bonds between the solute and solvent molecules. If the energy released from the formation of new bonds between the solute and solvent molecules is greater than the energy required to break the bonds between the solvent molecules, the solute can dissolve, and the reverse is also true.
- The evidence for the solubility of solid compounds is the disappearance of the solid within the solution, while evidence for the solubility of liquid compounds is that the resulting solution is homogeneous and does not separate into two layers.

ORGANIC IDENTIFICATION LABORATORY

- The main factors that affect the solubility of organic compounds are:

1) Molecular weight: The correlation between solubility and molecular weight is reversible ($\text{solubility} \propto \frac{1}{\text{molecular weight}}$) because the nonpolar hydrophobic tail becomes larger, while the polar head remains the same size. Eventually, the disruptive non-polar tail outweighs the polar head's ability to pull the molecule into the water solution. In general, as molecular weight increases, MP or BP increases, while solubility decreases.

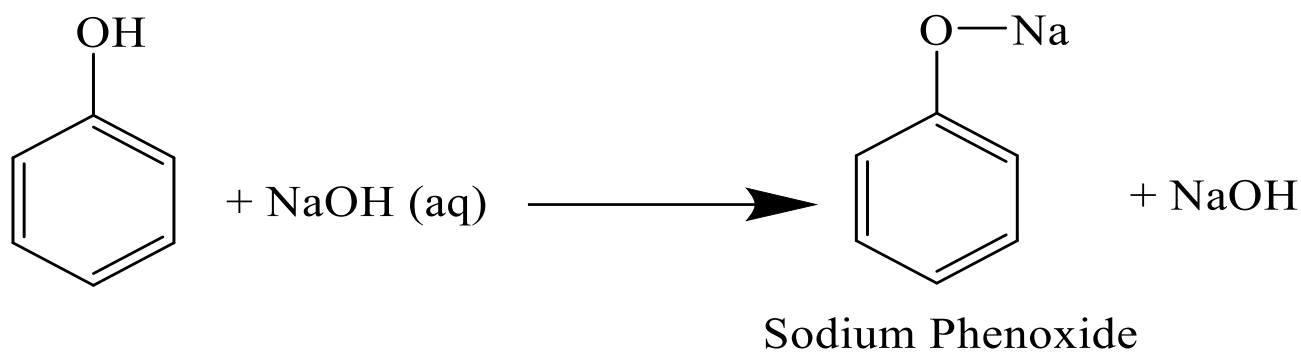
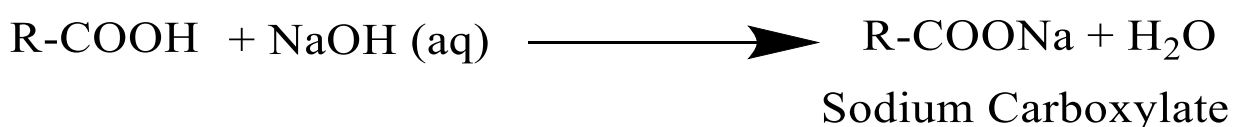
2) Branching in the chain: Branched molecules have low surface area (bulkier and irregularly shaped), which minimizes Van der Waals forces, and being poorly packed, their intermolecular bonds are weak, which in turn increases solubility.

- The simplest solvent used in our daily lives is water (H_2O). H_2O has a high dipole moment, which is why it can overcome the strong attractive forces between the negative and positive ions (ionic bonds) in salts, thereby dissolving them. On the other hand, H_2O is amphoteric, which is why it can break the covalent bonds in acids or bases, allowing them to dissolve in it as negative or positive ions.
- H_2O is a polar protic solvent and can dissolve organic compounds such as carboxylic acids, sugars, bases, aldehydes, and ketones—provided they have fewer than five carbon atoms ($\text{C} \leq 5$) by forming hydrogen bonds (H-bonding) with them, thereby making them soluble in it. On the other hand, carboxylic acids, sugars, bases, aldehydes, and ketones with more than five carbon atoms

ORGANIC IDENTIFICATION LABORATORY

($C \geq 6$) cannot dissolve in H_2O because of the large size of the alkyl group (hydrophobic effect).

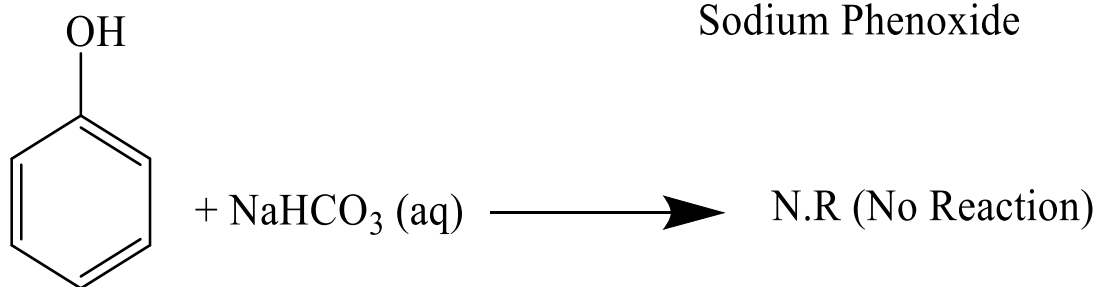
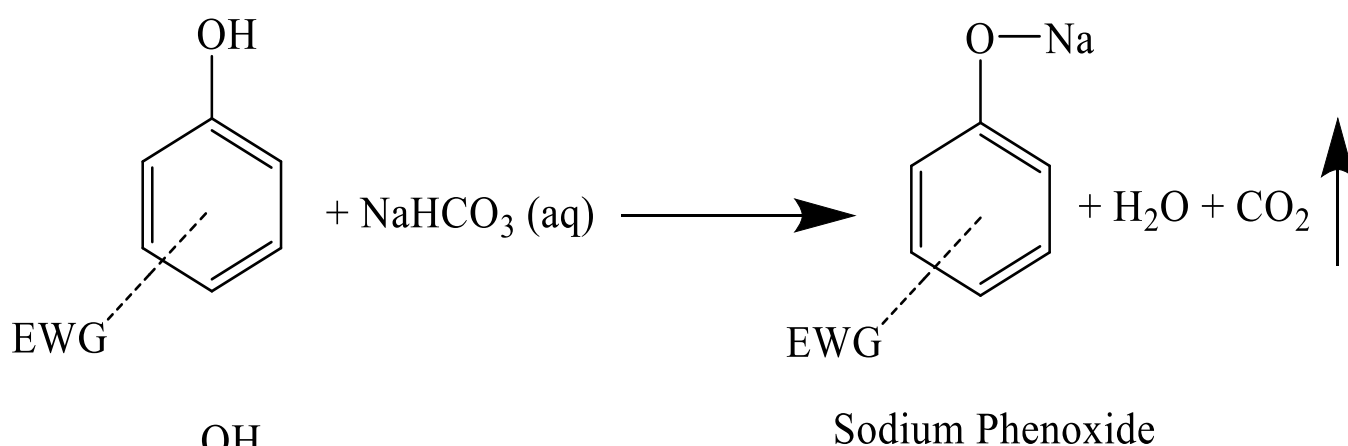
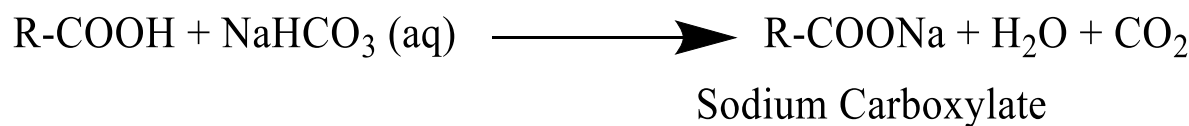
- Ether is a weakly aprotic polar and non-polar solvent that can dissolve both weakly polar and non-polar organic compounds. Ether can dissolve carboxylic acids, bases, alcohol, aldehydes, and ketones, but it cannot dissolve sugar. When dissolving with ether, **the test tube must be dry and cold**.
- Aqueous sodium hydroxide (% NaOH) is a highly powerful, reactive, and alkaline solvent that can dissolve carboxylic acids and acidic behavior compounds such as phenols by forming salts with them, and thus is soluble in water.



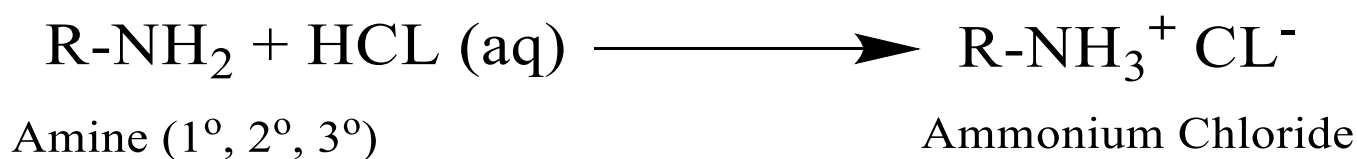
- Aqueous sodium bicarbonate (% $NaHCO_3$) is a reactive, mildly alkaline solvent. Because % $NaHCO_3$ is a weak base, it is only strong enough to dissolve strong carboxylic acids and phenols with electron-withdrawing groups (EWG) by forming salts with them, and thus is soluble in water. On the other hand, pure phenols (without any groups) cannot dissolve in % $NaHCO_3$. Solubility feature of carboxylic acids and phenols substituted with

ORGANIC IDENTIFICATION LABORATORY

EWGs is the formation of bubbles, effervescence, or a fizzing resulting from the release of CO_2 gas.



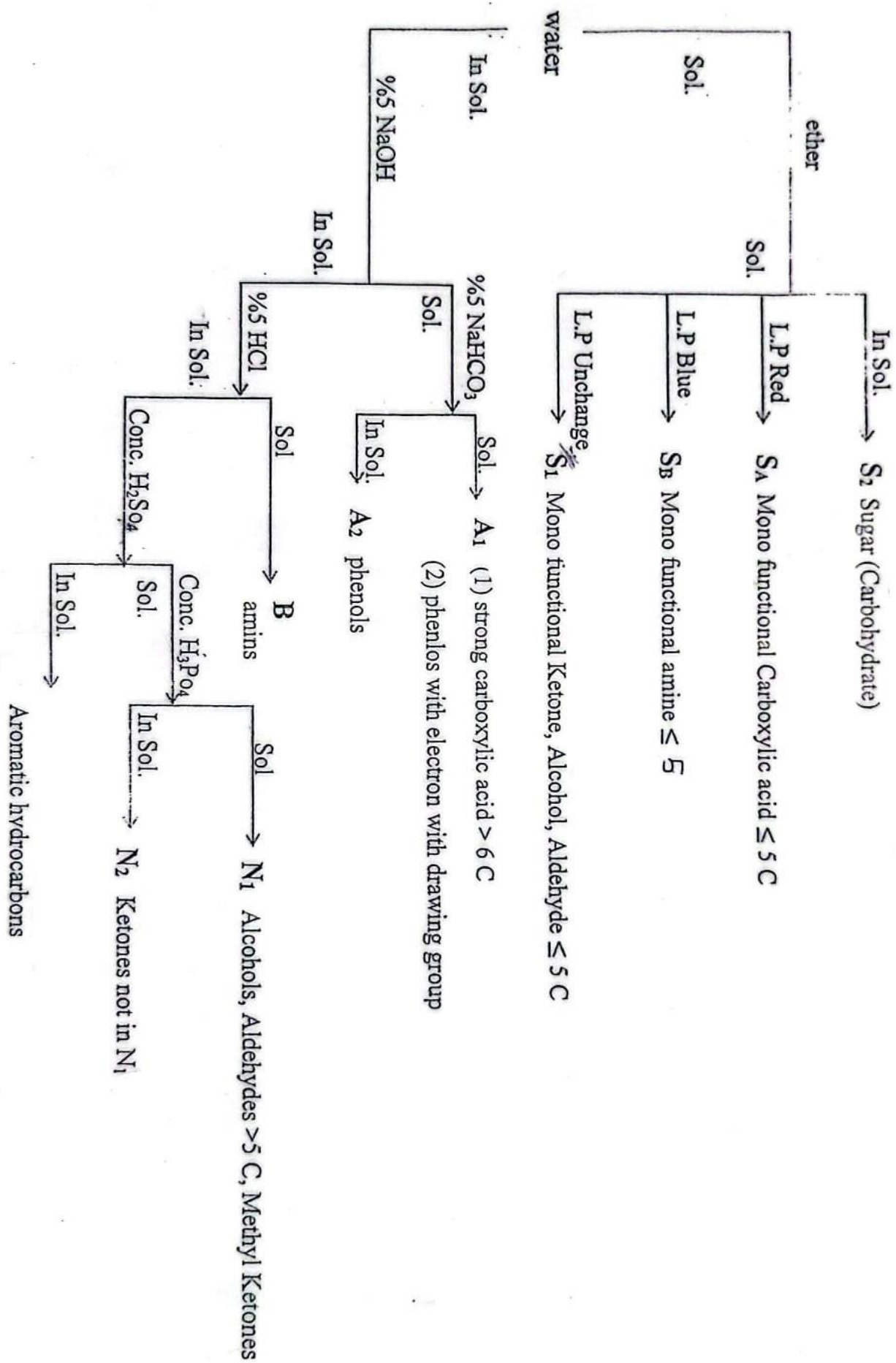
- ★ 5% NaHCO_3 is an important test that is used to distinguish between normal or pure phenol and phenols substituted with EWGs through the formation of bubbles, effervescence, or a fizzing resulting from the release of CO_2 gas.
- Aqueous hydrochloric acid (% HCL) is a classic and highly effective solvent used for dissolving basic compounds like amines by turning them into a water-soluble ammonium salt.



ORGANIC IDENTIFICATION LABORATORY

- Concentrated sulfuric acid (H_2SO_4 conc.) is a highly unique, highly polar, and protonic non-aqueous solvent in organic chemistry. Because it is highly acidic, it is an excellent solvent for dissolving largely polar compounds ($C \geq 6$), most unsaturated hydrocarbons, and weak bases. The evidence for the solubility of compounds in H_2SO_4 conc. is: **(1)** Heat generation, **(2)** Obtaining a suspension or emulsion solution, **(3)** The appearance of black spots in the solution indicates that the compound has carbonized. When dissolving with H_2SO_4 conc., the test tube must be dry, clean, and cold.
- Concentrated phosphoric acid (H_3PO_4 conc.) is a unique and highly specialized solvent that is used to dissolve oxygen-containing polar compounds ($C \geq 6$) such as alcohol, aldehyde, methyl ketone, and cyclic ketone because of its high polarity. In contrast to H_2SO_4 conc., when dissolved using H_3PO_4 conc., it does not cause the following: **(1)** Heat generation, **(2)** Obtaining a suspension or emulsion solution, **(3)** The appearance of black spots in the solution indicates that the compound has carbonized. When dissolving with H_3PO_4 conc., the test tube must be dry and clean.

Solubility Table



3. Ignition Test

The ignition test is one of the simplest, quickest preliminary tests you can perform in qualitative organic analysis. By burning a small sample of an organic compound on a spatula, you can get immediate clues about its chemical nature based on the color of the flame, the type of smoke, and whether any residue is left behind. An ignition test won't give the exact molecule, but it drastically narrows the playing field.

• Smoke observation

Observation	Suggested Compounds
Heavy black smoke with soot	Aromatic compounds (benzene and its derivatives)
Moderate black smoke without soot	May be cyclic compounds
Moderate white smoke without soot	May be aliphatic compounds
White or black smoke with chars	Carbohydrate or maybe hydroxyl acids

• Flame observation

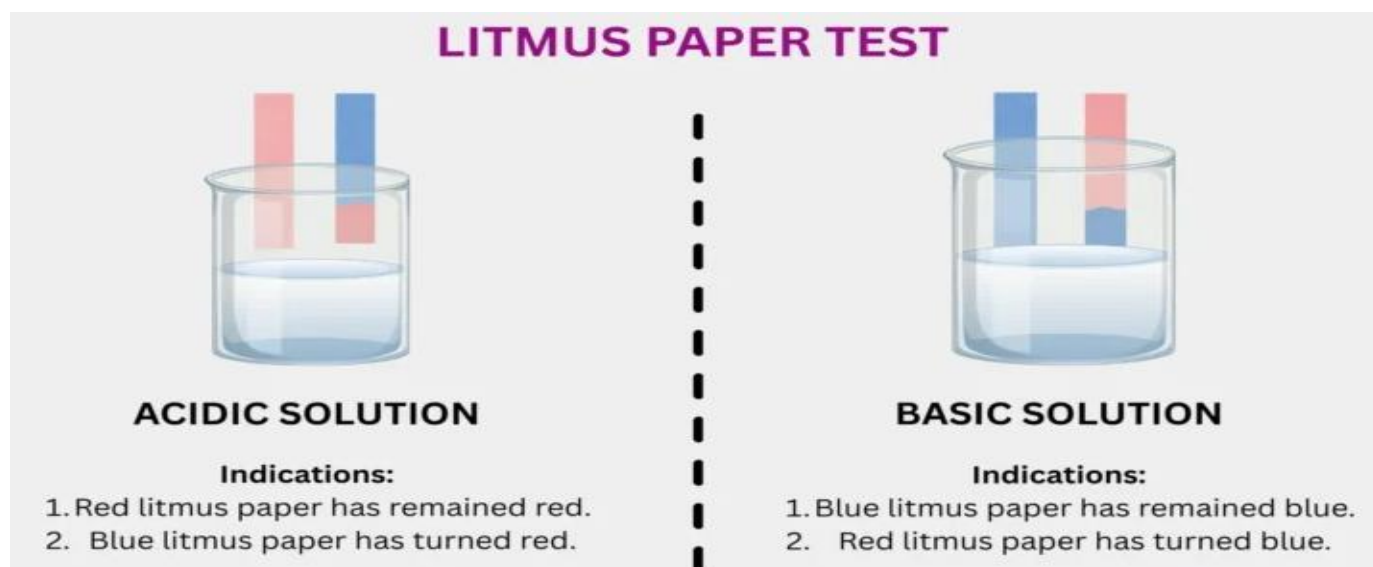
Observation	Suggested Compounds
Blue	May be oxygen-containing compounds or aliphatic compounds
Green	May be halogen-containing compounds
Yellow	May be aromatic or highly unsaturated compounds (alkenes and alkynes)

4. Acidity and Basicity Test

Testing for acidity and basicity is one of the quickest ways to narrow down the functional groups present in an unknown organic compound by easily classifying unknown organic compounds into one of two major categories: acidic or basic. Acidity and basicity tests in organic chemistry identify functional groups by measuring their ability to donate or accept protons (H^+). When there is high confidence in whether an unknown organic compound is an acid (e.g., a carboxylic acid) or a base (e.g., an amine), we use this test.

❖ **There are two methods for measuring acidity and basicity, which are:**

A. Litmus Paper Method: It is a fundamental qualitative analysis technique used in organic chemistry to determine acidic or basic compounds. This method is used when an unknown organic compound is water-soluble ($C \leq 5$).



