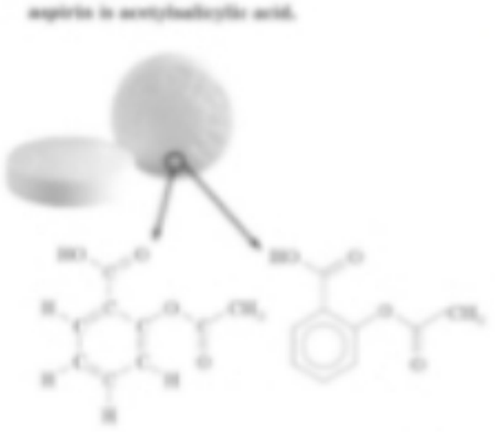
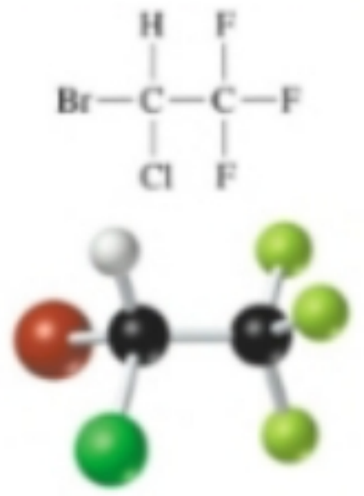
# Organic Chemistry

## Substituted Hydrocarbons



Grade 12 advanced

2020/2021



Prepared by

Mr / Naeem ElemamAkl

## Volume (I)

**Student`s name**:.....

**Class**:.....

هذه المذكرة لاتغني عن الكتاب المدرسي وليست بهدف البيع او الربح

تمنياتي لجميع الطلبة والطالبات بالتفوق والنجاح

# Organic chemistry

## Section 1: alkyl Halides and Aryl Halides

**Main idea**: A halogen atom can replace a hydrogen atom in some hydrocarbons
**CHEM 4YOU**: when atom substituted in hydrocarbon , the properites of new compound will be change like a player who is rested might substitute for a player who is tired . after the substitution , the characteristics of the team change .

| items | Definition |
|---|---|
| **afunctional group** | is an atom or group of atoms that always reacts in a certain way. |
| **halocarbon** | Any organic compound that contains a halogen substituent |
| **An alkyl halide** | is an organic compound containing a halogen atom covalently bonded to an aliphatic carbon atom. |
| **An aryl halide** | is an organic compound containing a halogen atom bonded to a benzene ring or other aromatic group. |
| **A plastic** | is a polymer that can be heated and molded while relatively soft |
| **A substitution reaction** | is one in which one atom or a group of atoms in a molecule is replaced by another atom or group of atoms. |
| **halogenation** | With alkanes, hydrogen atoms can be replaced by atoms of halogens, typically chlorine or bromine, in a process |
| | |

- **Functional groups:**
  - ✓ You can predict the properties of organic copounds for which you know the structure (functional groups)
  - ✓ Carbon atoms can form strong covalent bonds with other elements, the most common of which are oxygen, nitrogen, fluorine, chlorine, bromine,iodine sulfur, and phosphorus.
  - ✓ Atoms of these elements occur in organic substances as parts of functionalgroups.
  - ✓ **functional groups** in all the items – natural and synthetic that give them their individual characteristics, such as **smell**
  - ✓ the fruit and flowers have sweet – smelling aromas are due to ester molecules.
  - ✓ The **double and triple bonds** between two carbon atoms are considered functional groups.

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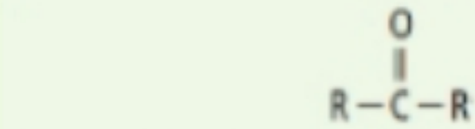
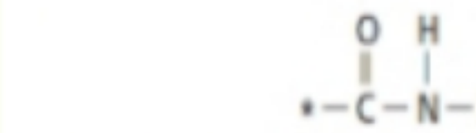
| Compound Type | General Formula | Functional Group |
|---|---|---|
| Halocarbon | R—X (X = F, Cl, Br, I) | Halogen |
| Alcohol | R—OH | Hydroxyl |
| Ether | R—OH—R' | Ether |
| Amine | $R—NH_2$ | Amino |
| Aldehyde |  | Carbonyl |
| Ketone |  | Carbonyl |
| Carboxylic acid |  | Carboxyl |
| Ester |  | Ester |
| Amide |  | Amide |

**The symbols (R )and( R ´ ):**

represent **carbon chains** or **rings bonded** to the functional group.

**(* )** : represents a **hydrogen** atom, **carbon chain**, or **carbon ring.**

## ▪ Organic Compounds Containing Halogens:

- The most simple functional groups can be thought of as substituent groups attached to a hydrocarbon.

اهدي هذا العمل المتواضع الي كلا من :

- بروفسور الكيمياء والموجه السابق أ. عادل الجيار
- بروفسور الكيمياء والموجه السابق أ. محمد ابوعبيد
- بروفسور الكيمياء والموجه السابق أ. ماهر الخولي
- بروفسور الكيمياء والموجه السابق أ.ماجدة منصور

سائلا المولي عزوجل ان يبارك في اعمارهم فقبل ان نستقي منهم ومن علمهم الغزير تعلمنا منهم التواضع والتفاني في العمل تحياتي لهم جميعا وتحياتي لكل الزملاء وتحياتي القلبية لابنائي الطلبة والطالبات.

مع تحيات نعيم الامام عقل

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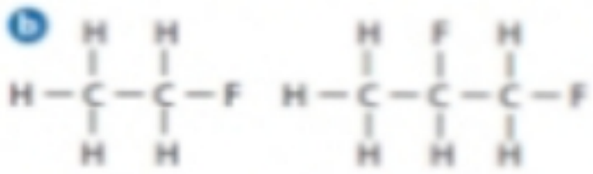
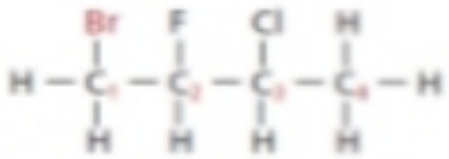
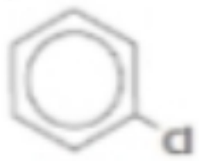
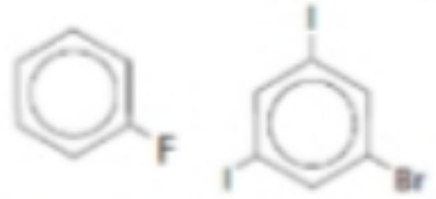
| Halocarbons | | |
|---|---|---|
| | **Alkyl halide** | **Aryl halide** |
| **General formula** | **R-X** | **Ar- x** |
| **Function group** | **X : F , Cl , Br , I** | |
| **Definetion** | is an organic compound containing a halogen atom covalently bonded to an aliphatic carbon atom. | is an organic compound containing a halogen atom bonded to a benzene ring or other aromatic group. |
| **Examples :** | b  Fluoroethane and 1, 2-Difluoropropane<br>c  1-Bromo-3-chloro-2-fluorobutane |  Chlorobenzene<br>d  Fluorobenzene and 1-Bromo-3,5-diiodobenzene |

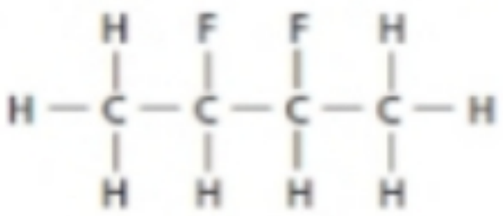
- **Naming halocarbons :**

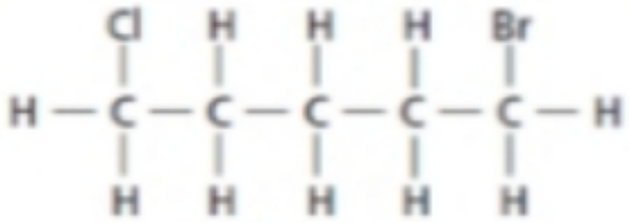
- **For the alkyl halides,** a prefix indicates which halogen is present.
- The prefixes are formed by changing the -***ine*** at the end of each halogen name to -**o**.
- Thus, **the prefix** for fluorine is *fluoro-*, chlorine is *chloro-*, bromine is *bromo-*, and iodine is *iodo-*
- If more than one kind of halogen atom is present in the same molecule, the atoms are listed alphabetically in the name.
- The chain also must be numbered in a way that gives the lowest position number to the substituent that comes first in the alphabet.
- **Similarly**, the benzene ring in an aryl halide is numbered to give each substituent the lowest position number possible.