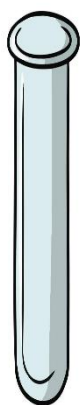
B. Phenolphthalein Method: It is a fundamental qualitative analysis technique used in organic chemistry to determine acidic or basic compounds. This method is used when an unknown organic compound is water-insoluble ($C \geq 6$).

5. Preliminary Functional Group Test

The preliminary functional group test is a systematic series of initial observations and quick chemical tests used to narrow down the identity of an unknown organic compound. This test is the counterpart to the solubility test for identifying the functional group in the unknown organic compound.

A. Preliminary test for alcohol compounds

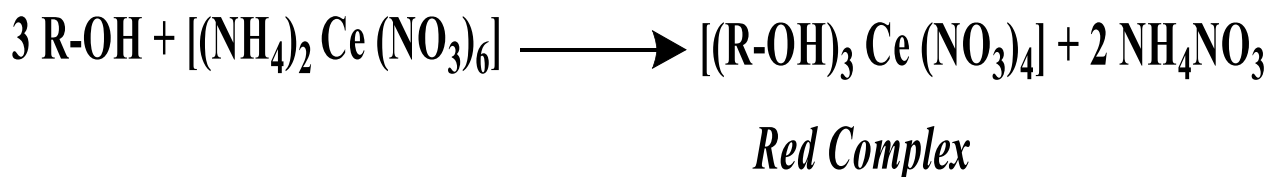
To detect alcohol compounds, **Ceric Ammonium Nitrate** $[(\text{NH}_4)_2 \text{Ce} (\text{NO}_3)_6]$ reagent is used, as follow:



Add to the test tube the following

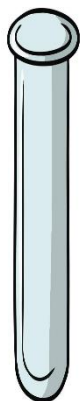
1. Unknown compound (5 drops)
2. Dioxane solvent (15 drops)
3. $[(\text{NH}_4)_2 \text{Ce} (\text{NO}_3)_6]$ reagent (15-20 drops), drop by drop, and shake the tube well
4. Note the color change

When the color of ceric ammonium nitrate reagent changes from **yellow** to **red**, it indicates the presence of an alcohol.



B. Preliminary test for carbonyl compounds (Aldehydes & Ketones)

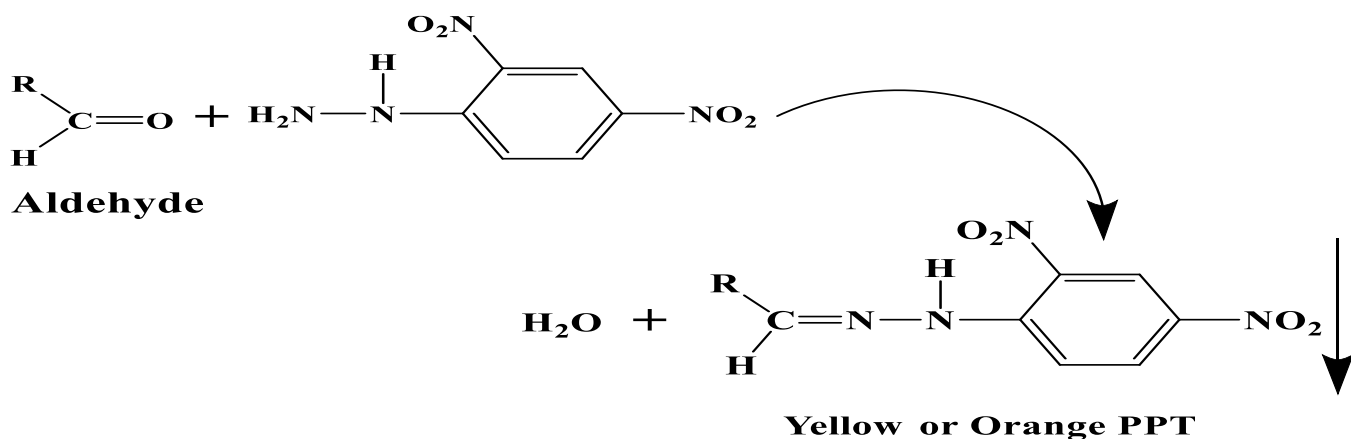
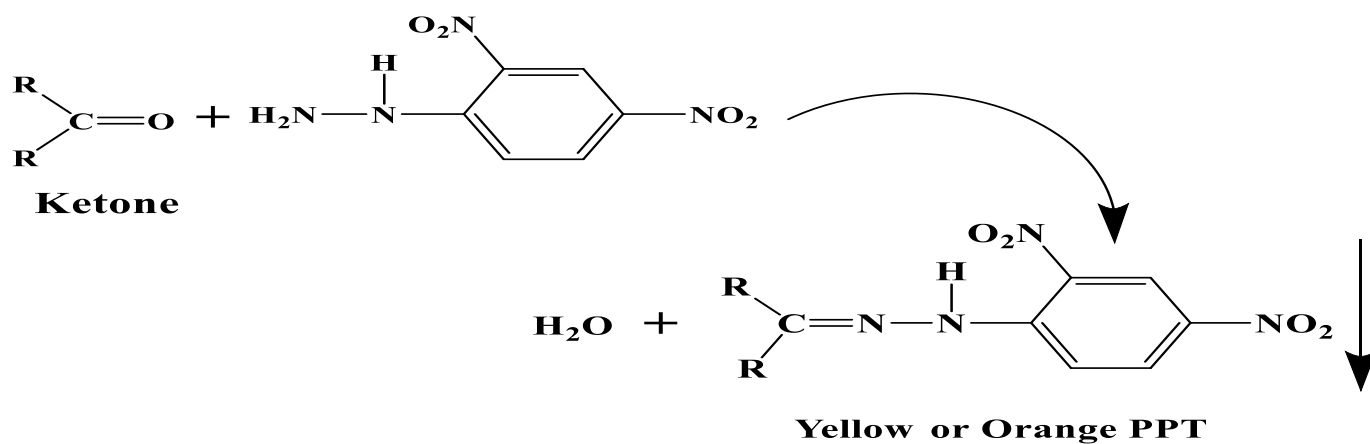
To detect carbonyl compounds, the Brady test (2,4-dinitrophenylhydrazine reagent) is used, as follows:



Add to the test tube the following

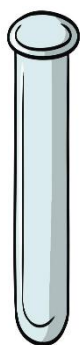
1. Unknown compound (5 drops / 50 mg)
2. Et-OH solvent (15 drops)
3. 2,4-dinitrophenylhydrazine reagent (15-20 drops) drop by drop, and shake the tube well
4. Note the precipitate

When a **yellow or orange precipitate** forms, it indicates the presence of a carbonyl (aldehyde or ketone) compound.



C. Preliminary test for phenol compounds

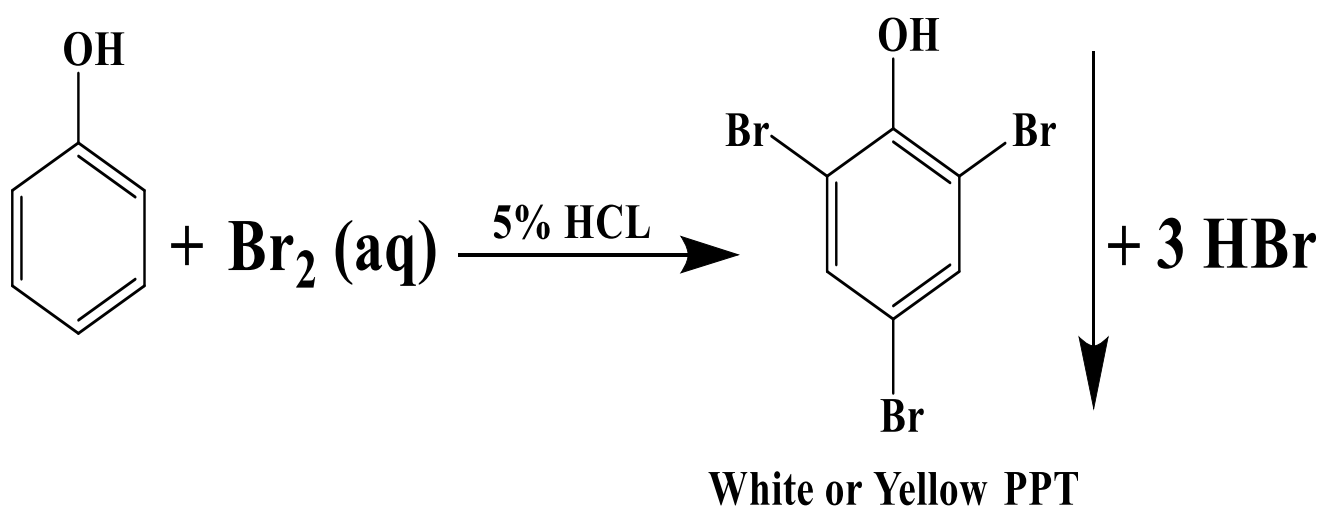
To detect phenol compounds, bromine-water test ($\text{Br}_2/\text{H}_2\text{O}$ reagent) is used, as follow:



Add to the test tube the following

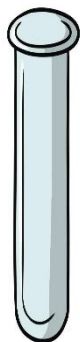
1. Unknown compound (50 mg)
2. 5% HCL (25-30 drops)
3. $\text{Br}_2/\text{H}_2\text{O}$ (10-20 drops), drop by drop, and shake the tube well
4. Note the precipitate

When the **red color** of the $\text{Br}_2/\text{H}_2\text{O}$ reagent disappears and a **white** or **yellow precipitate** forms, it indicates the presence of a phenol.



D. Preliminary test for carboxylic acid compounds

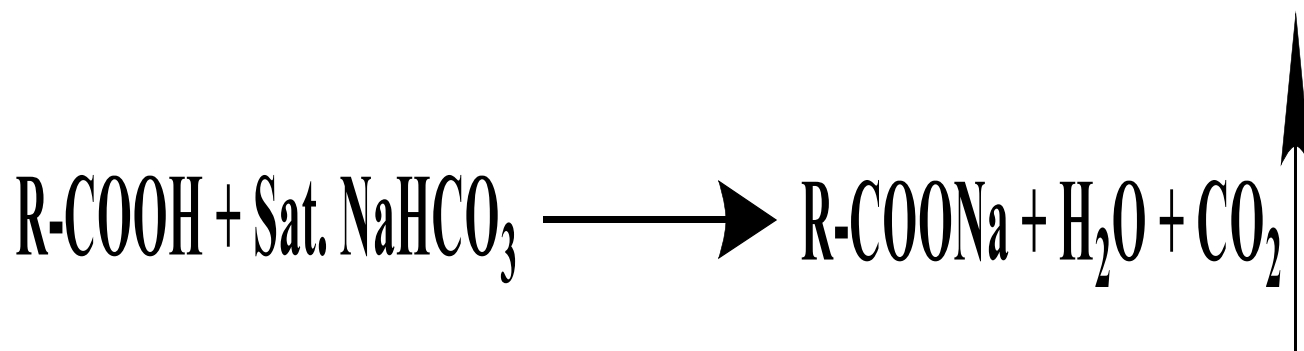
To detect carboxylic acid compounds, a saturated solution of sodium bicarbonate (NaHCO_3) reagent is used, as follows:



Add to the test tube the following

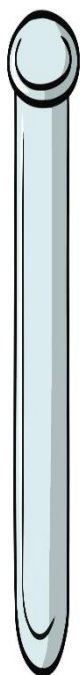
1. Unknown compound (50 mg)
2. Sat. NaHCO_3 (25-30 drops)
3. Shake the tube well
4. Note the solution

Formation of **bubbles, effervescence, or a fizzing** resulting from the release of CO_2 gas indicates the presence of a carboxylic acid.



E. Preliminary test for carbohydrate compounds

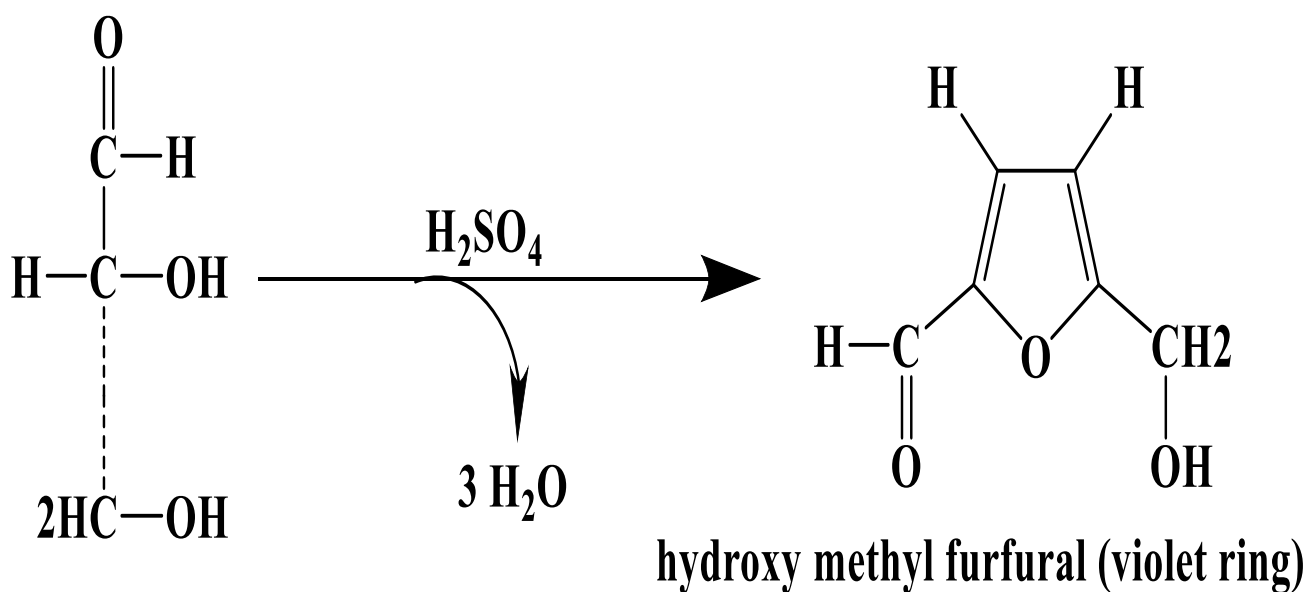
To detect carbohydrate compounds, the Molisch test (alcoholic α -naphthol reagent) is used, as follows:



Add to the test tube the following

1. Unknown compound (50 mg)
2. Distilled Water (DW) (15-20 drops) and shake the tube well until the compound dissolves completely
3. Alcoholic α -naphthol reagent (15-20 drops) and shake the tube well
4. Bend the test tube at a 35° angle and add concentrated sulfuric acid (10-15 drops) drop by drop to the walls of the test tube, and do not shake the test tube ever
5. Note the color of the solution

When the solution separates into two layers and a **purple or violet ring** appears between them, it indicates the presence of carbohydrate.



F. Preliminary test for hydrocarbon compounds

There is no preliminary test for hydrocarbon compounds because they lack functional groups. Therefore, relying on the ignition test to determine the structural form of hydrocarbon compounds, as follows:

Observation	Suggested Compounds
Heavy black smoke with soot	Aromatic compounds (benzene and its derivatives)
Moderate black smoke without soot	May be cyclic compounds
Moderate white smoke without soot	May be aliphatic compounds

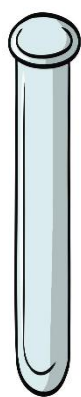
6. Secondary Functional Group Test

The secondary functional group tests are considered a major means of identifying an organic compound and pinpointing its exact chemical family.

A. Secondary test for alcohol compounds

i. Jones oxidation test (chromic acid oxidation)

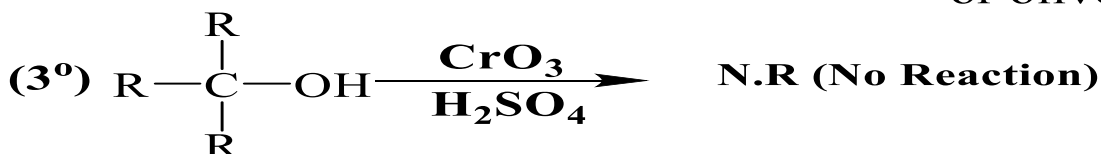
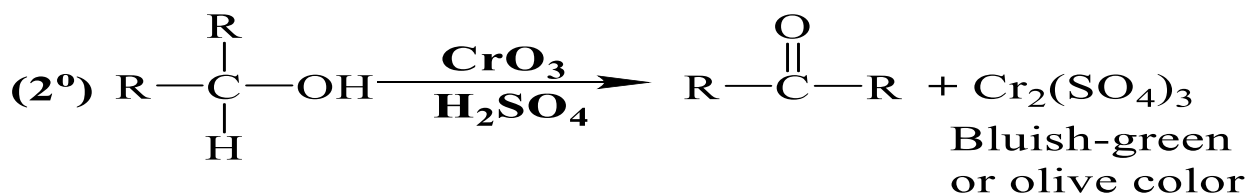
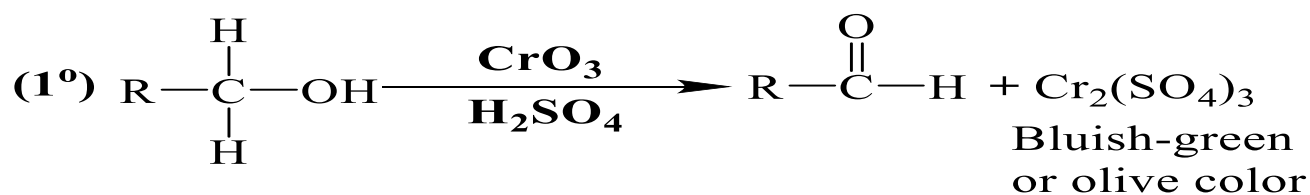
This type of test is used to distinguish between chemical types of alcohol (1° , 2° , 3°), as follows:



Add to the test tube the following

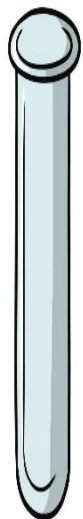
1. Unknown compound (5 drops)
2. Acetone solvent (10-15 drops)
3. 7-15 drops of chromic acid ($\text{CrO}_3/\text{H}_2\text{SO}_4$) reagent drop by drop, and shake the tube well
4. Note the solution

When the **reddish-orange color** of the $\text{CrO}_3/\text{H}_2\text{SO}_4$ reagent disappears and a **bluish-green** or **olive color** forms, it indicates the presence of primary (1°) or secondary (2°) alcohol. The persistence of the reddish-orange color of the $\text{CrO}_3/\text{H}_2\text{SO}_4$ reagent indicates the presence of tertiary (3°) alcohol.



ii. Iodoform test

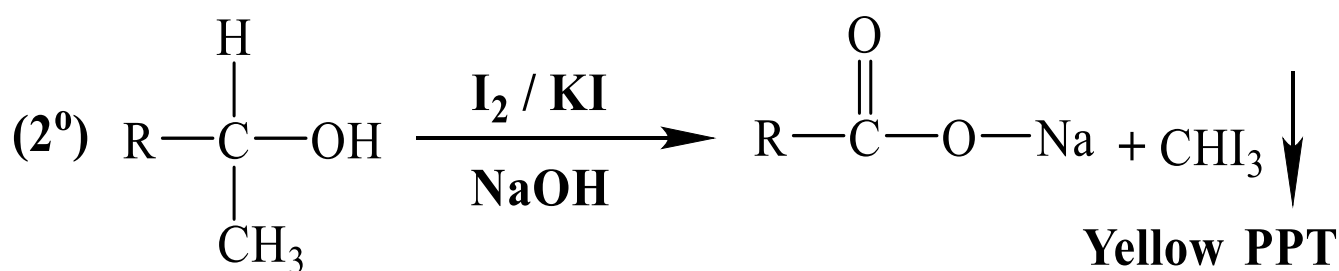
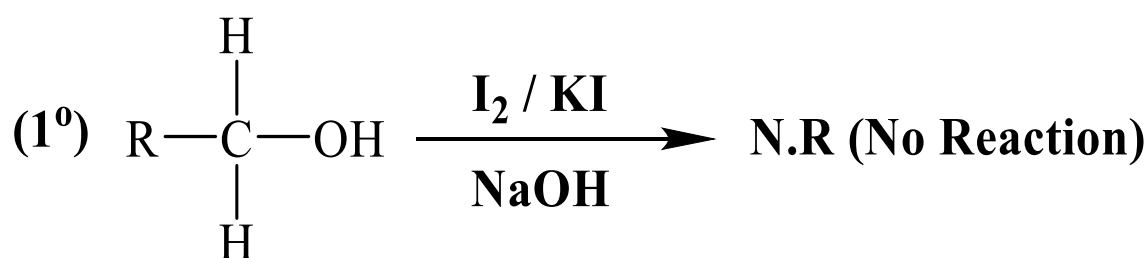
This type of test is used to distinguish between chemical types of alcohol (1° , 2° , 3°) based on precipitate formation, as follows:



Add to the test tube the following

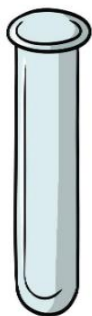
1. Unknown compound (5 drops)
2. Dioxane solvent (10-15 drops)
3. 10% NaOH (10-15 drops)
4. 10-15 drops of iodoform (KI/I_2) reagent drop by drop, and shake the tube well
5. Incubate the test tube in a water bath for 15 minutes
6. Note the precipitate

When a **yellow precipitate** forms, it indicates the presence of secondary (2°) or tertiary (3°) alcohol. The persistence of the yellowish-orange color of the KI/I_2 reagent indicates the presence of primary (1°) alcohol.



iii. Lucas test

This type of test is used to distinguish between chemical types of alcohol (1° , 2° , 3°) based on the separation into two layers, as follows:



Add to the test tube the following

1. Unknown compound (5 drops)
2. 10-15 drops of Lucas reagent (HCL/ZnCL_2), drop by drop, and shake the tube well
3. Note the solution

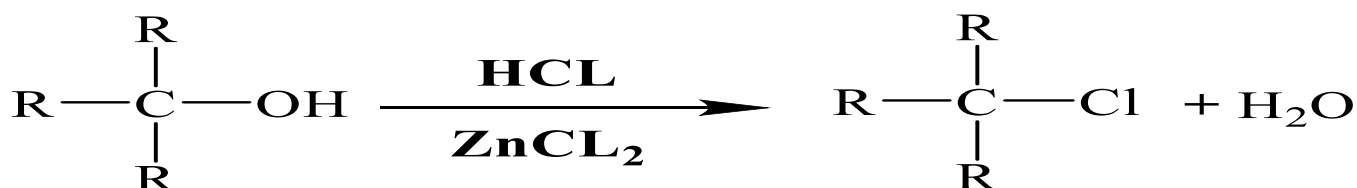
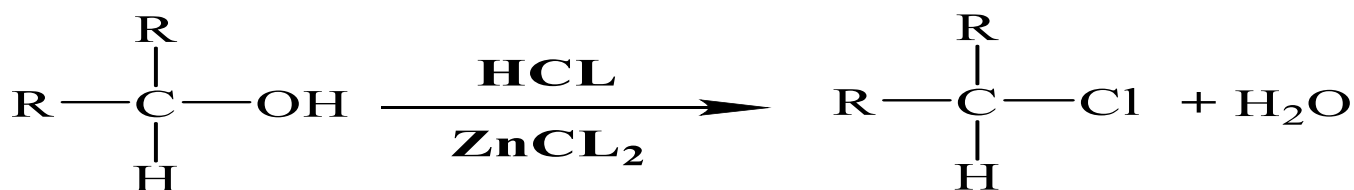
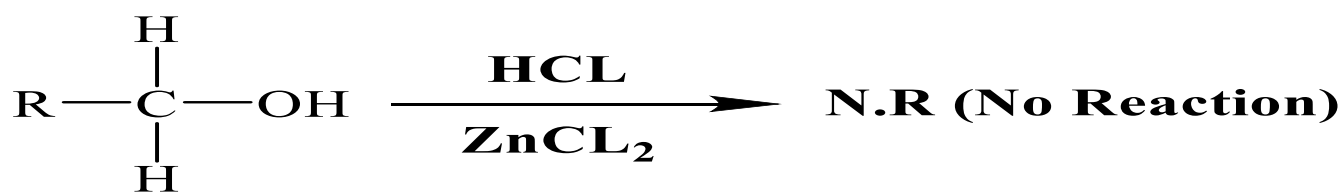
Must be clean and dry

When the solution separates into two layers:

Immediately $\longrightarrow$ Tertiary (3°) alcohol

5-10 minutes $\longrightarrow$ Secondary (2°) alcohol

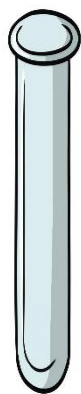
≥ 20 minutes or inseparable $\longrightarrow$ Primary (1°) alcohol



B. Secondary test for carbonyl compounds (Aldehydes & Ketones)

i. Jones oxidation test (chromic acid oxidation)

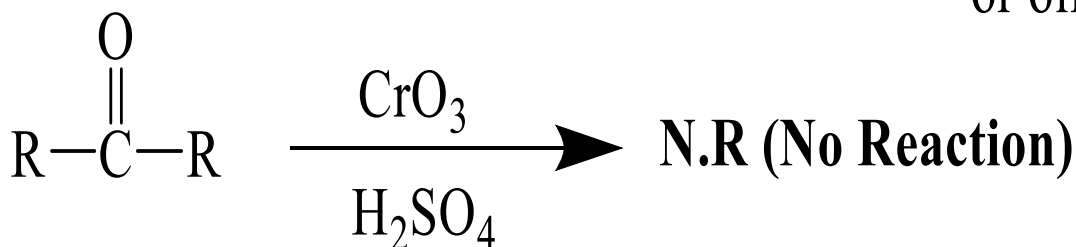
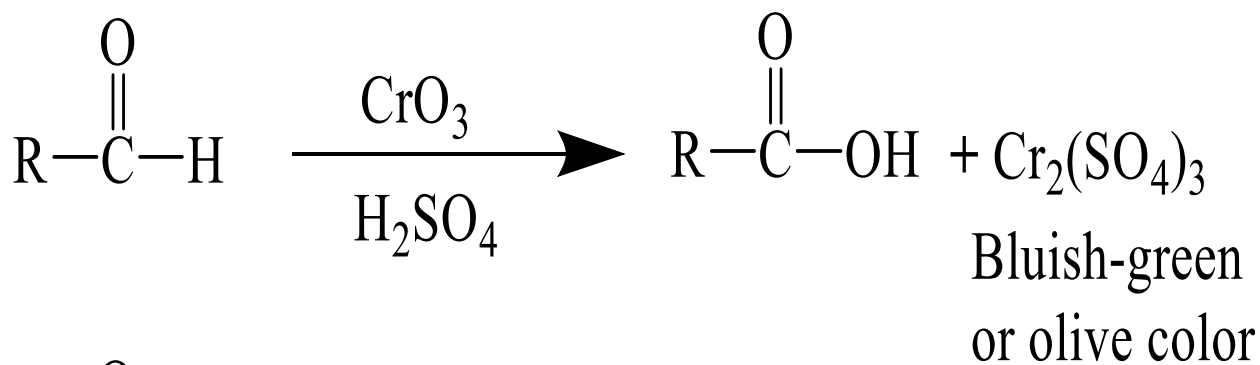
This type of test is used to distinguish between aldehyde and ketone, as follows:



Add to the test tube the following

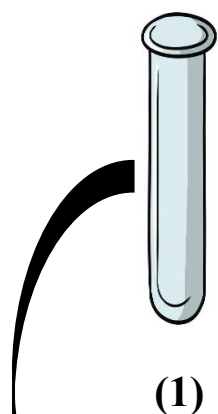
1. Unknown compound (5 drops)
2. Acetone solvent (10-15 drops)
3. 7-15 drops of chromic acid ($\text{CrO}_3/\text{H}_2\text{SO}_4$) reagent drop by drop, and shake the tube well
4. Note the solution

When the **reddish-orange color** of the $\text{CrO}_3/\text{H}_2\text{SO}_4$ reagent disappears and a **bluish-green** or **olive color** forms, it indicates the presence of an aldehyde. The persistence of the reddish-orange color of the $\text{CrO}_3/\text{H}_2\text{SO}_4$ reagent indicates the presence of a ketone.



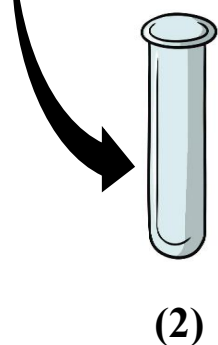
ii. Tollens' test (silver mirror image)

This type of test is used to distinguish between aldehyde and ketone, as follows:



Add to the first test tube the following

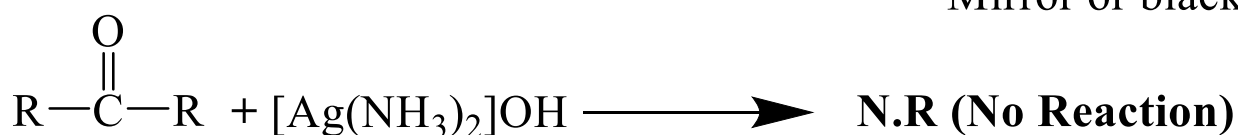
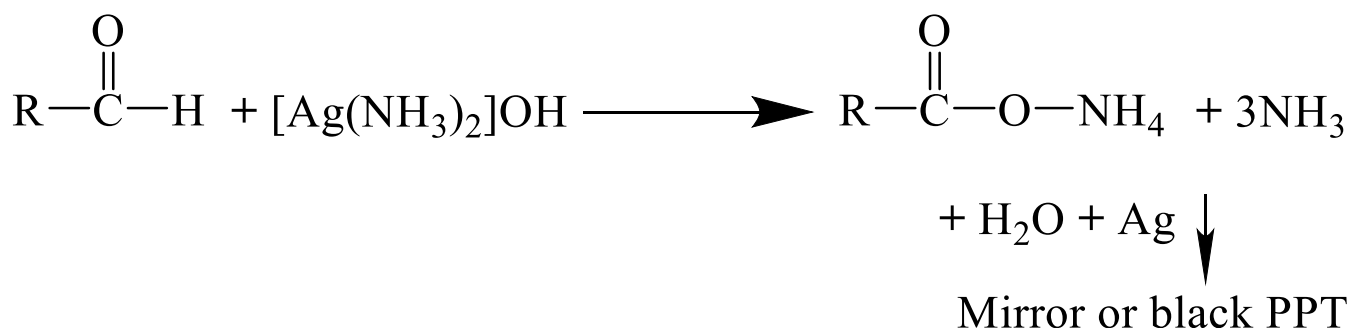
1. Aqueous silver nitrate (AgNO_3) (10-15 drops)
2. 10% NaOH (2-3 drops), will form a black precipitate
3. Drop by drop of ammonia (NH_3) or ammonium hydroxide (NH_4OH) reagent with shaking until the black precipitate disappears



Add to the second test tube the following

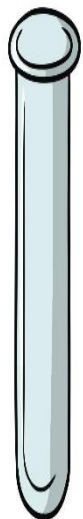
1. Wash the tube with distilled water (DW)
2. Wash the tube with 10% NaOH
3. Unknown (5 drops)
4. Et-OH solvent (10-15 drops)

Added the contents of tube (1) to the contents of tube (2) without shaking the tube and incubated in a water bath for 5-10 minutes. Covering the wall of the tube with a **mirror** or the formation of a **black precipitate** in the solution indicates the presence of an aldehyde.



iii. Iodoform test

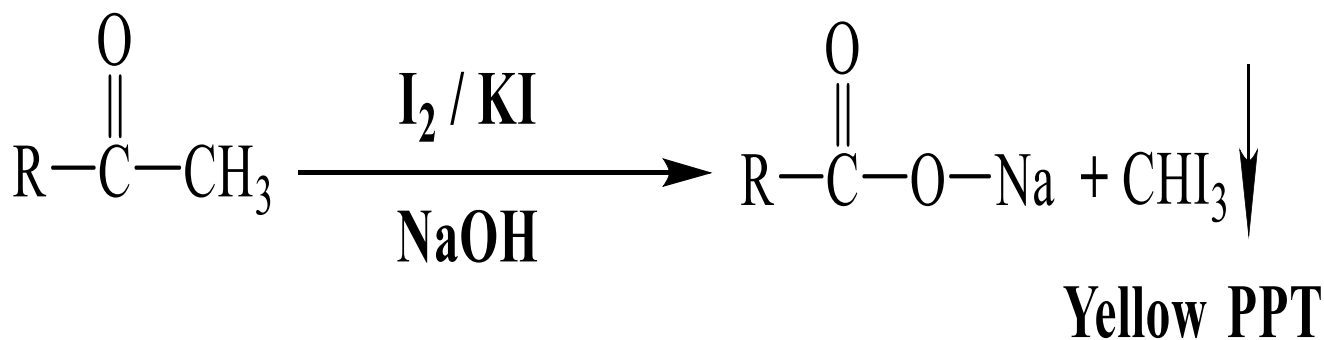
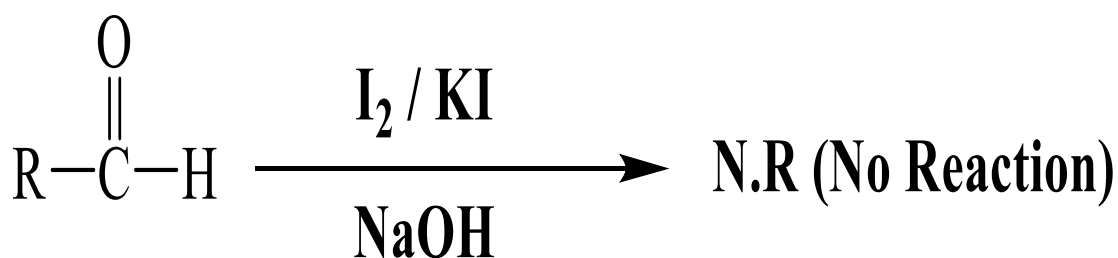
This type of test is used to distinguish between aldehyde and methyl ketone, as follows:



Add to the test tube the following

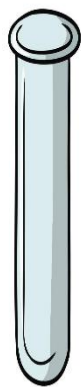
1. Unknown compound (5 drops)
2. Dioxane solvent (10-15 drops)
3. 10% NaOH (10-15 drops)
4. 10-15 drops of iodoform (KI/I₂) reagent drop by drop, and shake the tube well
5. Incubate the test tube in a water bath for 5-10 minutes
6. Note the precipitate

When a **yellow precipitate** forms, it indicates the presence of methyl ketone. The persistence of the yellowish-orange color of the KI/I₂ reagent indicates the presence of aldehyde.



C. Secondary test for phenol compounds

The main secondary test for phenol compounds is the ferric chloride test (FeCl_3), as follows:

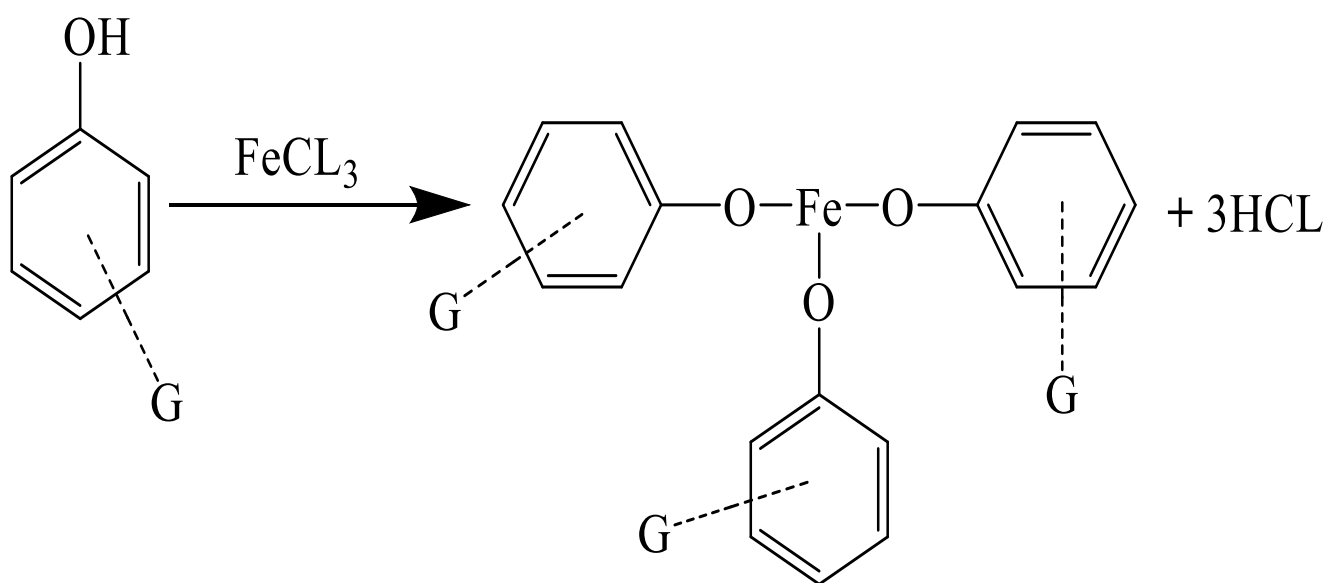


Add to the test tube the following

1. Unknown compound (50 mg)
2. Et-OH solvent (3-5 mL)
3. 10-15 drops of ferric chloride (FeCl_3) reagent drop by drop, and shake the tube well
4. Note the color of the solution

The color of the solution depends on the type of phenol, as follows:

Phenol and derivatives	→	Blue
Catechol	→	Green
Resorcinol	→	Blue
Hydroquinone	→	Blue
α -naphthol and β -naphthol	→	Green

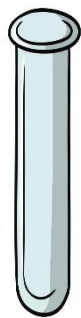


Different color

D. Secondary test for carboxylic acid compounds

i. Acidity test

➤ When a carboxylic acid dissolves in water (depends on the solubility step)

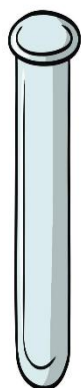


Add to the test tube the following

1. Unknown compound (50 mg)
2. Distilled water (DW) solvent (10-15 drops)
3. Litmus paper (LP)
4. Note the LP

The change in the color of LP from blue to red indicates the presence of carboxylic acid.