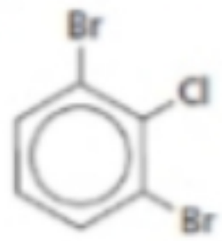
**Application :**



**Name the alkyl or aryl halide whose structure is shown:**

1. 

2. 

3. 

- **Properties and uses of halocarbons:**

**physical properties of alkyl halide :**

**a- Boiling point and density :**

✓ **alkyl chloride** has a **higher boiling point** and a **higher density** than the alkane with the same number of carbon atoms.

✓ **the boiling points and densities increase as the halogen changes from fluorine to chlorine, bromine, and iodine** This trend occurs primarily **(why)?**

**because** the halogens from fluorine to iodine have

- **increasing numbers of electrons** that lie farther from the halogen nucleus.
- These **electrons shift position easily** and, as a result, the halogen-substituted
- hydrocarbons have an increasing tendency to form **temporary dipoles.**
- Because **the dipoles attract each other**, the **energy** needed to separate the molecules also **increases.**
- Thus, the boiling points of halogen-substituted alkanes increase as the size of the halogen atom increases.

**b- Solubility :**

✓ Alkyl halides are readily soluble in organic solvent

✓ slightly soluble in water.

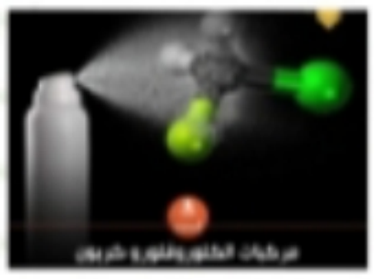


**c- Organic halides are seldom found in nature, although human thyroid hormones are organic iodides.**

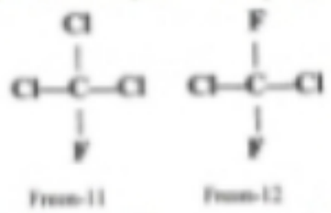
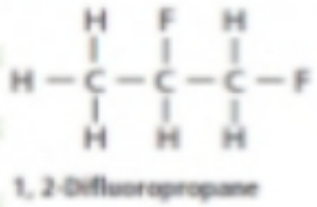
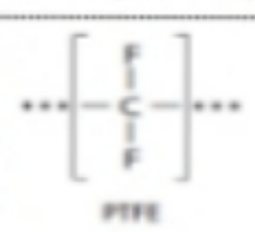
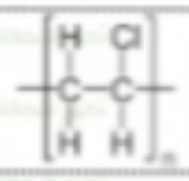
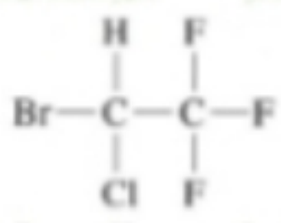
| Structure | Name | Boiling Point (°C) | Density (g/mL) in Liquid State |
|---|---|---|---|
| $CH_4$ | methane | −162 | 0.423 at −162°C (boiling point) |
| $CH_3Cl$ | chloromethane | −24 | 0.911 at 25°C (under pressure) |
| $CH_3CH_2CH_2CH_2CH_3$ | pentane | 36 | 0.626 |
| $CH_3CH_2CH_2CH_2CH_2F$ | 1-fluoropentane | 62.8 | 0.791 |
| $CH_3CH_2CH_2CH_2CH_2Cl$ | 1-chloropentane | 108 *Increases* | 0.882 *Increases* |
| $CH_3CH_2CH_2CH_2CH_2Br$ | 1-bromopentane | 130 | 1.218 |
| $CH_3CH_2CH_2CH_2CH_2I$ | 1-iodopentane | 155 | 1.516 |

## Chemical properties :

- ✓ **alkyl halides are often used as starting materials in the chemical industry.(why?)**
  **because the Halogen atoms bonded to carbon atoms are more reactive than the hydrogen atoms they replace.**
- ✓ **Alkyl halides are also used as solvents and cleaning agents** (why?)
  **because** they readily dissolve nonpolar molecules, such as greases.



- **Uses of halocarbons :**

| Compound | Structure | Uses |
|---|---|---|
| **Chloromethane** | $CH_3Cl$ | ✓ is used in the manufacturing process for **silicone products**, such as window and door **sealants** |
| **chlorofluorocarbons (CFCs)** |  Freon-11 Freon-12 | ✓ are widely used as refrigerants.<br>✓ used in **refrigerators**<br>✓ used in **air-conditioning** systems<br>✓ A **spray paint cans**<br>✓ **Aerosol hair spray cans**<br>**disadvantage**<br>✓ effect on ozone layer causing ozone depletion |
| **HFCs (hydrofluorocarbons)** |  1, 2-Difluoropropane (R134a) | ✓ replace CFCs which contain only hydrogen and fluorine atoms bonded to carbon.<br>Naeem akl |
| **polytetrafluoroethene (PTFE)** |  PTFE | ✓ is a plastic made up of hundreds of units from gaseous tetrafluoroethylene<br>✓ provides **a nonstick surface** for many kitchen items, including bakeware. |
| **vinyl polyvinyl chloride (PVC)** |  | ✓ It can be manufactured **soft** and **hard**, as thin sheets<br>✓ **molded into objects**. |
| **Halothane (2-bromo-2-chloro-1,1,1-trifluoroethane)** |  | was introduced into medicine in the 1950s as a **general anesthetic** for patients undergoing surgery. |

## ▪ Substitution Reactions

✓ the ultimate source of nearly all synthetic organic compounds is **petroleum**
✓ petroleum is a fossil fuel that consists almost entirely of hydrocarbons, especially alkanes.

**How can alkanes be converted into compounds as different as alkyl halides, alcohols, and amines?**

✓ the generic form of a substitution reaction. In thisreaction, **X** can be fluorine, chlorine, or bromine, but not iodine.
✓ **Iodine does not react well with alkanes.**

| | |
|---|---|
| **Generic Substitution Reaction**<br>$R{-}CH_3 + X_2 \rightarrow R{-}CH_2X + HX$<br>where X is fluorine, chlorine, or bromine | **Example of General Substitution Reaction (Halogenation)**<br>$C_2H_6 + Cl_2 \rightarrow C_2H_5Cl + HCl$<br>Ethane Chloroethane |
| **General Alkyl Halide-Alcohol Reaction**<br>$R{-}X + OH^- \rightarrow R{-}OH + X^-$<br>Alkyl halide Alcohol | **Example of an Alkyl Halide-Alcohol Reaction**<br>$CH_3CH_2Cl + OH^- \rightarrow CH_3CH_2OH + Cl^-$<br>Chloroethane Ethanol |
| **General Alkyl Halide-Ammonia Reaction**<br>$R{-}X + NH_3 \rightarrow R{-}NH_2 + HX$<br>Alkyl halide Amine | **Example of an Alkyl Halide-Ammonia Reaction**<br>$CH_3(CH_2)_6CH_2Br + NH_3 \rightarrow CH_3(CH_2)_6CH_2NH_2 + HBr$<br>1-Bromooctane Octaneamine |

## ▪ Further substitution

✓ an alkane has been halogenated, the resulting alkyl halide
✓ alkyl halide can undergo other types of substitution reactions in which the **halogen atom** is replaced by another atom or group of atoms.

✓ **Example**

- reacting **an alkyl halide** with **a basic solution** results in the replacement of the halogen atom by an –OH group, forming **an alcohol**.

- Reacting an **alkyl halide** with **ammonia (N H 3 )** replaces the halogen atom with an amino group (–N H 2 ), forming **an alkyl amine** . Some of the newly formed amines continue to react, resulting in a mixture of amines.