➤ When a carboxylic acid does not dissolve in water (depends on the solubility step)



Add to the test tube the following

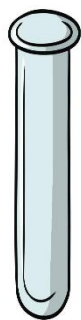
1. Unknown compound (50 mg)
2. Et-OH solvent (10-15 drops)
3. Phenolphthalein (ph.ph) (2 drops)
4. Drop by drop of 5% NaOH with shaking
5. Note the color of the solution

The color of the solution changes to pink when 5% NaOH is added after:

- | | | |
|------------|--------|---------------------------|
| 1-2 drops | —————→ | Strong carboxylic acid |
| 3-10 drops | —————→ | Weak carboxylic acid |
| ≥ 11 drops | —————→ | Very weak carboxylic acid |

ii. Baeyer test

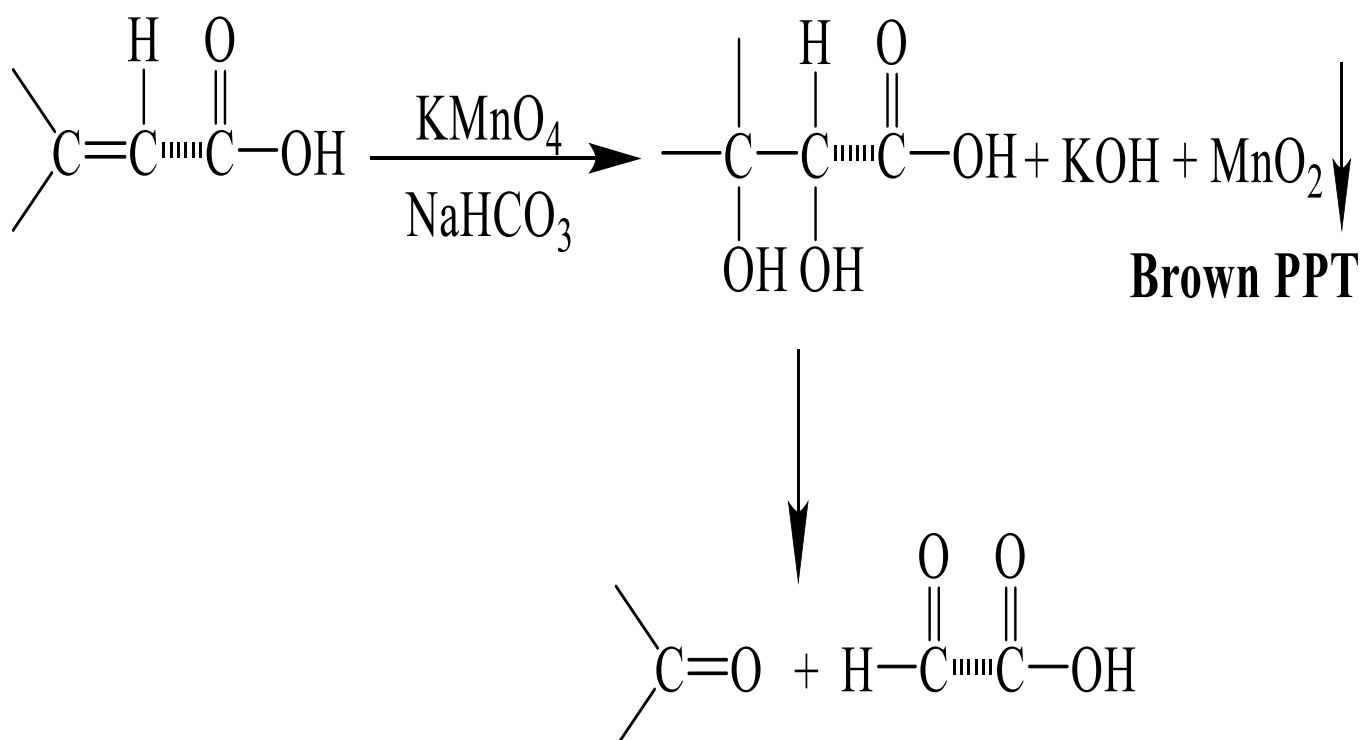
Baeyer's test (also known as the unsaturation test) is used to distinguish the unsaturation state in the alkyl groups within the carboxylic acid compounds, as follows:



Add to the test tube the following

1. Unknown compound (50 mg)
2. Saturated NaHCO_3 (10-15 drops)
3. Potassium permanganate (KMnO_4) (5-10 drops)
4. Note the precipitate

The disappearance of the purple color of the KMnO_4 reagent and the formation of a **brown precipitate** indicate the presence of unsaturated bonds in the alkyl group of the carboxylic acid. The persistence of the purple color of the KMnO_4 reagent indicates all bonds within the alkyl group of the carboxylic acid are saturated.

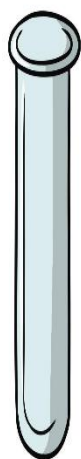


E. Secondary test for carbohydrates

The main secondary tests that are used to distinguish between different types of carbohydrates (sugars) are:

- 1) Benedict test
- 2) Barfoed test
- 3) Bial test
- 4) Seliwanoff test

The procedure for each test is the same, as follows:



Add to the test tube the following

1. Unknown compound (50 mg)
2. Distilled Water (DW) (1 mL)
3. 15-20 drops of the specific reagent (Benedict / Barfoed / Bial / Seliwanoff)
4. Incubate in a water bath for 5 minutes
5. Note the solution

The solution will change its color or form a precipitate depending on the specific reagent, as shown in the following diagram:

ORGANIC IDENTIFICATION LABORATORY

Carbohydrate (Sugar)

1

**Benedict Reagent
(Reducing) Sugar**

Reducing sugar
Positive Test (+ve)
*Red or orange
precipitate forms*

Non-Reducing Sugar
Negative Test (-ve)
*No red or orange
precipitate forms*

2

**Barfoed Reagent
(Mono / Di) Sugar**

Mono-Reducing sugar
Positive Test (+ve)
Red precipitate forms

Di-Reducing Sugar
Negative Test (-ve)
No red precipitate forms

3

**Bial Reagent
(Pentose / Hexose) Sugar**

Pentose Reducing sugar
Positive Test (+ve)
greenish-blue color forms

Hexose Reducing Sugar
Negative Test (-ve)
No greenish-blue color forms

4

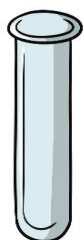
**Seliwanoff Reagent
(Aldehyde / Ketone) Sugar**

Ketone Reducing sugar
Positive Test (+ve)
Red color forms

Aldehyde Reducing Sugar
Negative Test (-ve)
No red color forms

F. Secondary test for hydrocarbons

The main secondary test for hydrocarbon compounds is the nitration test, as follows:



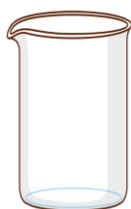
(1)

Add to the first test tube the following

1. HNO_3 (15-20 drops)

2. H_2SO_4 (15-20 drops)

★ Care must be taken when mixing them, and one should not rush, as they are strong acids.



(2)

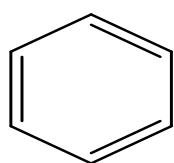
Add to the beaker the following

Unknown compound (50 mg / 5 drops)

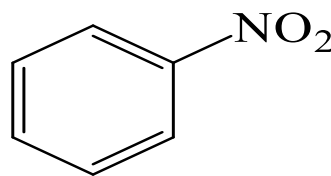
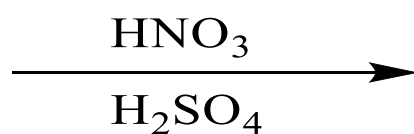
Add the contents of test tube (1) to beaker (2), stir and shake vigorously, and then add the beaker contents to cold water and note the result.

Viscous oil with pale yellow $\longrightarrow$ Aromatic hydrocarbon

Non-viscous oil with pale yellow $\longrightarrow$ Aliphatic hydrocarbon

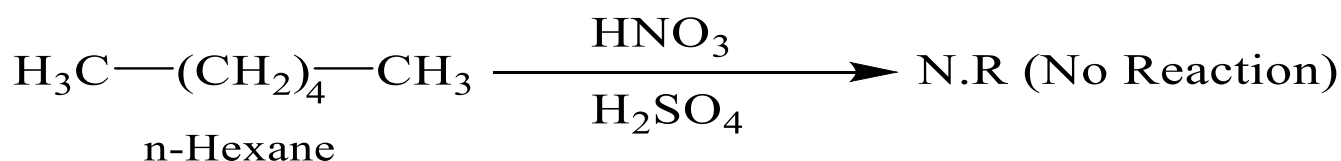


Benzene



Nitrobenzene

(Pale yellow viscous oil)

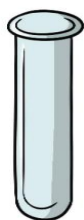


Derivative Preparation for Functional Group

In organic chemistry, synthesizing derivatives of functional groups relies on chemical reactions that convert the functional group into a pure, well-defined solid compound.

1. Preparation of Alcohol Compound Derivatives

To prepare alcohol derivatives, follow the following:



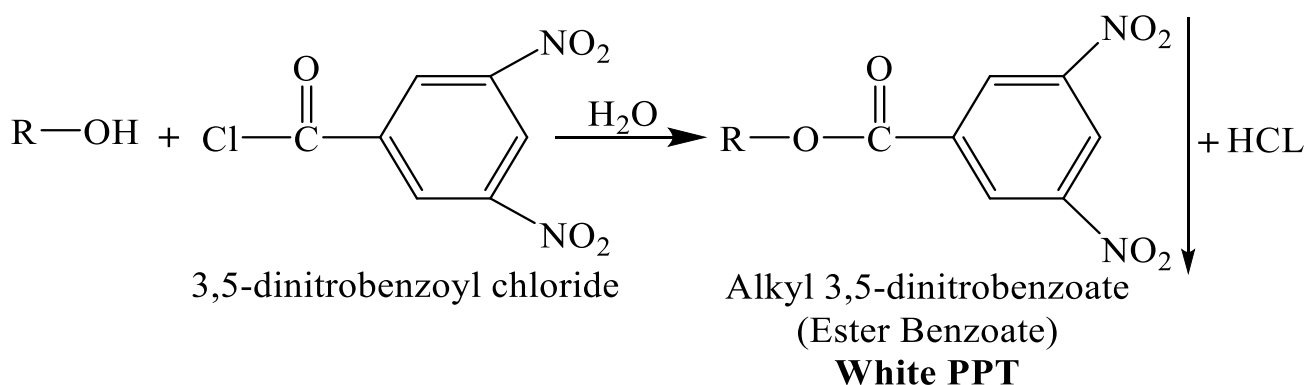
Add to the test tube the following

1. Unknown alcohol (20 drops)
2. 0.125 gm of 3,5-dinitrobenzoyl chloride
3. Incubate in the water bath for 5 minutes

Must be clean and dry

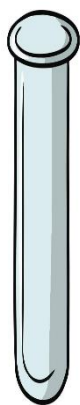
After spending 5 minutes in the water bath, follow these steps:

- i. Place the test tube components in the beaker and continue stirring.
- ii. Gradually add 3 mL of cold distilled water (DW) to the beaker contents and continue stirring until a **white precipitate** forms.
- iii. After the white precipitate forms, filter the beaker contents to separate the precipitate from the filtrate.
- iv. Wash the precipitate with the smallest possible amount of cold DW at least twice, and let it dry at room temperature.
- v. After the precipitate has dried completely, measure its melting point.



2. Preparation of Carbonyl Compound Derivative

To prepare the carbonyl derivative, follow the following:

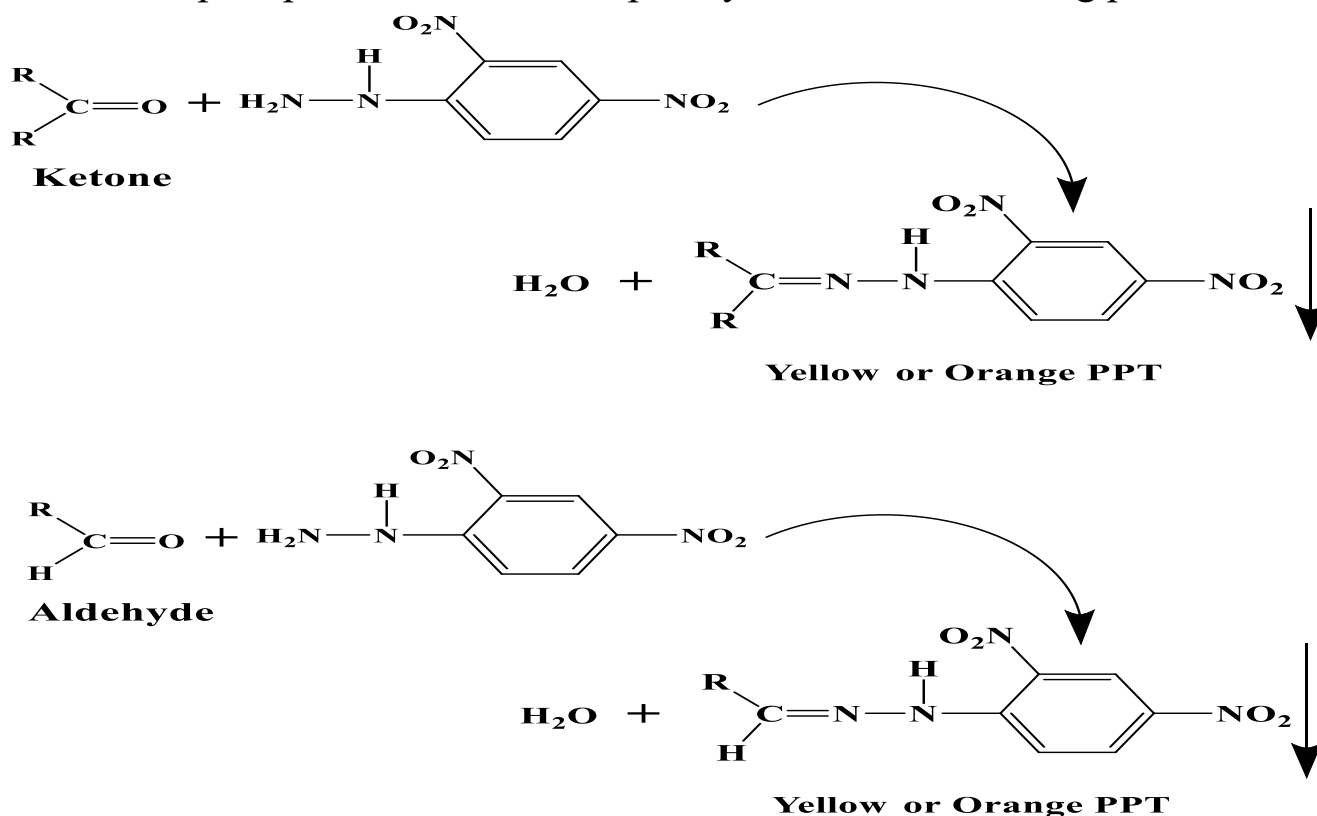


Add to the test tube the following

1. Unknown carbonyl (10 drops / 50 mg)
2. Et-OH solvent (15 drops)
3. 20-25 drops of 2,4-dinitrophenylhydrazine reagent drop by drop, and shake the tube well
4. Note the precipitate

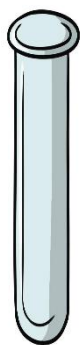
When a **yellow or orange precipitate** forms, follow these steps:

- i. Filter the test tube contents to separate the precipitate from the filtrate.
- ii. Wash the precipitate with the smallest possible amount of cold distilled water (DW).
- iii. Wash the precipitate with the smallest possible amount of ethanol (Et-OH).
- iv. Place the precipitate in the oven at 75 °C and let it dry.
- v. After the precipitate has dried completely, measure its melting point.



3. Preparation of Phenol Compound Derivative

To prepare phenol derivatives, follow the following:

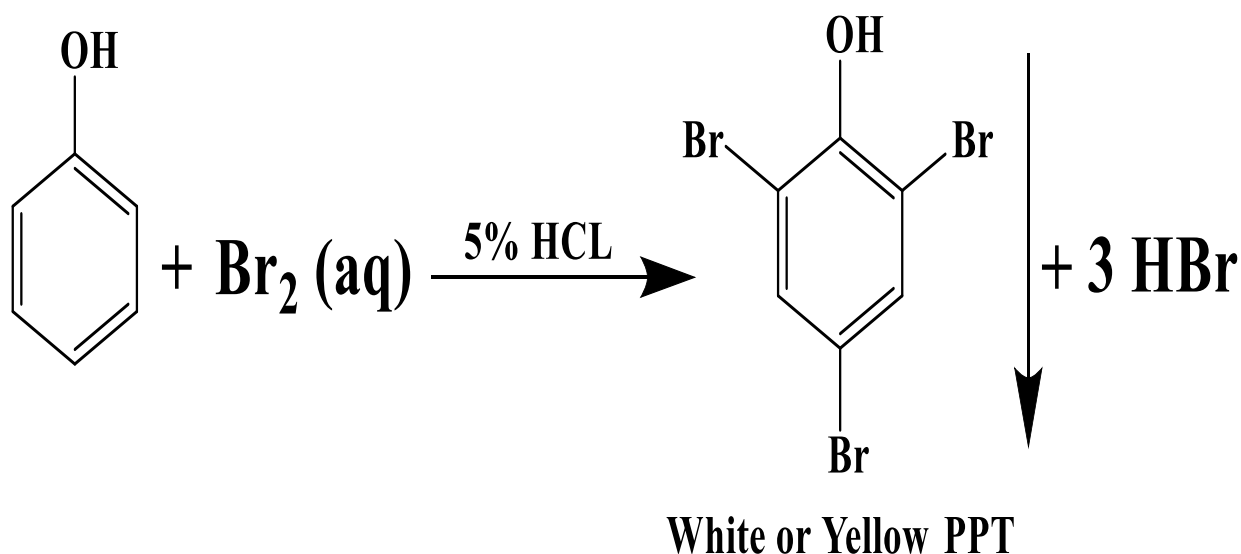


Add to the test tube the following

1. Unknown phenol (50 mg)
2. 5% HCL (25-30 drops)
3. 10-20 drops from Br₂/H₂O drop by drop and shake the tube well
4. Note the precipitate

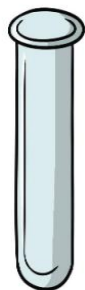
When a **white** or **yellow precipitate** forms, follow these steps:

- i. Filter the test tube contents to separate the precipitate from the filtrate.
- ii. Wash the precipitate with the smallest possible amount of cold distilled water (DW) at least twice.
- iii. Transfer the precipitate to another filter paper, and let it dry at room temperature.
- iv. After the precipitate has dried completely, measure its melting point.