# Section 2: Alcohols, Ethers, and Amines

**Main idea :**
Oxygen and nitrogen are two of the most-common atoms found in organic functional groups.

**Chemistry for you**

- ✓ The last time you hadavaccination, the nurse probably disinfected your skin with an alcohol wipe(ethanol) before giving you the injection.
- ✓ Did you know that the nurse was using a substituted hydrocarbon

| item | Definetion |
|---|---|
| **a hydroxyl group (–OH)** | An oxygen-hydrogen group covalently bonded to a carbon atom . |
| **an alcohol R-OH** | An organic compound in which a hydroxyl groupreplacesahydrogen atom of a hydrocarbon. |
| **Denatured alcohol** | is ethanol to which small amounts of noxious materials, such as aviation gasoline or other organic solvents, have been added. **Ethanol is denatured in order to make it unfit to drink.** |
| **An ether R-O-R** | is an organic compound containing an oxygen atom bonded to two carbon atoms. |
| **Amines $RNH_2$** | contain nitrogen atoms bonded to carbon atoms in aliphatic chains or aromatic rings |

## Alcohols

- ✓ the general formula for an alcohol is **ROH**.
- ✓ The function group is OH
- ✓ the simplestalcohol, **methanol**.$CH_3OH$

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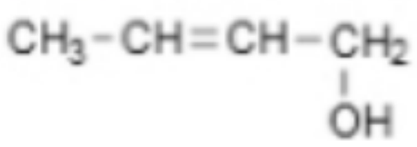
## ▪ naming of alcohols by IUPAC rules :

- ✓ the names of alcohols are based on alkane names
- ✓ like the names of alkyl halides
- ✓ . naming the parent carbon chain or ring first and then changing the -e at the end of the name to -ol to indicate the presence of a hydroxyl group.
- ✓ the hydroxyl group can be at two or more positions. To indicate the position, a number is added
- ✓ **A carbon chain can also have more than one hydroxyl group**.
- ✓ prefixes such as **di-**, **tri-**, and **tetra-** are used before the -ol to indicate the number of hydroxyl groups present.
- ✓ The full alkane name, including -ane, is used before the prefix.
- ✓ in The compound's ring structure contains six carbons with only single bonds, so **the parent hydrocarbon is cyclohexane**.
- ✓ Because an –OH group is bonded to a carbon, it is an alcohol and the name will end in -ol.
- ✓ No number is necessary if only one OH group bonded to cyclic because all carbons in the ring are equivalent.

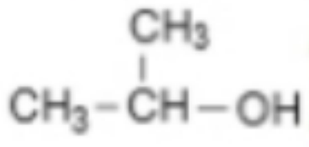
**Examples:**



$CH_4$ is methane and $\mathbf{CH_3OH}$ is methanol
$CH_3$-$CH_3$ is ethane and $\mathbf{CH_3CH_2OH}$ is ethanol.

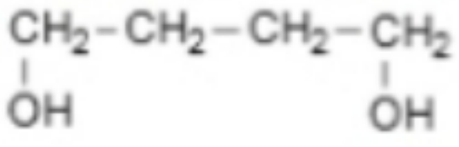


2-buten-1-ol

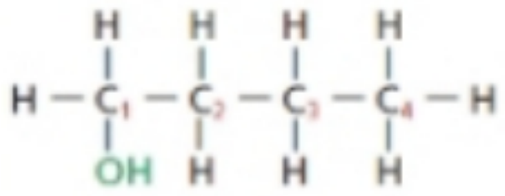


2-propanol

(iso propyl alcohol)



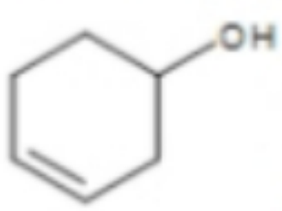
1,4-butanediol

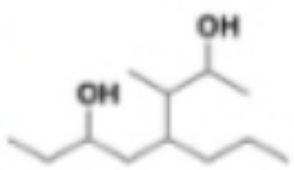


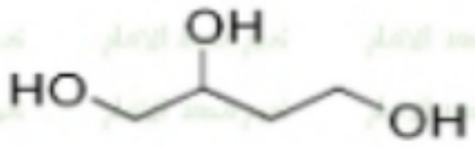
. 1-Butanol

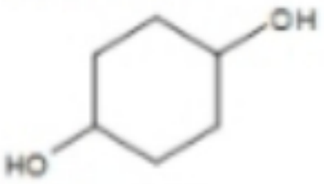
**Application :**

**Name the alcohols whose structure is shown:**









**Draw structures for the following alcohol?**

**a.** 1,2-butanediol
**b.** 2-methyl-1-butanol
**c.** cyclopentanol
**d**. 2-hexanol

## ▪ Preparation of ethanol $C_2H_5OH$

**(1)-Fermentation of sugars by yeasts produce ethanol and Carbon dioxide**

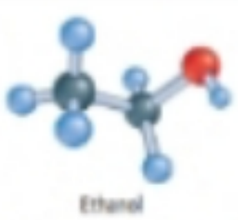
$$\text{Sugar + yeast} \rightarrow C_2H_5OH + CO_2$$

**Sugars** such as those in grapes and bread dough.

**(2)-from alkyl halide in basic medium (hydrolysis)**

$$R\text{-}X + OH^- \rightarrow R\text{-}OH + X^-$$

$$C_2H_5Cl + OH^- \rightarrow C_2H_5OH + Cl^-$$

| Ethanol | Water |
|---|---|
| ✓ General formula R-OH<br>✓ Lower boiling point than water<br>  <br>Ethanol | ✓ $H_2O$<br>✓ Higher boiling point than ethanol<br>  <br>Water |
| ✓ that the covalent bonds from the oxygen in ethanol are at roughly the **same angle** as the bonds around the oxygen in the water molecule<br>✓ **(OH )**groups of alcohol molecules are moderately **polar**, as with water, and are able to form **hydrogen bonds** with the hydroxyl groups of other alcohol molecules.<br>✓ **ethanol is completely miscible with water**. | |

**Note**

- ✓ When alcohol and water they are mixed, it is difficult to separate water and ethanol completely.
- ✓ **Distillation** is used to remove ethanol from water, but even after that process is complete, about 5% water remains in the ethanol-water mixture.
- ✓ **Alcohols are neutral substance not effected on litmus paper**

## ▪ Classification of alcohols according to OH groups

**Molecules can be classified based on the number of alcohol groups**

| monohydric | dihydric | Trihydric | polyhydric |
|---|---|---|---|
| ✓ Contain one alcohol group(OH) on the molecule<br>**Ex:** $CH_3OH$<br>**methanol** | ✓ Contain two alcohol groups(OH) on the molecule<br>**EX:**<br>$CH_2(OH)$-$CH_2(OH)$<br>**1,2-ethanediol** | ✓ Contain three group of OH on the molecule<br>**Ex:**<br>$CH_2(OH)$-$CH(OH)$-$CH_2(OH)$<br>**1,2,3-propane triol** | ✓ more than 3 alcohol groups(OH) on the molecule<br>✓ **Ex:sorbitol has 6 Group of OH** |

## ▪ Properties of alcohols:

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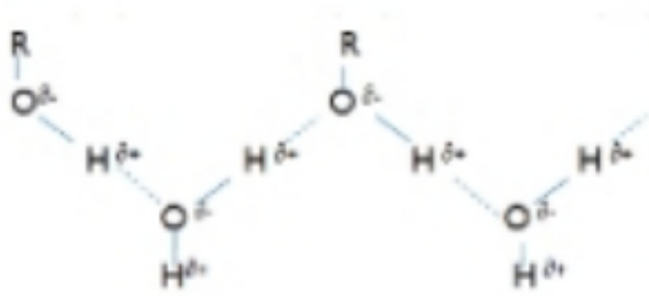
### a- Solubility in water :

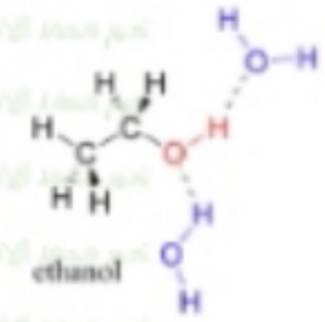
✓ **Alcohols are miscible with water.(why?)**

Because :polarity of alcoholes and it have OH groups which make hydrogen bonds between molecules of alcoholes and water .

**Table 22.15 Alcohol Solubility in Water (mol/100 g $H_2O$)**

| Name | Alcohol | Solubility |
|---|---|---|
| Methanol | $CH_3OH$ | infinite |
| Ethanol | $C_2H_5OH$ | infinite |
| Propanol | $C_3H_7OH$ | infinite |
| Butanol | $C_4H_9OH$ | 0.11 |
| Pentanol | $C_5H_{11}OH$ | 0.030 |
| Hexanol | $C_6H_{13}OH$ | 0.0058 |
| Heptanol | $C_7H_{15}OH$ | 0.0008 |



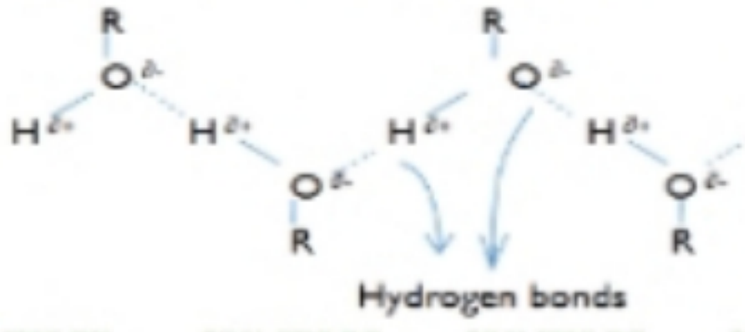



✓ When **carbon chain of alcoholes increase** the solubility of alcoholes in water **decrease**

### b- Boiling point :

✓ **alcohols have much higher boiling points than hydrocarbons of similar shape and size.(why ?)**

becaus alcoholes have OH groups which make hydrogen bonds between molecules of alcoholes beween each other when it need more energy to break it



- ✓ **when increasing OH groups in amolecule of alcoholes the boiling point increase(why?)**

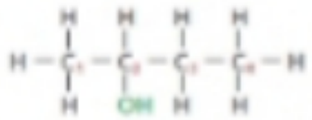
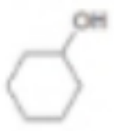
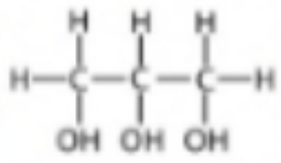
  because the hydrogen bonds increases so it will need more energy to break it

- ✓ **the boiling point of alcoholes increase by increasing of carbon chain**

| Alkane | Boiling point (℃) | Alcohol | Boiling point (℃) |
|---|---|---|---|
| methane | - 164 | methanol | 65 |
| ethane | - 89 | ethanol | 79 |
| propane | - 42 | 1-propanol | 97 |
| butane | - 0,5 | 1-butanol | 117 |
| pentane | 36 | 1-pentanol | 138 |
| hexane | 69 | 1-hexanol | 156 |



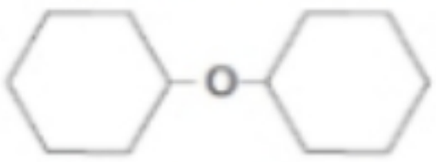
- **Uses of alcoholes :**

| Alcoholes | Structural | Uses |
|---|---|---|
| **Methanol** | $CH_3OH$ | ✓ the smallest alcohol<br>✓ is a common industrial solvent found in **some paint strippers** |
| **Ethanol** | $C_2H_5OH$ | ✓ **found in alcoholic beverages**<br>✓ **medicinal products**<br>✓ ethanol can be used to swab skin before an injection<br>✓ because it is an effective **antiseptic**<br>✓ It is also a gasoline additive(gashol)<br>✓ an important starting material for the synthesis of more complex organic compounds |
| **2-butanol** |  | **is found in some stains and varnishes.** |
| **Cyclohexanol** |  | ✓ It is a **poisonous** compound<br>✓ used as a **solvent** for certain **plastics**<br>✓ used in the manufacture of **insecticides.** |
| **1,2,3-propanetriol (Glycerol )** |  | ✓ is often used as an **antifreeze** and as an airplane **deicing fluid**. |

# Ethers

- ✓ **the general formula for an ether** is **R-O-R`**.
  **where R and R' represent carbon chains or rings bonded to functional groups**
- ✓ **The function group** is –O-
- ✓ **the simplest ether, di methyl ether**.$CH_3$-O- $CH_3$

## ▪ classification of ethers :

| symmetrical ethers | asymmetrical ethers |
|---|---|
| ✓ If the two alkyl groups are similar | ✓ If the two alkyl groups are different |
|  Cyclohexyl ether | $CH_3CH_2CH_2-O-CH_2CH_2CH_3$ Propyl ether |
| $CH_3CH_2-O-CH_2CH_2CH_2CH_3$ Butylethyl ether | $CH_3CH_2-O-CH_3$ Ethylmethyl ether |



## ▪ Naming of ether :

- ✓ ethers that have two identical alkyl chains bonded to oxygen
- ✓ first name the alkyl group and then add the word ether.
- ✓ the groups are listed in alphabetical order and then followed by the word ether

**appication :**

**Draw structures for the following ether molecules.**

**a.** butyl pentyl ether
**b.** cyclobutyl methyl ether
**c.** isopropyl ethe
**d**.di cyclopentyl ether .

## ▪ properties of ether :

### a- solubility in water :

- ✓ **Ethers are much less soluble in water than alcohols(why?)**
  **because** they have no hydrogen to donate to a hydrogen bond. However, the oxygen atom can act as a receptor for the hydrogen atoms of water molecules.

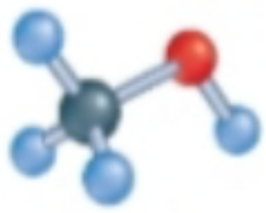
### b- Boiling point :

- ✓ ethers are generally **more volatile and have much lower boiling points** than alcohols of similar size and mass(why?)
  **Because** ethers have **no hydrogen** atoms bonded to the oxygen atom, their molecules cannot form hydrogen bonds with each other like alcohols .

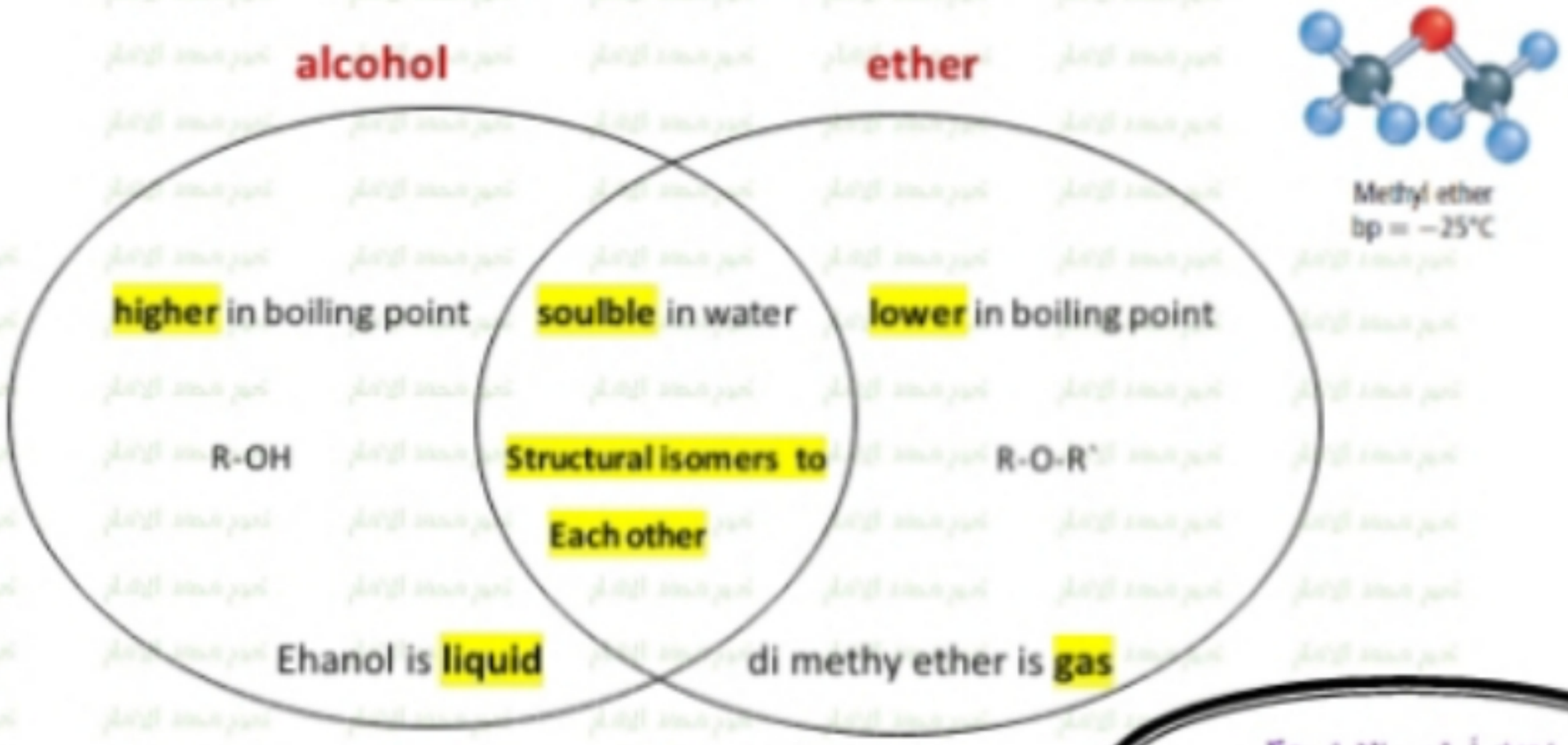
- **uses of di ethyl ether ( $C_2H_5$-$OC_2H_5$ ):**
  - ✓ **an anesthetic in surgery** from 1842 until the twentieth century and not use (why?.)
    because it is a **volatile** and **highly flammable** substance that was