4. Preparation of Carbohydrate Compound Derivatives

To prepare carbohydrate derivatives, follow the following:



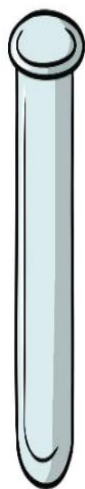
(1)

Must be clean

Add to the first test tube the following

1. 4 mL of distilled water (DW)
2. 0.4 gm of phenyl hydrazine hydrochloride, with shaking until it dissolves completely
3. 0.6 gm of sodium acetate, with shaking until it dissolves completely

After the solution has completely dissolved, filter the test tube contents and follow these steps:



(2)

Must be clean

Add to the second test tube the following

1. The filtrate produced by the filtration process from the first test tube
 2. 0.2 gm of unknown carbohydrate
 3. Shake the test tube well
 4. Incubate in the water bath for 20 minutes
 5. Note the precipitate
- ★ The contents of the test tube should be observed every minute to check for the formation of a yellow precipitate.

When a yellow precipitate forms, follow these steps:

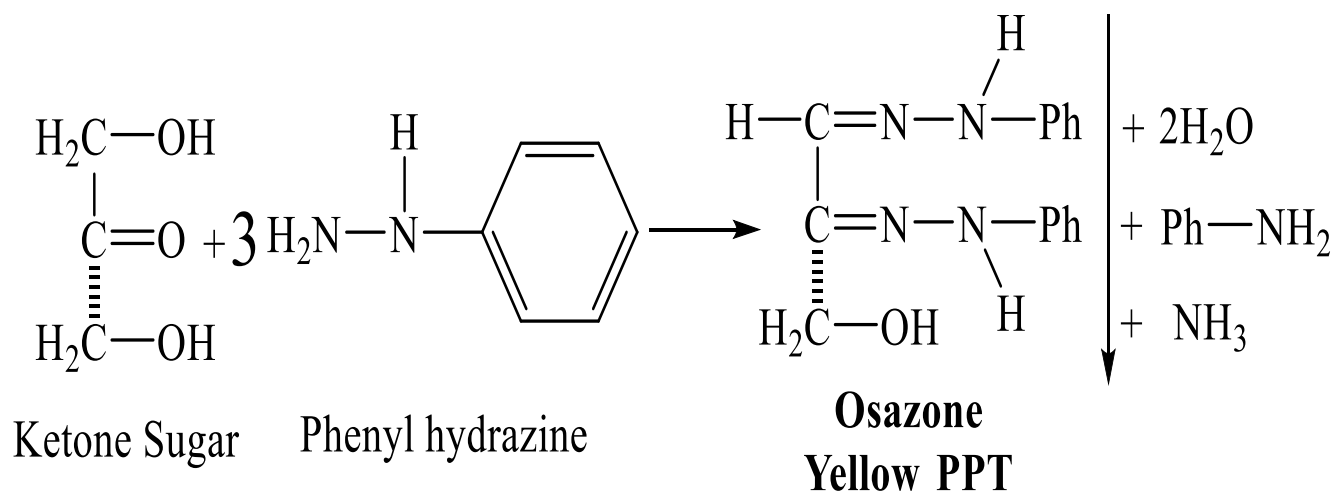
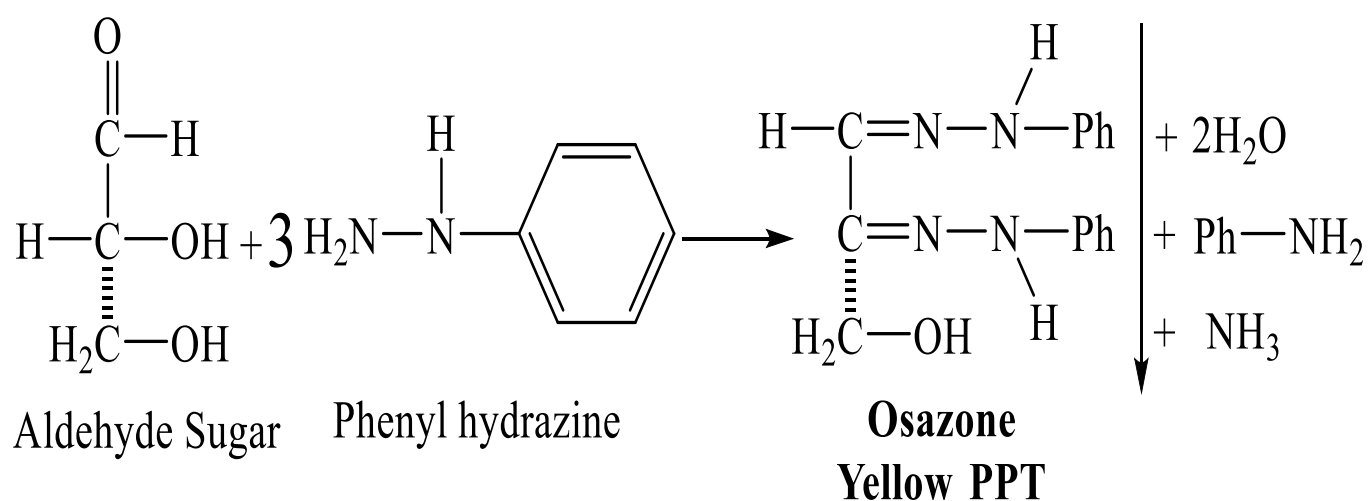
- i. Filter the test tube contents to separate the precipitate from the filtrate.
- ii. Let the precipitate dry at room temperature.

ORGANIC IDENTIFICATION LABORATORY

iii. After the precipitate has dried completely, measure its melting point.

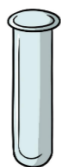
➤ The time required for a yellow precipitate derived from a certain sugar compound to form is:

Fructose	2 minutes
Glucose	4-5 minutes
Xylose	7 minutes
Arabinose	10 minutes
Galactose	15-19 minutes



5. Preparation of Hydrocarbon Compound Derivatives

To prepare hydrocarbon derivatives, follow the following:

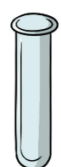


(1)

Must be clean and dry

Add to the first test tube the following

1. Unknown hydrocarbon (10 drops / 50 mg)
2. Et-OH (5 mL)
3. Close the nozzle of the test tube



(2)

Must be clean and dry

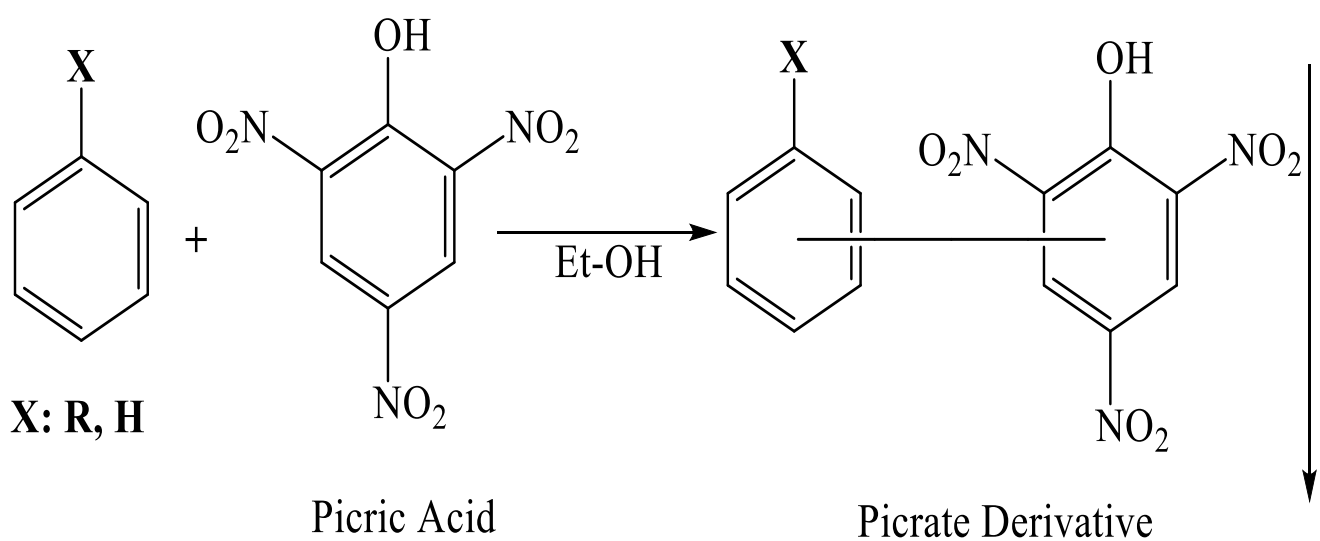
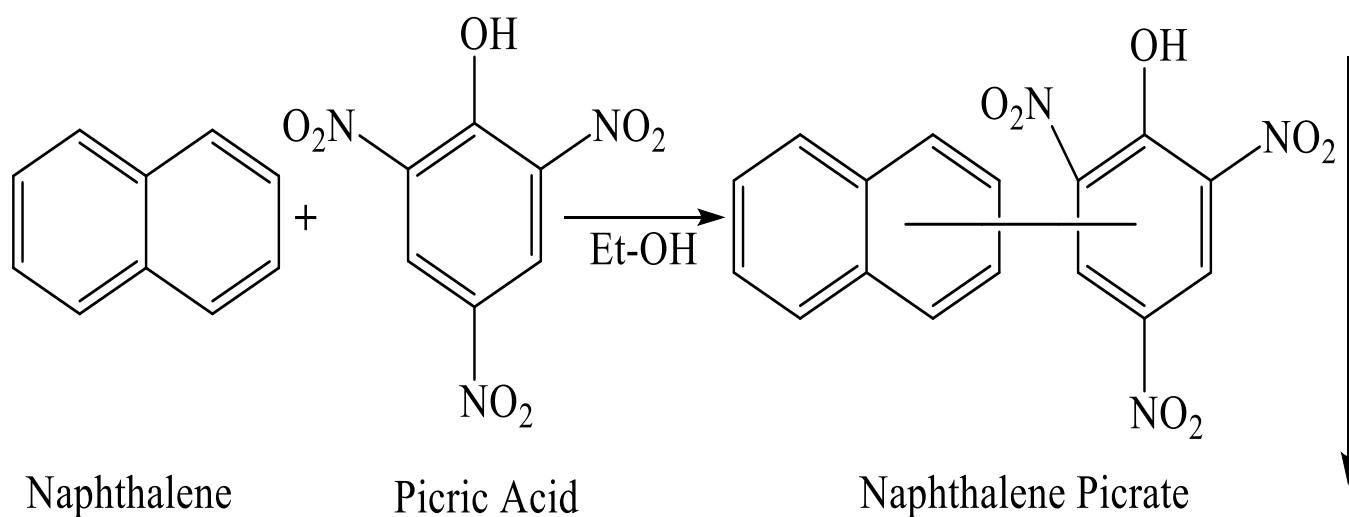
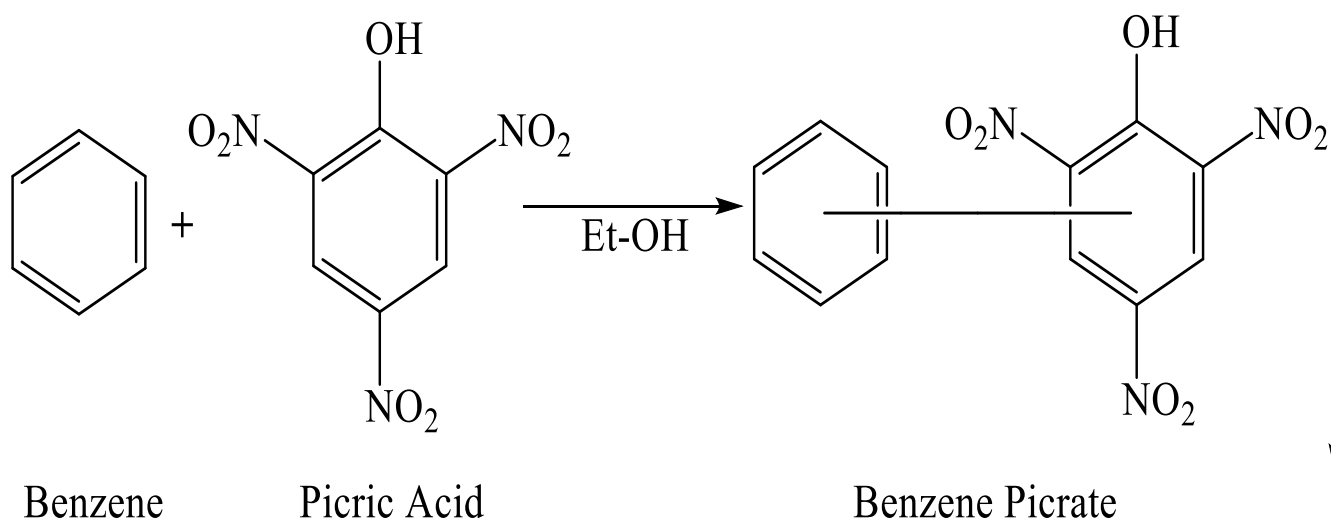
Add to the second test tube the following

1. Picric acid (50mg)
2. Et-OH (5 mL)
3. Close the nozzle of the test tube

Place the two test tubes in a water bath for 5 minutes, taking care not to allow the solutions in the test tubes to reach the boiling point to preserve the solvent, and then follow these steps:

- i. Filter the contents of the two test tubes, one at a time.
- ii. Mix the filtrates of the two test tubes in another clean and dry test tube.
- iii. Let the resulting solution sit at room temperature to allow the precipitate to form.
- iv. After the precipitate forms, filter the test tube contents to separate the precipitate from the filtrate.
- v. Let the precipitate dry at room temperature.
- vi. After the precipitate has dried completely, measure its melting point.

ORGANIC IDENTIFICATION LABORATORY



6. Preparation of Carboxylic Acid Compound Derivatives

The purpose of preparing carboxylic acid derivatives is to determine the molecular weight of the carboxylic acid through a titration process with a strong base (NaOH or KOH), as follows:



Add to the conical flask the following

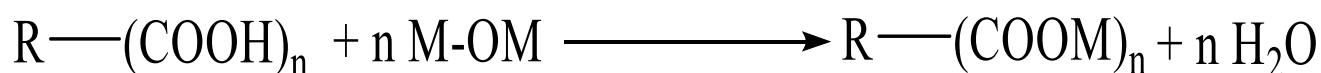
1. 25 mL of DW or Et-OH (depends on solubility step)
2. 0.1 gm of unknown carboxylic acid
3. Shake the conical flask well until the unknown carboxylic acid dissolves completely
4. 2-3 drops of phenolphthalein (ph.ph)
5. Titrate with strong base (NaOH or KOH)
6. Note the solution color

After the solution changed color, record the volume dispensed from the burette, and apply the following equations:

$$\text{Equivalent Weight (EW)} = \frac{1000 \times \text{Weight (gm)}}{\text{Molarity (M)} \times \text{Volume (mL)}}$$

$$\text{Molecular Weight (MW)} = \text{Equivalent Weight (EW)} \times X$$

X: represent the number of carboxylate group in the unknown carboxylic acid



جدول رقم (1)
الهيدروكربونات الاروماتية
Aromatic Hydrocarbons

Compound Name	Melting Point (°C)	Boiling Point (°C)	Picrate (°C)
Benzene	5	80	-
Toluene	-	110	-
Ethylbenzene	-	136	-
<i>p</i> -Xylene	14	137	-
<i>m</i> -Xylene	-	139	-
<i>o</i> -Xylene	-	142	-
Cumene	-	152	-
Mesitylene	-	164	-
<i>p</i> -Cumene	-	175	-
Tetralene	-	206	-
α -Naphthalene	-	240	141
Diphenylmethane	27	261	-
β -Phenylnaphthalene	32	240	166
Dibenzyl	52	284	-
Diphenyl	70	254	-
Durence	80	193	95
Naphthalene	80	218	150
Triphenylmethane	92	-	-
Acenaphthene	95	277	161
Phenanthreng	100	340	143
Fluorene	115	295	84
Pyrene	149	-	227
Arthracene	216	351	138
Chrysene	254	-	273

جدول رقم (2)
السكريات Carbohydrate

Compound Name	Melting Point (°C)	Osazone	
		Melting Point (°C)	Time of Formation (min)
Mannose	132	205	0-5
Fructose	103-104	205	2
Sorbose	159-161	162	4
Glucose (anhydrous)	146	205	4
Glucose (hydrated)	85-90	205	4
Xylose	144	164	7
Arabinose	160	166	9
Galactose (hydrated)	118-120	196	15-19
Galactose (anhydrous)	165-166	196	15-19
Sucrose	160-170	205	30
Lactose (hydrated)	203	200	-
Maltose (hydrated)	100-110	208	-

جدول رقم (3)
الكحولات الاليفاتية Aliphatic Alcohol

Compound Name	Boiling Point (°C)	Melting Point (°C)	MP for 3,5-Dinitrobenzoate (°C)
Methyl alcohol	64	-	109
Ethyl alcohol	78	-	94
<i>n</i> -Propyl alcohol	97	-	75
<i>iso</i> -Propyl alcohol	82	-	122
<i>n</i> -Butyl alcohol	118	-	64
<i>iso</i> -Butyl alcohol	108	-	88
<i>sec</i> -Butyl alcohol	99	-	76
<i>tert</i> -Butyl alcohol	82	25	142
<i>n</i> -Amyl alcohol (1-Pentanol)	138	-	46
<i>iso</i> -Amyl alcohol (Isopentyl alcohol)	131	-	62
2-Pentanol	119	-	62
3-Pentanol	116	-	100
<i>sec</i> -Butyl carbinol	129	-	70
<i>tert</i> -Amyl alcohol	102	-	118
<i>n</i> -Hexyl alcohol	156	-	61
<i>n</i> -Heptyl alcohol	176	-	48
<i>n</i> -Octyl alcohol	194	-	62
<i>n</i> -Nonyl alcohol	212	-	52
<i>n</i> -Decyl alcohol	229	6	57
Neo-Pentyl alcohol	113	52	-
2-Ethyl-1-butanol	149	-	52
2-Heptanol	159	-	49
2-Octanol	179	-	32
Cyclopentanol	141	-	-
Cyclohexanol	161	25	113
Furfuryl alcohol	170	-	81
Tetrahydrofurfuryl alcohol	177	-	84
Allyl alcohol	97	-	50
Diacetone alcohol	166	-	55
Ethylene bromohydrin	149	-	-
Ethylene chlorohydrin	128	-	-
Ethylene glycol	197	-	169
Glycerol	209	-	-