**Note**

- ✓ The term ether was first used in chemistry as a name for ethyl ether,
- ✓ Because ethers have **no hydrogen atoms bonded to the oxygen atom**, their molecules cannot form hydrogen bond to each other .



Methanol
bp = 65°C






Methyl ether
bp = −25°C

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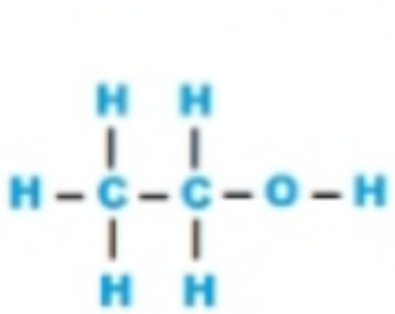
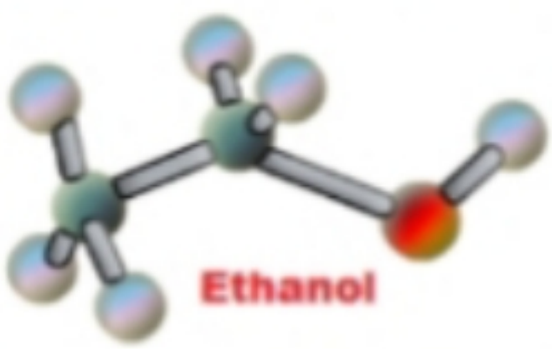
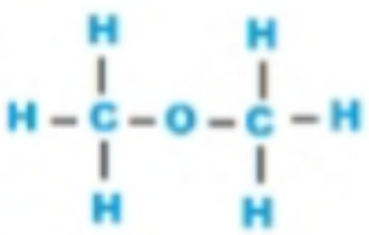
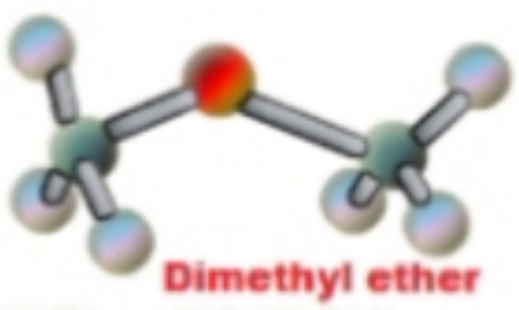
**Example: draw the isomers of $C_2H_6O$?**





Ethanol





Dimethyl ether

# Amines

- ✓ the general formula for an amines **R- $NH_2$**.

**where R represents a carbon chain or ring bonded to the functional group**

The function group is $-NH_2$

- ✓ **the simplest amine, methyl amine**.$CH_3$-$NH_2$

## ▪ classification of amines

(depending on number of organic groups replaced in H atoms)

- ✓ **amines derivatives of ammonia(N H 3).**

| | Primary amine (1°) | Secondary amine(2°) | Tertiary amine(3°) |
|---|---|---|---|
| **definetion** | Has **only one alkyl group** directly attached to the nitrogen | Has **two alkyl group** directly attached to the nitrogen.. | Has **three alkyl group** directly attached to the nitrogen |
| **Chemical formula** | **$RNH_2$**<br>where "R" is an alkyl group. | **$R_2NH$**<br>where both of the hydrocarbon groups are alkyl groups and both are the same. | **$R_3N$**<br>where all three of the hydrocarbon groups are alkyl groups and all three are the same. |
| **Example** | $CH_3-\underset{\displaystyle H}{\overset{\displaystyle |}{N}}-H$<br>Methyl amine | $CH_3-\underset{\displaystyle CH_2-CH_3}{\overset{\displaystyle |}{N}}-H$<br>Ethyl methyl amine | $CH_3-\underset{\displaystyle CH_3}{\overset{\displaystyle |}{N}}-CH_3$<br>Tri methyl amine |

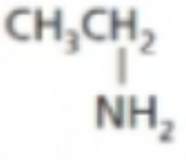
## ▪ Naming of amines :

- ✓ **the $-NH_2$ (amino)** group is indicated by the suffix –amine
- ✓ When necessary, the position of the amino group is designated by a number,
- ✓ If more than one amino group is present, the prefixes di-, tri-, tetra-, and so on are used to indicate the number of groups.



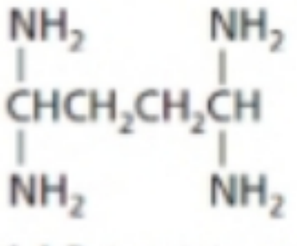
**Examples :**

Cyclohexylamine

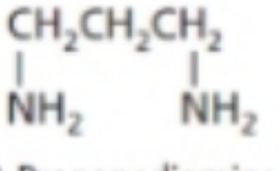


Ethylamine

Aniline



1,1,4,4-Butanetetraamine

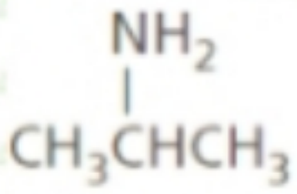


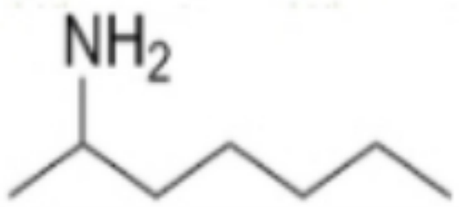
1,3-Propanediamine

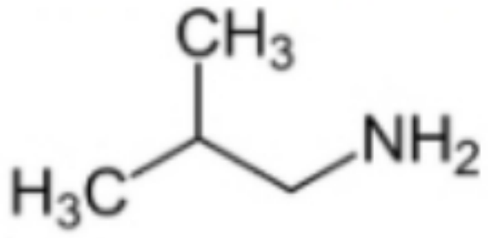
Ap

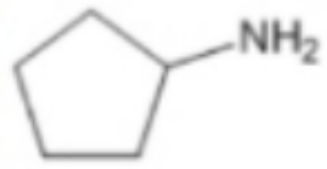
**plication :**

**1-name the following copounds**




**2-Draw the structure for each molecule.**

**a.** 1,2-propanediamine b. 5-aminohexane

**c.** 1,3-diaminobutane

## ▪ Preparation of amine :

$R\text{-}X + NH_3 \rightarrow R\text{-}NH_2 + HX$

$C_2H_5Cl + NH_3 \rightarrow C_2H_5OH + HCl$



## ▪ properties of amines :

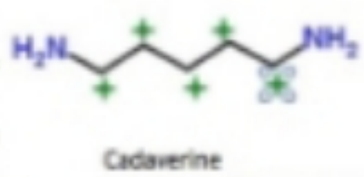
- ✓ **Solubility in water :**
  - ✓ Primary and secondry amines soulble in water because it make hydrogen bond with water
  - ✓ Teriary amine not soulble in water because not has a hydrogen atom attached to nitrogen to make hydrogen bond.
- ✓ **Amines are basic**

$$R\text{-}NH_2 + H_2O \rightarrow R\text{-}NH_3^+ + OH^-$$

- ✓ **Boiling point**:
  - ✓ Amines lower boiling point than alchols because amines less polarity than alcoholes
  - ✓ **The order of boiling point of amines is as follows:**

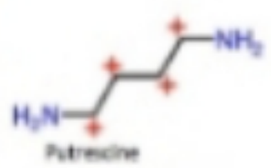
Primary > Secondary > Tertiary.