جدول رقم (4)
الكحولات الاروماتية Aromatic Alcohol

Compound Name	Boiling Point (°C)	Melting Point (°C)	MP for 3,5-Dinitrobenzoate (°C)
Benzyl alcohol	205	-	113
β -Phenylethyl alcohol	220	-	108
Methylphenyl carbinol	203	20	94
Ethylphenyl carbinol	219	-	-
<i>n</i> -Propylphenyl carbinol	140	-	-
<i>n</i> -Butylphenyl carbinol	137	-	-
Diphenyl carbinol	298	69	142
γ -Phenyl- <i>n</i> -propyl alcohol	235	-	92
Triphenyl carbinol	-	165	-
<i>o</i> -Nitrobenzyl alcohol	270	74	-
<i>m</i> -Nitrobenzyl alcohol	-	27	-
<i>p</i> -Nitrobenzyl alcohol	185	93	-
<i>o</i> -Aminobenzyl alcohol	-	82	-
<i>m</i> -Aminobenzyl alcohol	-	97	-
<i>p</i> -Aminobenzyl alcohol	-	65	-
<i>o</i> -Chlorobenzyl alcohol	230	74	-
<i>m</i> -Chlorobenzyl alcohol	234	-	-
<i>p</i> -Chlorobenzyl alcohol	235	75	-
<i>o</i> -Bromobenzyl alcohol	-	80	-
<i>m</i> -Bromobenzyl alcohol	254	-	-
<i>o</i> -Hydroxybenzyl alcohol	-	87	-
<i>m</i> -Hydroxybenzyl alcohol	-	73	-
<i>p</i> -Hydroxybenzyl alcohol	-	125	-
<i>o</i> -Methoxybenzyl alcohol	249	-	-
<i>m</i> -Methoxybenzyl alcohol	252	-	-
<i>p</i> -Methoxybenzyl alcohol	259	25	-
2-Methylbenzyl alcohol	219	36	-
3-Methylbenzyl alcohol	217	-	-
4-Methylbenzyl alcohol	217	60	-
Cinnamyl alcohol	257	33	121
3,4-Methylenedioxybenzyl alcohol	-	68	-
Benzoin	-	137	-

جدول رقم (5)
 الالديهيدات الاليفاتية Aliphatic Aldehyde

Compound Name	Boiling Point (°C)	MP for 2,4-Dinitrophenyl hydrazone (°C)
Formaldehyde	-21	166
Acetaldehyde	20	168
Propionaldehyde	49	155
<i>n</i> -Butyraldehyde	75	123
<i>iso</i> -Butyraldehyde	64	187
Trimethylacetaldehyde	75	209
<i>n</i> -Valeraldehyde	104	98
<i>iso</i> -Valeraldehyde	92	123
<i>n</i> -Hexaldehyde	128	107
<i>n</i> -Heptaldehyde	154	108
<i>n</i> -Ocataldehyde	170	106
<i>n</i> -Nonaldehyde	185	100
<i>n</i> -Decylaldehyde	208	104
Crotonaldehyde	102	190
Diethylacetaldehyde	117	130
Furfural	161	230
Aldol	83/20	-
Hexahydrobenzaldehyde	162	-
Acrolein	52	165
α -Citronellal	207	78
Citral	229	110
Chloral	98	131
Bromal	174	-
Chloral hydrate	96	-
Paraldehyde	124	-

جدول رقم (6)
الالدهيدات الاروماتية Aromatic Aldehyde

Compound Name	Melting Point (°C)	Boiling Point (°C)	MP for 2,4-Dinitrophenyl hydrazone (°C)
Benzaldehyde	-	179	237
<i>o</i> -Chlorobenzaldehyde	11	213	209
<i>m</i> -Chlorobenzaldehyde	18	213	-
<i>p</i> -Chlorobenzaldehyde	47	214	-
<i>o</i> -Bromobenzaldehyde	22	230	-
<i>m</i> -Bromobenzaldehyde	-	234	-
<i>p</i> -Bromobenzaldehyde	67	-	-
<i>o</i> -Iodobenzaldehyde	37	-	-
<i>m</i> -Iodobenzaldehyde	57	-	-
<i>p</i> -Iodobenzaldehyde	78	-	-
Salicylaldehyde	-	197	252
<i>m</i> -Hydroxybenzaldehyde	108	240	259
<i>p</i> -Hydroxybenzaldehyde	116	-	280
<i>o</i> -Methoxybenzaldehyde	38	236	253
<i>m</i> -Methoxybenzaldehyde	-	230	-
<i>p</i> -Methoxybenzaldehyde	2	248	254
<i>o</i> -Nitrobenzaldehyde	44	-	265
<i>m</i> -Nitrobenzaldehyde	58	-	292
<i>p</i> -Nitrobenzaldehyde	106	-	320
<i>o</i> -Aminobenzaldehyde	40	-	-
<i>m</i> -Aminobenzaldehyde	-	-	-
<i>p</i> -Aminobenzaldehyde	72	-	-
<i>o</i> -Tolualdehyde	-	197	194
<i>m</i> - Tolualdehyde	-	199	-
<i>p</i> - Tolualdehyde	-	204	233
3,4-Dihydroxybenzaldehyde	153	-	275
Phenylacetaldehyde	195	34	121
Cinnamaldehyde	252	-	255
Hexahydrobenzaldehyde	162	-	-
α -Naphthaldehyde	202	34	-
β -Naphthaldehyde	-	61	270

جدول رقم (7)
الكيتونات الاليفاتية Aliphatic Ketone

Name of Compound	Boiling Point (°C)	Melting Point (°C)	MP for 2,4-Dinitrophenyl hydrazone (°C)
Acetone	56	-	128
Diethyl ketone	102	-	156
Di- <i>n</i> -propyl ketone	144	-	75
Di- <i>iso</i> -propyl ketone	124	-	88
Di- <i>n</i> -butyl ketone	185	-	-
Di- <i>iso</i> -butyl ketone	168	-	92
Di- <i>n</i> -amyl ketone	223	-	-
Di- <i>n</i> -hexyl ketone	255	53	-
Ethyl methyl ketone	80	-	117
Methyl <i>n</i> -propyl ketone	102	-	144
Methyl <i>iso</i> -propyl ketone	94	-	120
Methyl <i>n</i> -butyl ketone	128	-	107
Methyl <i>iso</i> -butyl ketone	117	-	95
Methyl <i>n</i> -amyl ketone	151	-	89
Methyl <i>n</i> -hexyl ketone	173	-	58
Chloroacetone	119	-	129
Hydroxyacetone (Acetol)	146	-	129
Methyl acetyl carbinol (Acetoin)	145	-	318
Cyclopentanone	131	-	146
Cyclohexanone	156	-	162
Cycloheptanone	180	-	148
2-Methyl cyclopentanone	139	-	-
2-Methyl cyclohexanone	165	-	137
3-Methyl cyclohexanone	170	-	155
4-Methyl cyclohexanone	171	-	-
Diacetone alcohol	166	-	203
Pinacolone	106	-	125
Phorone	199	28	-
<i>iso</i> -Phorone	215	-	-
Acetylacetone	139	-	209
Diacetyl	88	-	315
Acetonyl acetone	194	-	257
Furoin	-	135	217
Furil	-	165	-

جدول رقم (8)
الكيتونات الاروماتية Aromatic Ketone

Name of Compound	Boiling Point (°C)	Melting Point (°C)	MP for 2,4-Dinitrophenyl hydrazone (°C)
Acetophenone	202	20	237
<i>o</i> -Chloroacetophenone	229	-	-
<i>m</i> -Chloroacetophenone	228	-	-
<i>p</i> -Chloroacetophenone	236	20	239
<i>o</i> -Bromoacetophenone	112	-	-
<i>m</i> -Bromoacetophenone	131	8	-
<i>p</i> -Bromoacetophenone	256	51	230
<i>p</i> -Iodoacetophenone	-	85	-
<i>o</i> -Methyl acetophenone	214	-	159
<i>m</i> -Methyl acetophenone	220	-	207
<i>p</i> -Methyl acetophenone	226	28	258
<i>o</i> -Hydroxy acetophenone	215	-	-
<i>m</i> -Hydroxy acetophenone	-	96	-
<i>p</i> -Hydroxy acetophenone	-	109	261
<i>o</i> -Methoxy acetophenone	245	-	-
<i>m</i> -Methoxy acetophenone	240	-	-
<i>p</i> -Methoxy acetophenone	258	39	220
<i>o</i> -Nitro acetophenone	159	-	-
<i>m</i> -Nitro acetophenone	-	81	228
<i>p</i> -Nitro acetophenone	-	81	-
<i>o</i> -Amino acetophenone	251	20	-
<i>m</i> -Amino acetophenone	-	99	-
<i>p</i> -Amino acetophenone	294	106	-
2,4-Dihydroxy acetophenone	-	147	-
2,4,6-Trihydroxy acetophenone	-	219	-
Ethyl phenyl ketone	218	20	191
<i>n</i> -Propyl phenyl ketone	229	12	190
<i>iso</i> -Propyl phenyl ketone	221	-	163
<i>n</i> -Butyl phenyl ketone	242	-	166
Benzyl methyl ketone	216	27	-
Benzyl ethyl ketone	226	-	-
Benzyl phenyl ketone	320	60	204
Benzophenone	306	49	238
Dibenzyl ketone	331	35	100
Benzoin	-	137	234
Benzil	-	95	189

جدول رقم (9)

الحوامض الكربوكسيلية الأليفاتية Aliphatic Carboxylic Acid

Name of Compound	Boiling Point (°C)	Melting Point (°C)
Formic acid (Methanoic acid)	101	8
Acetic acid (Ethanoic acid)	118	16
Propionic acid	141	-
<i>n</i> -Butyric acid	163	-
<i>iso</i> -Butyric acid	154	-
<i>n</i> -Valeric acid	187	-
<i>iso</i> -Valeric acid	174	-
<i>n</i> -Hexoic acid (Caproic acid)	205	-
<i>n</i> -Heptoic acid	223	-
<i>n</i> -Octoic acid	239	16
<i>n</i> -Nonoic acid	254	12
<i>n</i> -Decoic acid (Capric acid)	269	31
Myristic acid (Tetradecanoic acid)	-	58
Palmitic acid	-	63
Stearic acid	-	70
Monochloroacetic acid	189	63
Dichloroacetic acid	194	10
Trichloroacetic acid	196	58
Monobromoacetic acid	208	50
Monoiodoacetic acid	-	83
α -Chloropropionic acid	186	-
β -Chloropropionic acid	206	25
Lactic acid	122	18
Acrylic acid (2-Propenoic acid)	140	13
Crotonic acid (2-Butenoic acid)	189	72
Furoic acid	-	134
Oleic acid	286	14
Pyruvic acid	165	13
Nicotinic acid	-	232
Oxalic acid	-	100
Malonic acid	-	135
Succinic acid	-	185
Glutaric acid	-	98
Adipic acid	-	152
Pimelic acid	-	105
Suberic acid	-	142

تكملة جدول رقم (9)

الحوامض الكربوكسيلية الأليفاتية Aliphatic Carboxylic Acid

Name of Compound	Boiling Point (°C)	Melting Point (°C)
Azelaic acid	-	106
Malic acid	-	101
Fumaric acid	-	286
Maleic acid	-	135
Citraconic acid	-	91
Itaconic acid	-	166
Camphoric acid	-	187
<i>rac</i> -Tartaric acid	-	206
<i>meso</i> -Tartaric acid	-	140
<i>d</i> -Tartaric acid	-	170
Citric acid (hydrated)	-	100
Aconitic acid	-	191

جدول رقم (10)

الحوامض الكربوكسيلية الأروماتية Aromatic Carboxylic Acid

Name of Compound	Boiling Point (°C)	Melting Point (°C)
Benzoic acid	249	122
<i>o</i> -Toluic acid	259	105
<i>m</i> -Toluic acid	263	112
<i>p</i> -Toluic acid	274	181
Phenylacetic acid	265	76
<i>o</i> -Chlorobenzoic acid	-	141
<i>m</i> -Chlorobenzoic acid	-	158
<i>p</i> -Chlorobenzoic acid	-	240
<i>o</i> -Bromobenzoic acid	-	150
<i>m</i> -Bromobenzoic acid	-	155
<i>p</i> -Bromobenzoic acid	-	252
<i>o</i> -Iodobenzoic acid	-	162
<i>m</i> -Iodobenzoic acid	-	187
<i>p</i> -Iodobenzoic acid	-	270
<i>o</i> -Nitrobenzoic acid	-	147
<i>m</i> -Nitrobenzoic acid	-	141
<i>p</i> -Nitrobenzoic acid	-	239
2,4-Dinitrobenzoic acid	-	183
3,5-Dinitrobenzoic acid	-	205
2,4,6-Trinitrobenzoic acid	-	228
Salicylic acid	-	159
<i>m</i> -Hydroxybenzoic acid	-	201
<i>p</i> -Hydroxybenzoic acid	-	215
<i>o</i> -Methoxybenzoic acid	-	101
<i>m</i> -Methoxybenzoic acid	-	110
Anisic acid	-	184
Anthranilic acid	-	146
<i>m</i> -Aminobenzoic acid	-	174
<i>p</i> -Aminobenzoic acid	-	188
<i>o</i> -Methoxybenzoic acid	-	19
<i>m</i> -Methoxybenzoic acid	-	137
<i>p</i> -Methoxybenzoic acid	-	198
Phenoxyacetic acid	-	99
α -Naphthoic acid	-	161
β -Naphthoic acid	-	185

تكملة جدول رقم (10)

الحوامض الكربوكسيلية الاروماتية Aromatic Carboxylic Acid

Name of Compound	Boiling Point (°C)	Melting Point (°C)
Phthalic acid	-	208
iso-Phthalic acid	-	347
Terephthalic acid	-	300
3-Nitrophthalic acid	-	219
4-Nitrophthalic acid	-	165
Cinnamic acid	300	133
<i>o</i> -Nitrocinnamic acid	-	240
<i>m</i> -Nitrocinnamic acid	-	205
<i>p</i> -Nitrocinnamic acid	-	287
Benzylmalonic acid	-	120
Phenylpropionic acid	-	135
β -Phenylalanine	-	273
<i>dl</i> -Mandelic acid	-	120
Benzilic acid	-	151
<i>o</i> -Benzoylbenzoic acid	-	128
Acetylsalicylic acid	-	135
Hexahydrobenzoic acid	-	233
Diphenic acid	-	229
Di-phenylacetic acid	-	148

جدول رقم (11)
الفينولات Phenols

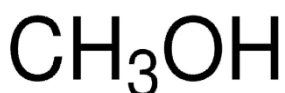
Compound Name	Boiling Point (°C)	Melting Point (°C)	MP for Bromo Derivative (°C)
Phenol	182	43	95
2-Methylphenol (<i>o</i> -Cresol)	191	30	56
3-Methylphenol (<i>m</i> -Cresol)	202	12	84
4-Methylphenol (<i>p</i> -Cresol)	202	34	49
<i>o</i> -Chlorophenol	175	9	-
<i>m</i> -Chlorophenol	214	33	-
<i>p</i> -Chlorophenol	217	43	-
<i>o</i> -Bromophenol	194	5	95
<i>m</i> -Bromophenol	236	33	-
<i>p</i> -Bromophenol	235	64	95
<i>o</i> -Iodophenol	-	43	-
<i>m</i> -Iodophenol	-	40	-
<i>p</i> -Iodophenol	-	94	-
2,4-Dichlorophenol	210	45	-
2,4-Dibromophenol	239	40	-
2,4-Diiodophenol	-	72	-
2,4,5-Trichlorophenol	249	68	-
2,4,6-Trichlorophenol	246	69	-
2,4,6-Tribromophenol	-	94	120
2,4,6-Triiodophenol	-	159	-
<i>o</i> -Nitrophenol	216	45	117
<i>m</i> -Nitrophenol	-	97	91
<i>p</i> -Nitrophenol	-	114	142
2,4-Dinitrophenol	-	113	-
2,4,6-Trinitrophenol (Picric acid)	-	122	-
<i>o</i> -Methoxyphenol	205	32	116
<i>m</i> -Methoxyphenol	244	-	104
<i>p</i> -Methoxyphenol	243	56	-
2,3-Dimethylphenol	218	75	-
3,4-Dimethylphenol	225	62	171
2,4-Dimethylphenol	211	28	-
3,5-Dimethylphenol	219	68	166
2,5-Dimethylphenol	211	75	178

تكملة جدول رقم (11)

الفينولات Phenols

Compound Name	Boiling Point (°C)	Melting Point (°C)	MP for Bromo Derivative (°C)
2,6-Dimethylphenol	203	49	79
<i>o</i> -Ethylphenol	207	-	-
<i>m</i> -Ethylphenol	214	-	-
<i>p</i> -Ethylphenol	219	47	-
<i>p-n</i> -Butylphenol	248	22	-
<i>p-tert</i> -Butylphenol	237	99	-
<i>p-tert</i> -Amylphenol	266	96	-
2-Isopropyl-5-methylphenol (Thymol)	233	51	55
α -Naphthol	279	94	105
β -Naphthol	285	123	84
<i>o</i> -Hydroxydiphenyl	275	58	-
<i>p</i> -Hydroxydiphenyl	306	165	-
Catechol	240	105	192
Resorcinol	280	110	112
Hydroquinone	286	170	186
Orcinol	-	108	104
Pyrogallol	309	133	158
Phloroglucinol	-	117	151

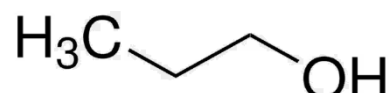
1. Alcohol Compounds (R-OH)



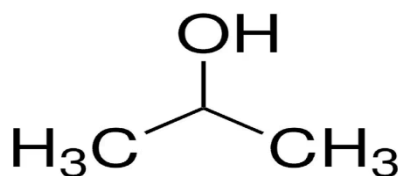
Methanol, Methyl alcohol
 CH_4O (1°)



Ethanol, Ethyl alcohol
 $\text{C}_2\text{H}_6\text{O}$ (1°)



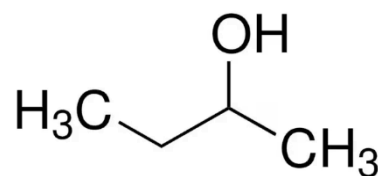
1-Propanol
 $\text{C}_3\text{H}_8\text{O}$ (1°)



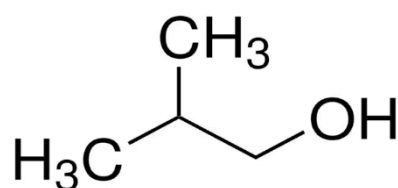
2-Propanol, Isopropanol
 $\text{C}_3\text{H}_8\text{O}$ (2°)