- ✓ **Other properties**
  - ✓ All volatile amines **have odors** that humans find **offensive**, and amines are responsible for many of the odors characteristic of dead, decaying organisms.




Cadaverine

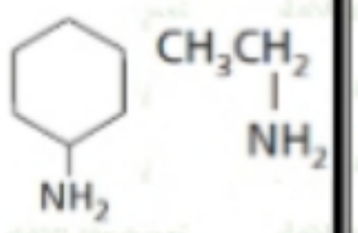
  - ✓ Two amines found in decaying human remains are **putrescine** and **cadaverine**. Specially trained dogs are used to locate human remains using these distinctive odors.




Putrescine

  - ✓ Sniffer dogs are often used after catastrophic events, such as **tsunamis**, **hurricanes**, and **earthquakes**.
  - ✓ They are also used in **forensic investigations**.

- **Uses of amines :**

| Amine | structure | uses |
|---|---|---|
| **Aniline (phenyl amine ) (Amino benzene)** |  | ▪ is used in the production of **dyes** with **deep shades of color** |
| **Cyclohexylamine and ethylamine** |  | **are important in the manufacture :**<br>▪ pesticides<br>▪ plastics<br>▪ pharmaceuticals<br>▪ rubber that is used to make tires. |

**Note**

1) **general formula** of **alcohol** and **ether** is $C_nH_{2n+2}O$ and are isomers to each other
2) **general formula** of **aldehyde** and **ketones** $C_nH_{2n}O$ and are isomers to each other
3) **general formula** of **carboxylic acids** and **esters** $C_nH_{2n}O_2$ and are isomers to each other

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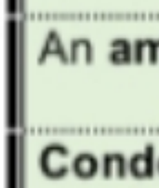
# Section 3: Carbonyl Compounds

**Main idea** :

. Carbonyl compounds contain a double-bonded oxygen in the functional group.

**Chemistry for you**

- ✓ Many natural fruits, such as **strawberries**, contain dozens of organic molecules that combine to give the distinctive aroma and flavor of fruits.




- ✓ The carbonyl group is found in many common types of artificial flavorings.

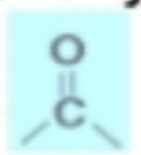
| item | Definetion |
|---|---|
| a **carbonyl group** | The arrangement in which an oxygen atom is double-bonded to a carbon atom |
| An **aldehyde** | is an organic compound in which a carbonyl group located at the end of a carbon chain is bonded to a carbon atom on one side and a hydrogen atom on the other. |
| A **ketone** | is an organic compound in which the carbon of the carbonyl group is bonded to two other carbon atoms. |
| A **carboxylic acid** | is an organic compound that has a carboxyl group. |
| A **carboxyl group** | consists of a carbonyl group bonded to a hydroxyl group |
| An **ester** | is any organic compound with a carboxyl group in which the hydrogen of the hydroxyl group has been replaced by an alkyl group, producing the arrangement shown |
| An **amide** | is an organic compound in which the –OH group of a carboxylic acid is replaced by a nitrogen atom bonded to other atoms |
| **Condensation reaction** | Is a reaction takeplace between two smaller organic molecules combine to form a more complex molecule, accompanied by the loss of a small molecule such as water. |

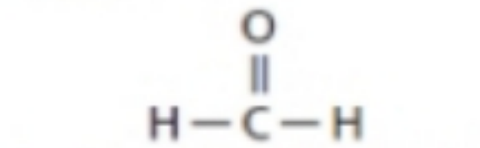
## ✓ Organic Compounds Containing the Carbonyl Group:

1- **Aldehyde**

2- **ketone**

# Aldehydes

- ✓ **the general formula *CHO**,
  where * represents an **alkyl group** or a **hydrogen atom** or **aril group**
- ✓ **the function group :** 
- ✓ **the simplest aldehydes is :** H-CHO Methanal (**formaldehyde**)



Methanal (formaldehyde)

- ✓ **naming of aldehyde**:
  - ✓ Aldehydes are formally named by changing the final -e of the name of the alkane with the same number of carbon atoms to the suffix -al.
  - ✓ no numbers are used in the name unless branches or additional functional groups are present **Because** the carbonyl group in an aldehyde always occurs at the end of a carbon chain.
  - ✓ Scientists often use **the common names** of organic compounds because they are familiar to chemists.
  - ✓ **Methanal** is also commonly called **formaldehyde.**
  - ✓ **Ethanal** has the common name **acetaldehyde**.

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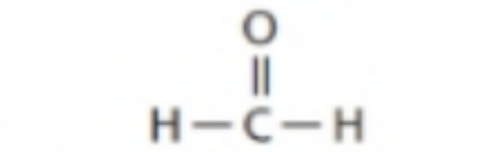
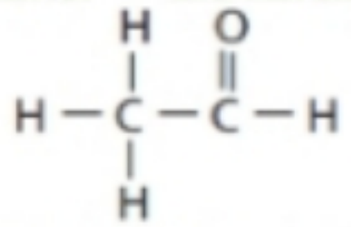
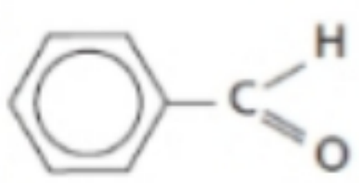
- ✓ **Examples:**

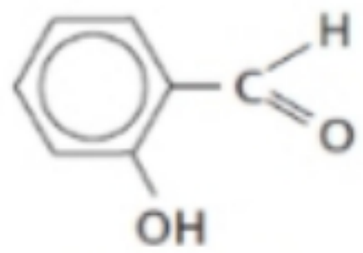


Methanal (formaldehyde)

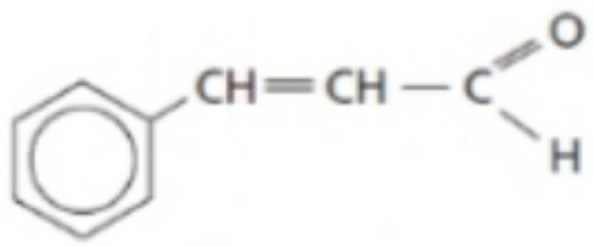


Ethanal (acetaldehyde)


Benzaldehyde



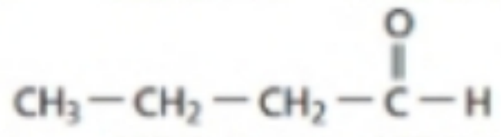
Salicylaldehyde

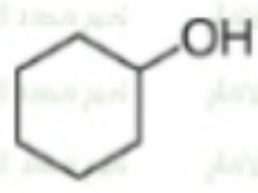


Cinnamaldehyde

## Application :

**1-name the following copounds:**


**2-Draw the structure for each molecule.**

a. 4-methylpentanal

b. cyclopentanal

## ✓ Properties of aldehyde :

### a- Solubility in water :

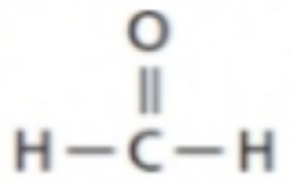
- ✓ Water molecules can form hydrogen bonds with the oxygen atom of aldehydes
- ✓ aldehydes are more soluble in water than alkanes but not as soluble asalcohols or amines.

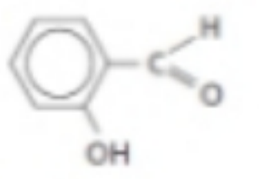
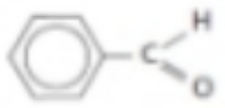
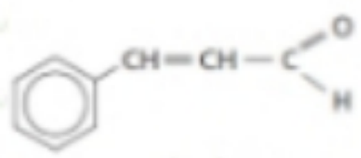
### b- Boiling point :

- ✓ An aldehyde molecule contains a polar, reactive structure. However like ethers
- ✓ aldehydes have lower boiling points than alcohols with the same number of carbon atoms. (why?)
  because aldehyde molecules molecules have **no hydrogen atoms** bonded to an oxygen atom and they cannot form hydrogen bonds among themselves

## ✓ uses of aldehyde :



| Aldehyde | Stractural | Uses |
|---|---|---|
| **Methanal (Formaldehyde)** |  | ✓ **a water solution of it was used in the past to preserve biological specimens.** However, formaldehyde's use has been **restricted in recent years** because studies indicate it might cause **cancer**. Naeem akl<br>✓ Industrially, large quantities of formaldehyde **are reacted with urea** to manufacture a type of grease-resistant, hard plastic **used to**:<br>• make buttons<br>• appliance<br>• automotive parts<br>• Electrical outlets.<br>✓ as well as **the glue that holds** the layers of plywood together. |

| | | |
|---|---|---|
| **Benzaldehyde and salicylaldehyde** |   | ✓ are two components that **give almonds their natural flavor** |
| **cinnamaldehyde** |  | **Give The aroma and flavor of cinnamon**, a spice that comes from the bark of a tropical tree, are produced largely |

# Ketones

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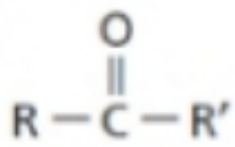
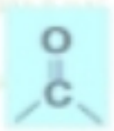
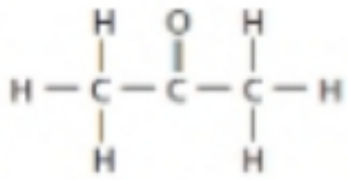
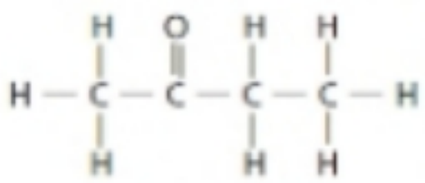
- ✓ **the general formula,** 
- ✓ **the function group :** 
- ✓ **the simplest ketones is :** propanone (**acetone**)


2-Propanone (acetone)

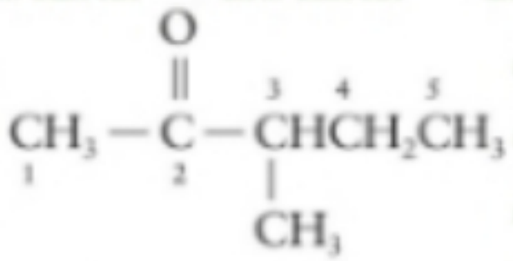
  - ✓ A carbonyl group can also be located within a carbon chain rather than at the end.

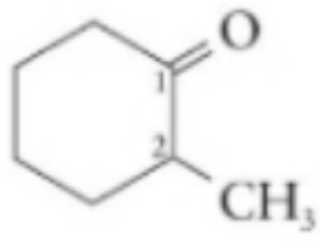
- ✓ **Naming of ketones :**
  - ✓ Ketones are formally named by changing the -e at the end of the alkane name to –one
  - ✓ including a number before the name to indicate the position of the ketone group
  - ✓ The carbonyl group can be located only in the center, but the prefix 2- is usually added to the name for clarity

**Examples :**


2-Butanone (methyethyl ketone)

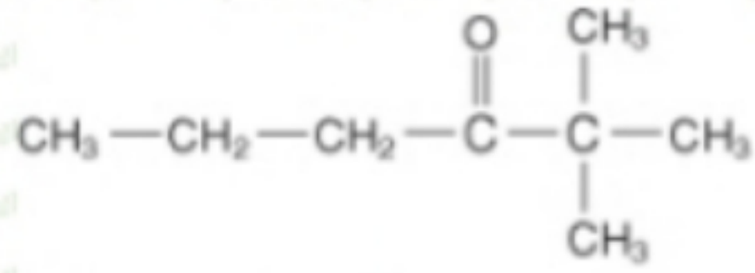

cyclohexanone

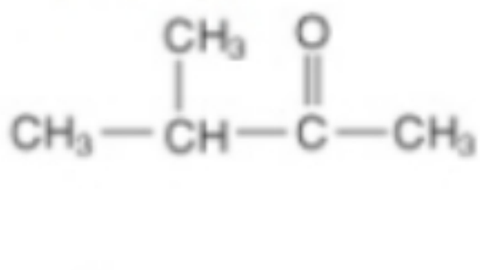

3-methyl-2-pentanone

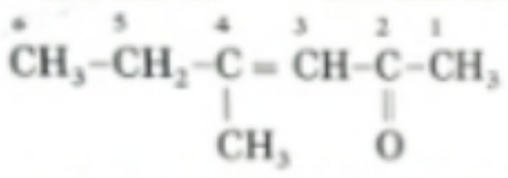

2-methylcyclohexanone

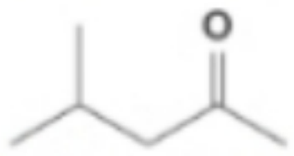
## application :

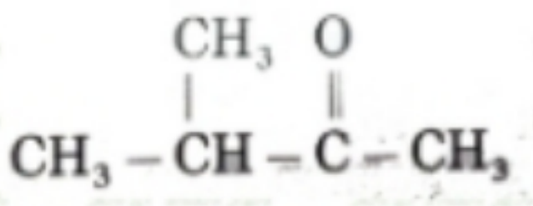
**1-name the following compounds :**

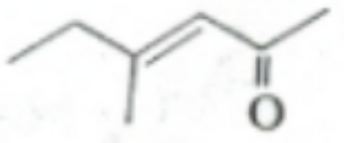












**2-draw the structural formula of the following compounds ?**

a. 2,2-dichloro-3-pentanone.
b. 3-ethyl – 2-hexanone

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### ✓ Properties of ketones :

**a. Solubility in water:**

- The Small ketones are freely soulble in water like acetone is **completely miscible** with water When carbon chain increase solubility will decrease
- Ketones can make hydrogen bond with water molecules

**b. Boiling point :**

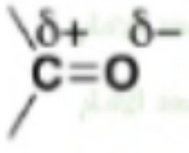
- Ketones are higher boiling point than alkanes but **lower than** coressponding alcohols **because** Like aldehydes, ketone molecules cannot form hydrogen bonds with each other

**c. Ketones and aldehydes share many chemical and physical properties(why?)**
because their structures are similar

### ✓ uses of ketones :

- **ketones are popular solvents for other moderately polar substances**, including waxes, plastics, paints, lacquers, varnishes, and glues .
- **acetone** : Nails polish remover.

**Note**



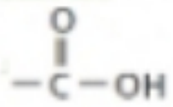
**the carbon-oxygen double bond very highly polar.(why?)**

- ✓ Oxygen is far more electronegative than carbon and so has a strong tendency to pull electrons in a carbon-oxygen bond towards itself.
- ✓ One of the two pairs of electrons that make up a carbon-oxygen double bond is even more easily pulled towards the oxygen.

# Carboxylic Acids

✓ **the general formula :** 

where * represents an **alkyl group** or a **hydrogen atom** or **aril group**

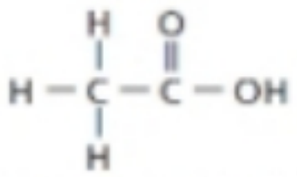
✓ **the function group :**  carboxyl group ( **condensed form by writing–COOH** )

✓ **the simplest aldehydes is :** H-COOH Methanoic acid (**formic acid**)

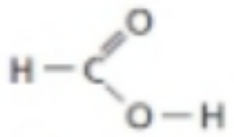
▪ **naming of carboxylic acid :**

✓ Although many carboxylic acids have common names, the formal name is formed by changing the **-ane** of the parent alkane to - **anoic acid** Thus, the formal name of acetic acid is ethanoic acid.