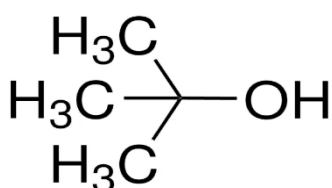
1-Butanol, n-Butyl alcohol
 $\text{C}_4\text{H}_{10}\text{O}$ (1°)



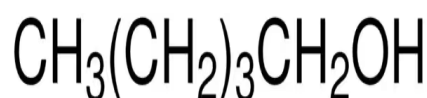
2-Butanol, Sec-butyl alcohol
 $\text{C}_4\text{H}_{10}\text{O}$ (2°)



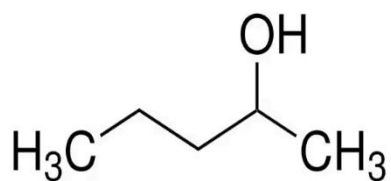
Isobutanol, 2-Methyl-1-propanol
 $\text{C}_4\text{H}_{10}\text{O}$ (1°)



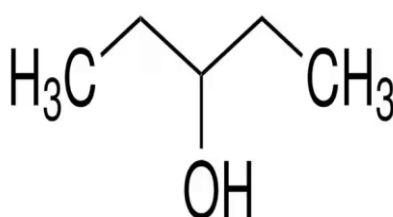
Tert-butanol, 2-Methyl-2-propanol, Tetra butyl alcohol
 $\text{C}_4\text{H}_{10}\text{O}$ (3°)



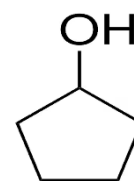
1-Pentanol, n-Amyl alcohol, n-Pentyl alcohol
 $\text{C}_5\text{H}_{12}\text{O}$ (1°)



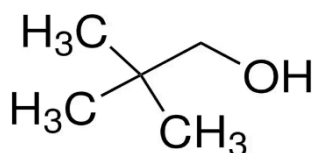
2-Pentanol, sec-Amyl alcohol, sec-Pentyl alcohol
 $\text{C}_5\text{H}_{12}\text{O}$ (2°)



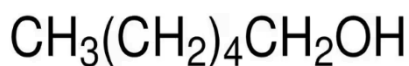
3-Pentanol, Diethyl carbinol
 $\text{C}_5\text{H}_{12}\text{O}$ (2°)



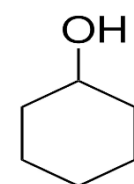
Cyclopentanol, Cyclopentyl alcohol, 1-Hydroxycyclopentane
 $\text{C}_5\text{H}_{10}\text{O}$ (2°)



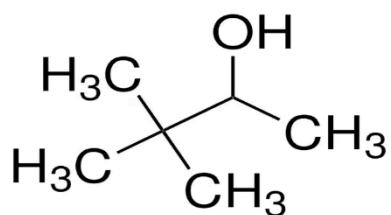
Neo-pentanol, Neo-pentyl alcohol, Neo-amyl alcohol
 $\text{C}_5\text{H}_{12}\text{O}$ (1°)



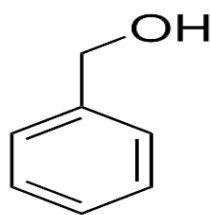
1-Hexanol n-Hexyl alcohol
 $\text{C}_6\text{H}_{14}\text{O}$ (1°)



Cyclohexanol
 $\text{C}_6\text{H}_{12}\text{O}$ (2°)

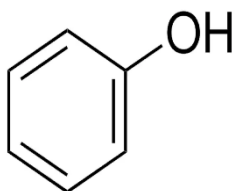


3,3-Dimethyl-2-butanol, Pinacolyl alcohol
 $\text{C}_6\text{H}_{14}\text{O}$ (2°)

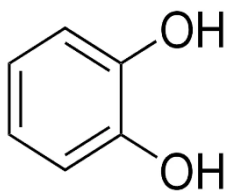


Benzenemethanol, Benzyl alcohol
 $\text{C}_7\text{H}_8\text{O}$ (1°)

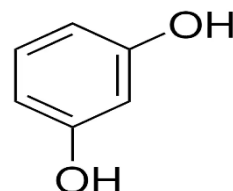
2. Phenol Compounds (Ar-OH)



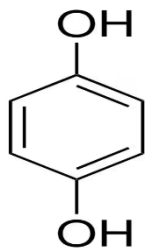
Phenol, 1-Hydroxybenzene
 C_6H_6O



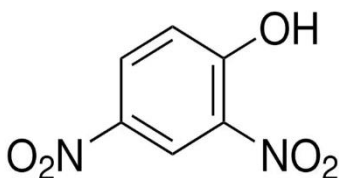
Catechol, 2 (o)-Hydroxyphenol
 $C_6H_6O_2$



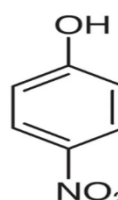
Resorcinol, 3 (m)-Hydroxyphenol
 $C_6H_6O_2$



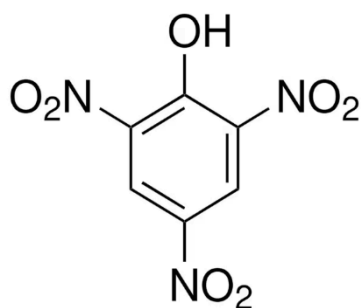
Hydroquinone, 4 (p)-
Hydroxyphenol
 $C_6H_6O_2$



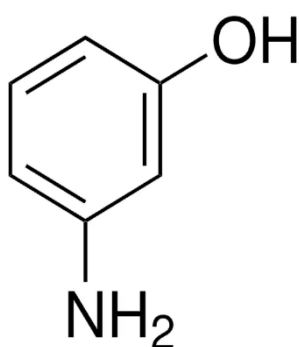
2,4-Dinitrophenol
 $C_6H_4N_2O_5$



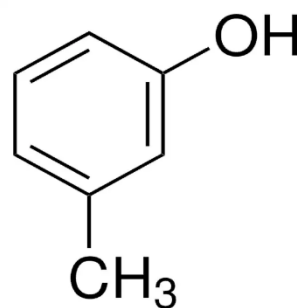
3 (p)-Nitrophenol
 $C_6H_5NO_3$



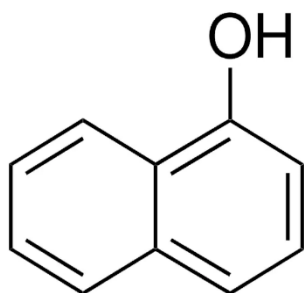
2,4,6-Trinitrophenol, Picric
acid
 $C_6H_3N_3O_7$



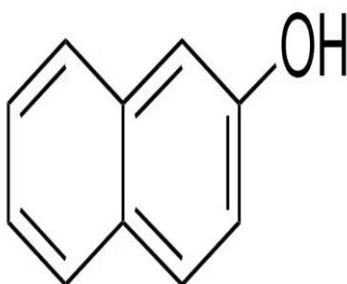
3 (m)-Aminophenol
 C_6H_7NO



3 (m)-Methylphenol, 3 (m)-
Hydroxytoluene, 3 (m)-Cresol
 C_7H_8O

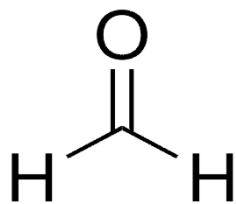


1 (α)-Naphthol, 1-
Hydroxynaphthalene
 $C_{10}H_8O$

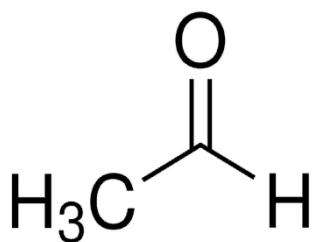


2 (β)-Naphthol, 2-
Hydroxynaphthalene
 $C_{10}H_8O$

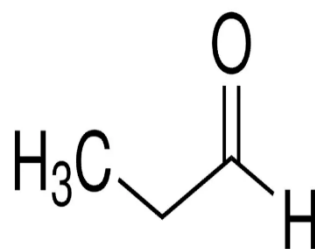
3. Aldehyde Compounds (R-CHO)



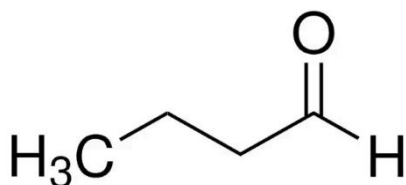
Methanal, Formaldehyde,
Formalin
 CH_2O



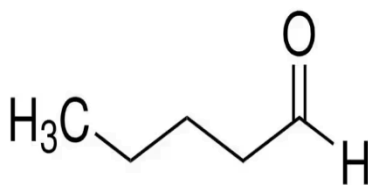
Ethanal, Acetaldehyde
 $\text{C}_2\text{H}_4\text{O}$



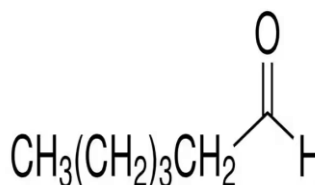
Propanal, Propionaldehyde
 $\text{C}_3\text{H}_6\text{O}$



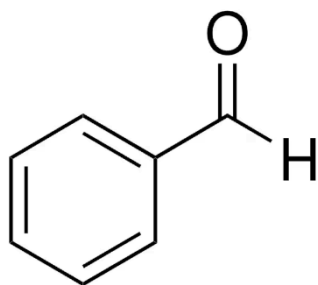
Butanal, Butyraldehyde
 $\text{C}_4\text{H}_8\text{O}$



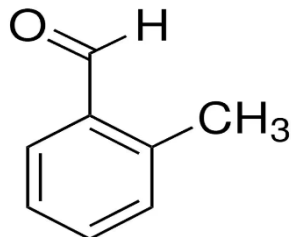
Pentanal, Valeraldehyde
 $\text{C}_5\text{H}_{10}\text{O}$



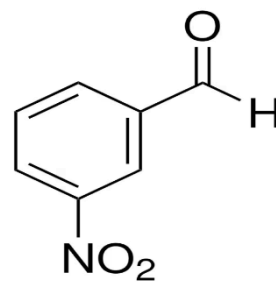
Hexanal, Caproaldehyde
 $\text{C}_6\text{H}_{12}\text{O}$



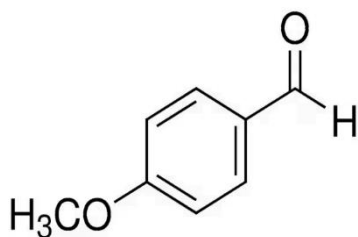
Benzaldehyde
 $\text{C}_7\text{H}_6\text{O}$



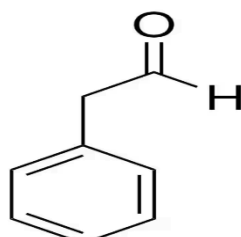
2 (o)-Methylbenzaldehyde, 2
(o)-Tolualdehyde
 $\text{C}_8\text{H}_8\text{O}$



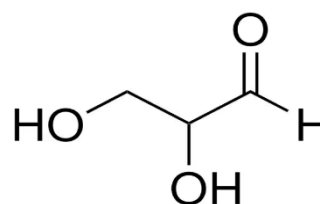
3 (m)-Nitrobenzaldehyde
 $\text{C}_7\text{H}_5\text{NO}_3$



4 (p)-Methoxybenzaldehyde,
4 (p)-Anisaldehyde
 $\text{C}_8\text{H}_8\text{O}_2$

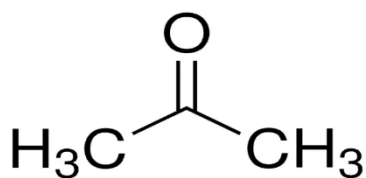


Phenylacetaldehyde, α -
Tolylaldehyde
 $\text{C}_8\text{H}_8\text{O}$

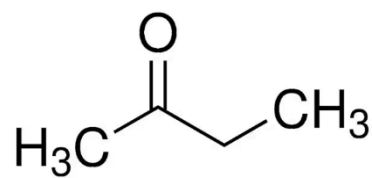


2,3-Dihydroxypropanal,
Glyceraldehyde
 $\text{C}_3\text{H}_6\text{O}_3$

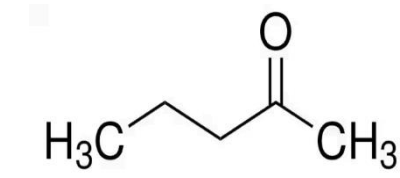
4. Ketone Compounds (R-CO-R)



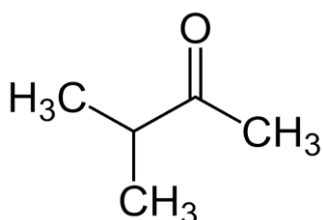
2-Propanone, Acetone,
Dimethyl Ketone
 C_3H_6O



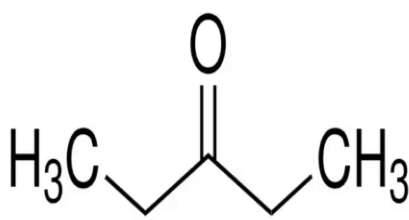
2-Butanone, Ethyl methyl
ketone
 C_4H_8O



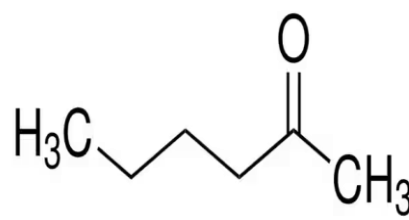
2-Pentanone, Methyl propyl
ketone
 $C_5H_{10}O$



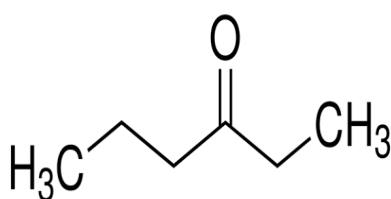
3-Methyl-2-butanone,
Isopropyl methyl ketone
 $C_5H_{10}O$



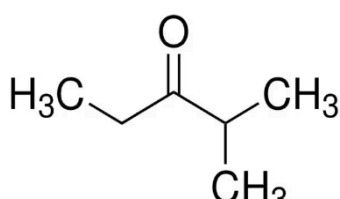
3-Pentanone, Diethyl ketone
 $C_5H_{10}O$



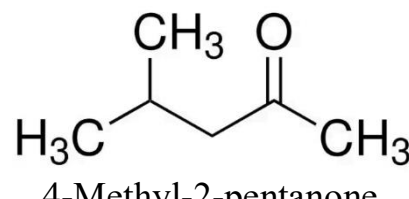
2-Hexanone, Butyl methyl
ketone
 $C_6H_{12}O$



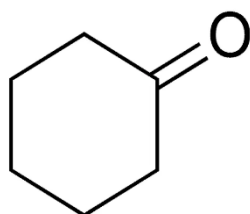
3-Hexanone, Ethyl propyl
ketone
 $C_6H_{12}O$



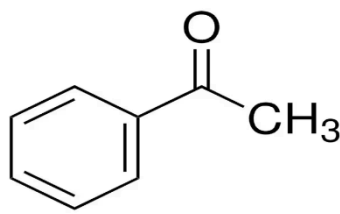
2-Methyl-3-pentanone, Ethyl
isopropyl ketone
 $C_6H_{12}O$



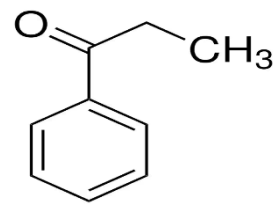
4-Methyl-2-pentanone,
Isobutyl methyl ketone,
Isopropylacetone
 $C_6H_{12}O$



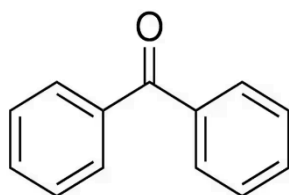
Cyclohexanone, pimelic
ketone
 $C_6H_{10}O$



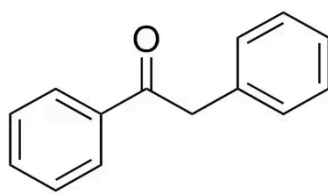
Methyl phenyl ketone,
Acetophenone
 C_8H_8O



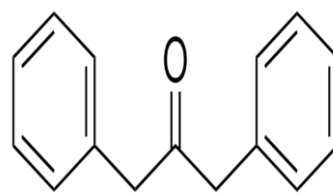
Ethyl phenyl ketone,
Propiophenone
 $C_9H_{10}O$



Diphenyl ketone,
Benzophenone
 $C_{13}H_{10}O$

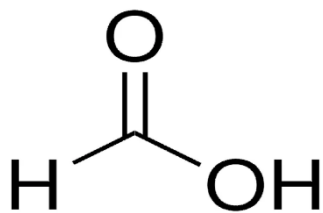


2-Phenylacetophenone,
Benzyl phenyl ketone
 $C_{14}H_{12}O$

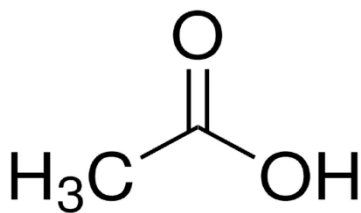


1,3-Diphenylacetone,
Dibenzyl ketone
 $C_{15}H_{14}O$

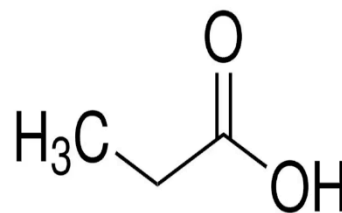
5. Carboxylic Acid Compounds (R-COOH)



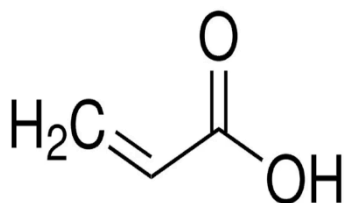
Methanoic acid, Formic acid
 CH_2O_2



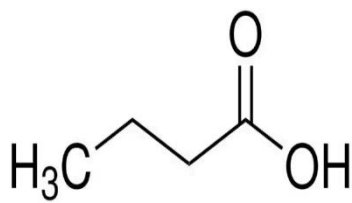
Ethanoic acid, Acetic acid
 $\text{C}_2\text{H}_4\text{O}_2$



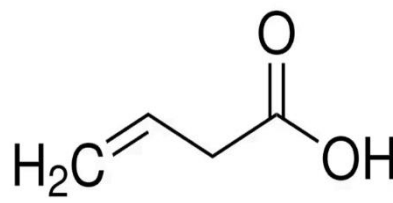
Propanoic acid, Propionic acid
 $\text{C}_3\text{H}_6\text{O}_2$



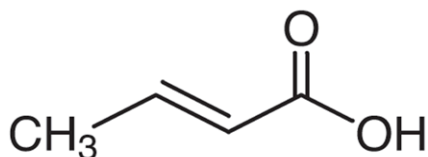
2-Propenoic acid, Acrylic acid
 $\text{C}_3\text{H}_4\text{O}_2$



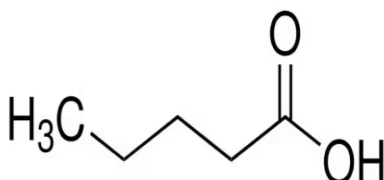
Butanoic acid, Butyric acid
 $\text{C}_4\text{H}_8\text{O}_2$



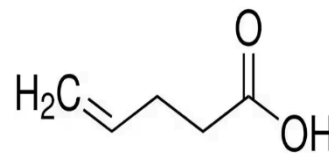
3-Butenoic acid, Vinylacetic acid
 $\text{C}_4\text{H}_6\text{O}_2$



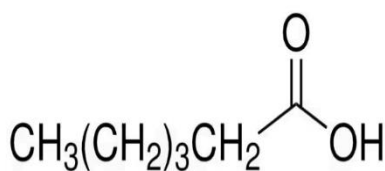
2-Butenoic acid, Crotonic acid
 $\text{C}_4\text{H}_6\text{O}_2$



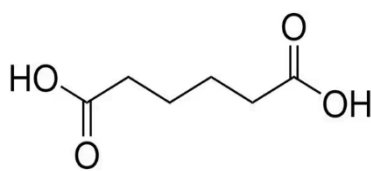
Pentanoic acid, n-Valeric acid
 $\text{C}_5\text{H}_{10}\text{O}_2$



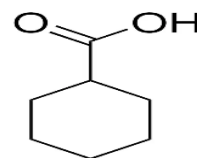
4-Pentenoic acid, Allylacetic acid
 $\text{C}_5\text{H}_8\text{O}_2$



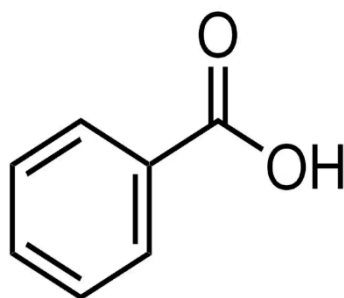
Hexanoic acid, Caproic acid
 $\text{C}_6\text{H}_{12}\text{O}_2$



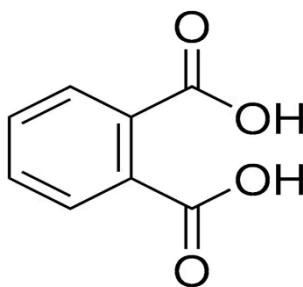
Hexanedioic acid, Adipic acid
 $\text{C}_6\text{H}_{10}\text{O}_4$



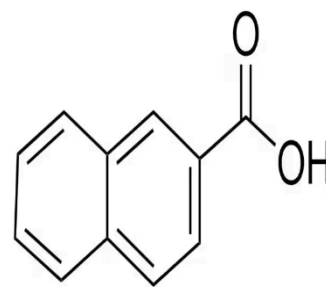
Cyclohexanecarboxylic acid, Hexahydrobenzoic acid
 $\text{C}_7\text{H}_{11}\text{O}_2$



Benzoic acid
 $\text{C}_6\text{H}_6\text{O}_2$

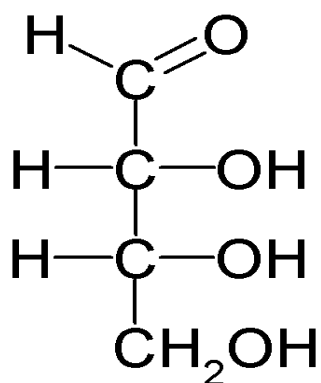


Phthalic acid
 $\text{C}_8\text{H}_6\text{O}_4$

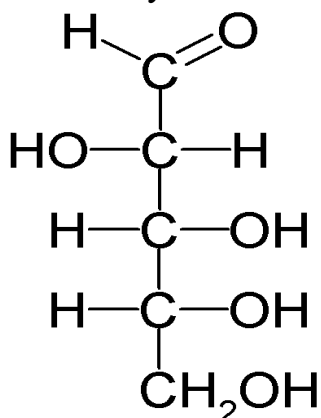


2-Naphthoic acid
 $\text{C}_{11}\text{H}_8\text{O}_2$

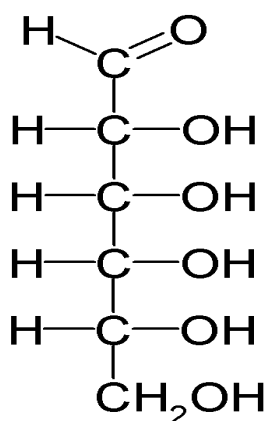
6. Carbohydrate (Sugar) Compounds



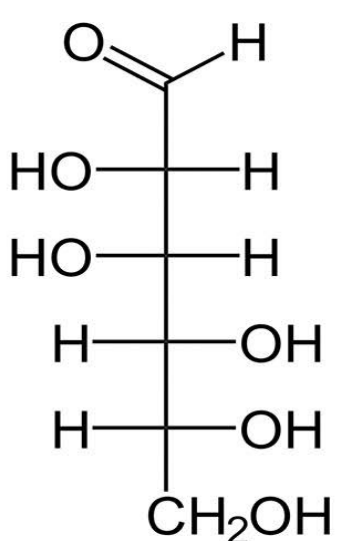
D-Erythrose



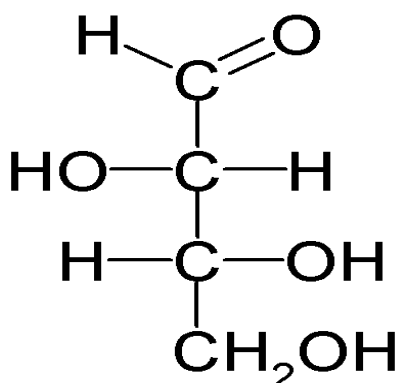
D-Arabinose



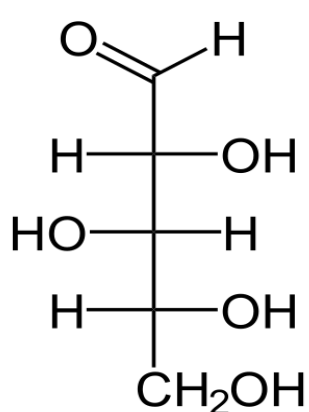
D-Allose



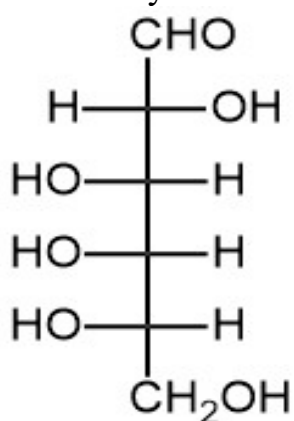
D-Mannose



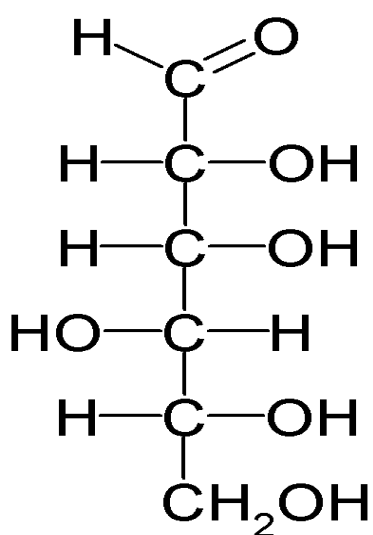
D-Threose



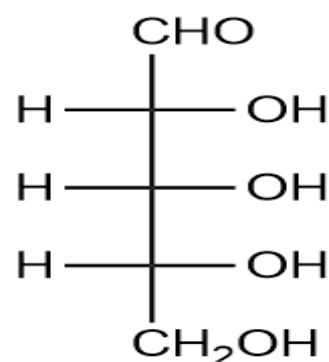
D-Xylose



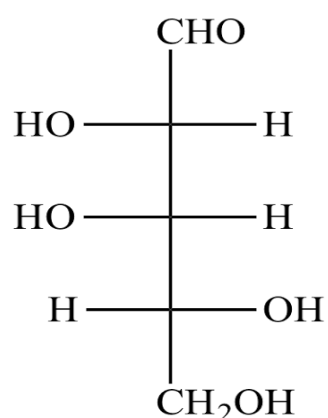
D-Altrose



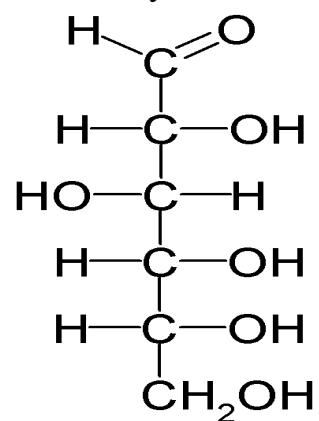
D-Gulose



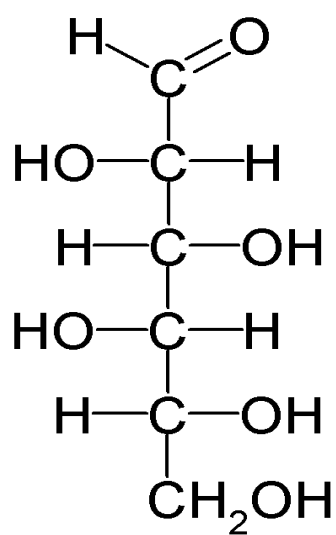
D-Ribose



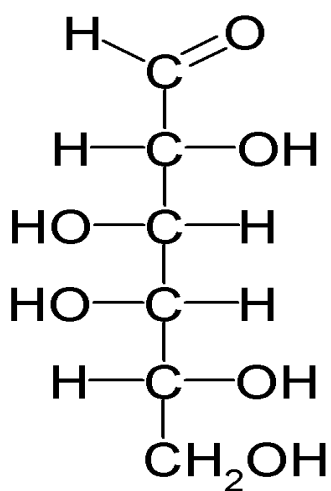
D-Lyxose



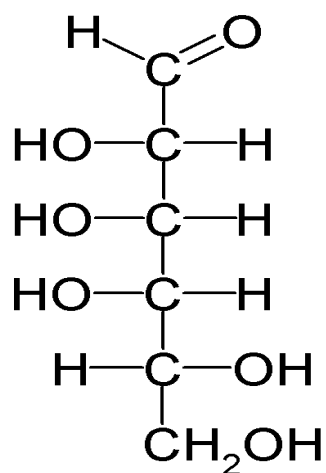
D-Glucose



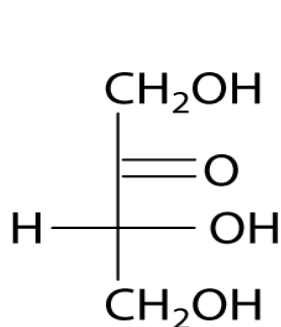
D-Idose



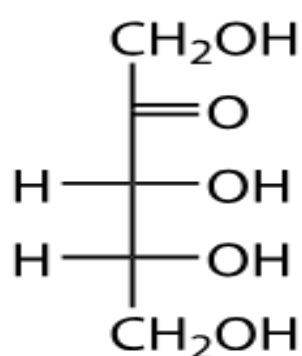
D-Galactose



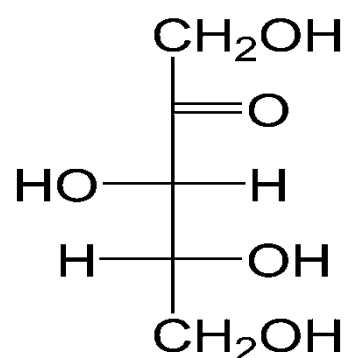
D-Talose



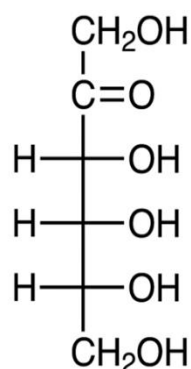
D-Erythrulose



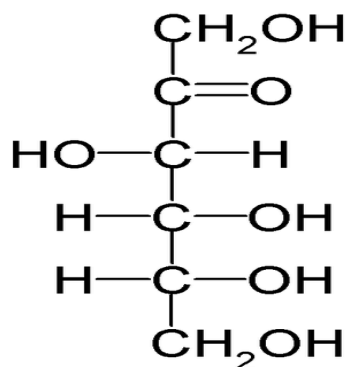
D-Ribulose



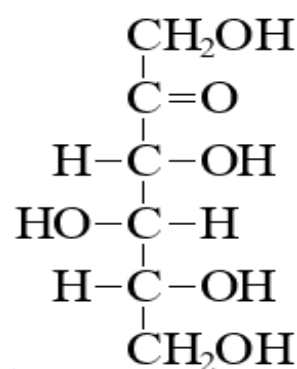
D-Xyulose



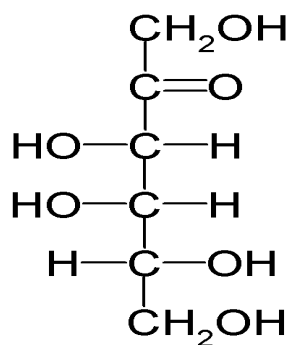
D-Psicose



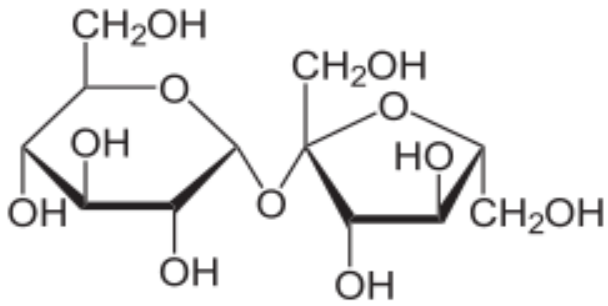
D-Fructose



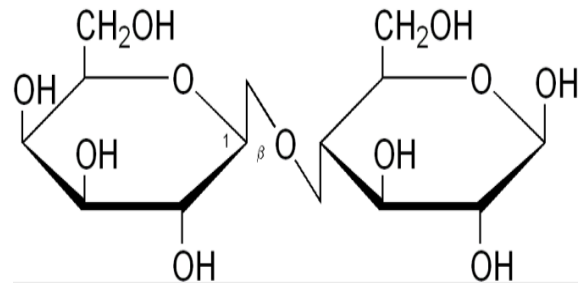
D-Sorbose



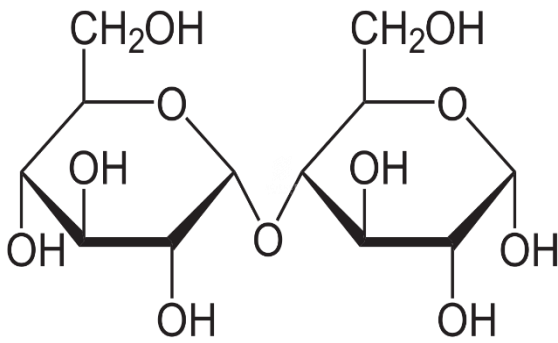
D-Tagatose



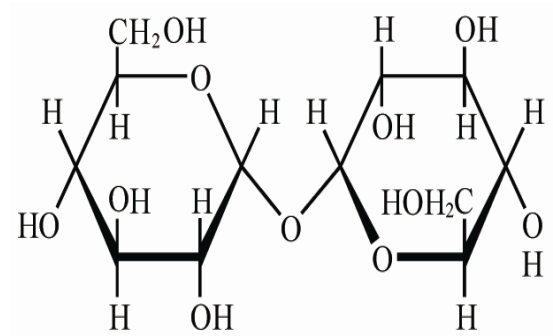
Sucrose
(Glucose + Fructose)



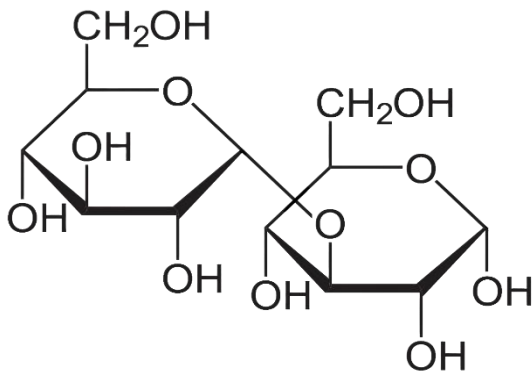
Lactose
(Glucose + Galactose)



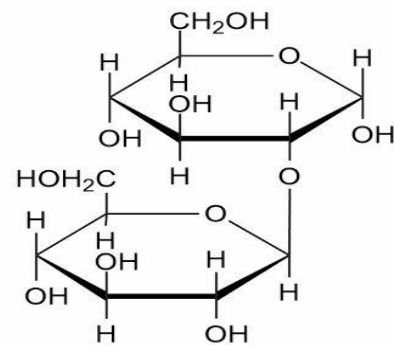
Maltose
(Glucose + Glucose)



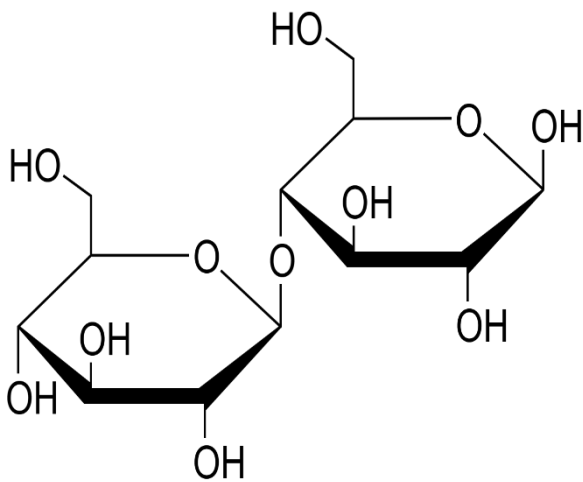
Trehalose
(Glucose + Glucose)



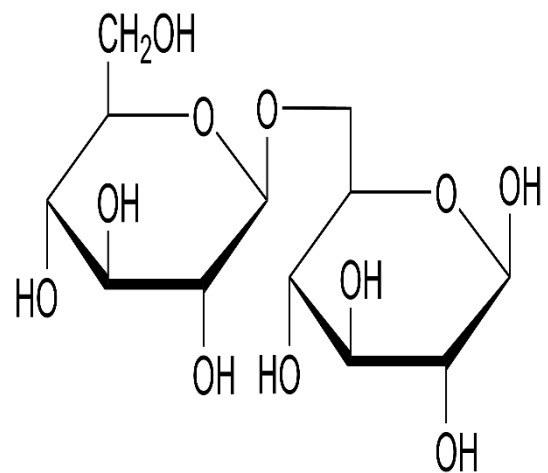
Nigerose
(Glucose + Glucose)



Sophorose
(Glucose + Glucose)



Cellobiose
(Glucose + Glucose)



Gentiobiose
(Glucose + Glucose)