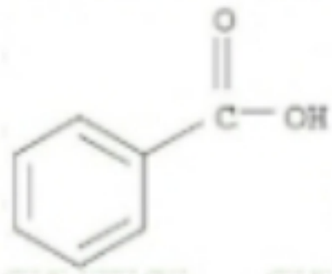
**Examples:**



Ethanoic acid (acetic acid)



Methanoic acid (formic acid)



Benzoic acid

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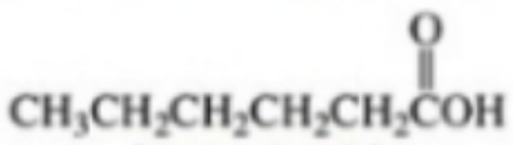
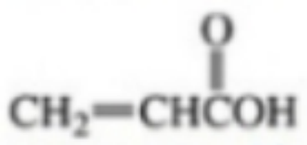
| | | | | |
|---|---|---|---|---|
| systematic name: | methanoic acid | ethanoic acid | propanoic acid | butanoic acid |
| common name: | formic acid | acetic acid | propionic acid | butyric acid |

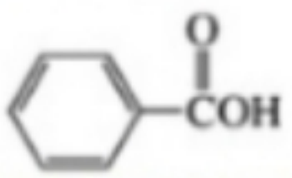
pentanoic acid
valeric acid



hexanoic acid
caproic acid



propenoic acid
acrylic acid



benzenecarboxylic acid
benzoic acid

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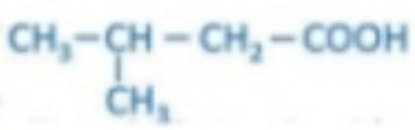
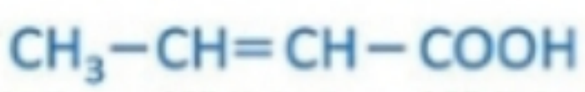
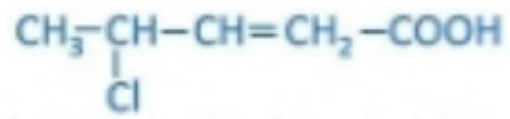
## Application :

**1-name the following copounds :**



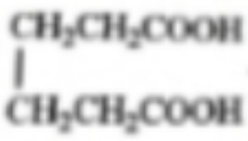
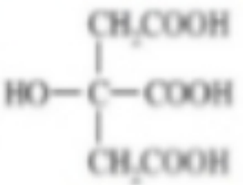




**2-Draw the structure of the following compounds :**

a.pentanoic acid b.heptanoic acid c.3-metheyl butanoic acid

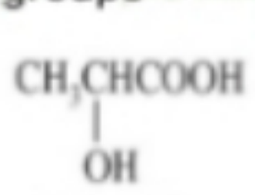
## ▪ Classification of carboxylic acids :

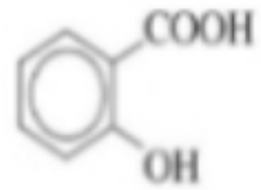
| Monocarboxylic acids | Dicarboxylic acids | Polycarboxylic acids |
|---|---|---|
| They have **only one** carboxyl group (-COOH)<br><br>**Example :**<br>Acetic acid<br><br>Benzoic acid<br><br>**Known as :**<br>monoprotic acids | An acids with **two carboxyl** groups(-COOH)<br><br>**Example :**<br>oxalic acid  <br>adipic acid  <br>phthalic acid<br>  <br>**known as** : diprotic acids | They have **more than two carboxyl groups**(-COOH)<br><br>**Example:**<br>Citric acid (lemon)  <br><br>**Known as** polyprotic acids |

**Hydroxy acids** : acids have hydroxyl (-OH) and carboxyl (-COOH) groups

**Examples :**

- lactic acid found in **yogurt.**


lactic acid
(2-hydroxypropanoic acid)


salicylic acid
(*o*-hydroxybenzoic acid)

**Properties of hydroxy acids**

- these acids are **more soluble** in water
- often more acidic than acids with only a carboxyl group.

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**TABLE 24.2 | Names and Formulas of Selected Dicarboxylic Acids**

| Common name* | IUPAC name | Formula |
|---|---|---|
| Oxalic acid | Ethanedioic acid | HOOCCOOH |
| Malonic acid | Propanedioic acid | $HOOCCH_2COOH$ |
| Succinic acid | Butanedioic acid | $HOOC(CH_2)_2COOH$ |
| Glutaric acid | Pentanedioic acid | $HOOC(CH_2)_3COOH$ |
| Adipic acid | Hexanedioic acid | $HOOC(CH_2)_4COOH$ |
| Pimelic acid | Heptanedioic acid | $HOOC(CH_2)_5COOH$ |
| Fumaric acid | *trans*-2-Butenedioic acid | $HOOCCH=CHCOOH$ |
| Maleic acid | *cis*-2-Butenedioic acid | $HOOCCH=CHCOOH$ |

*A mnemonic for remembering the common names of the saturated dicarboxylic acid uses the first letter of the acid name:
Oh My Such Good Apple Pie

- **Properties of carboxylic acids :**

1) **solublity in water :**
   - ✓ Carboxylic acids soulble in water and make hydrogen bond With water molecules
   - ✓ First aliphatic carboxylic acid dissolve in water
   - ✓ Aromatic carboxylic acid are solids and not dissolve in water

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2) **Boiling point** :
   - ✓ Are higher bioling point than alcohols because make more hydrogen bond than alcohols

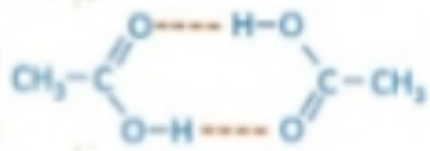

**Table 24.1 Names, Formulas, and Physical Properties of Saturated Aliphatic Carboxylic Acids**

| Common name (IUPAC name) | Formula | Melting point (°C) | Boiling point (°C) | Solubility in water* |
|---|---|---|---|---|
| Formic acid (methanoic acid) | HCOOH | 8.4 | 100.8 | ∞ |
| Acetic acid (ethanoic acid) | $CH_3COOH$ | 16.6 | 118 | ∞ |
| Propionic acid (propanoic acid) | $CH_3CH_2COOH$ | −21.5 | 141.4 | ∞ |
| Butyric acid (butanoic acid) | $CH_3(CH_2)_2COOH$ | −6 | 164 | ∞ |
| Valeric acid (pentanoic acid) | $CH_3(CH_2)_3COOH$ | −34.5 | 186.4 | 3.3 |
| Caproic acid (hexanoic acid) | $CH_3(CH_2)_4COOH$ | −3.4 | 205 | 1.1 |
| Caprylic acid (octanoic acid) | $CH_3(CH_2)_6COOH$ | 16.3 | 239 | 0.1 |
| Capric acid (decanoic acid) | $CH_3(CH_2)_8COOH$ | 31.4 | 269 | Insoluble |
| Lauric acid (dodecanoic acid) | $CH_3(CH_2)_{10}COOH$ | 44.1 | 225** | Insoluble |
| Myristic acid (tetradecanoic acid) | $CH_3(CH_2)_{12}COOH$ | 54.2 | 251** | Insoluble |
| Palmitic acid (hexadecanoic acid) | $CH_3(CH_2)_{14}COOH$ | 63 | 272** | Insoluble |
| Stearic acid (octadecanoic acid) | $CH_3(CH_2)_{16}COOH$ | 69.6 | 287** | Insoluble |
| Arachidic acid (eicosanoic acid) | $CH_3(CH_2)_{18}COOH$ | 77 | 298** | Insoluble |

*Grams of acid per 100 g of water.
**Boiling point is given at 100 mm Hg pressure instead of atmospheric pressure, because thermal decomposition occurs before this acid reaches its boiling point at atmospheric pressure.



3) **Carboxylic acids are polar and reactive.**

4) they have **most acidity** in organic copound (why?)
   - Because that dissolve in water ionize weakly to produce **hydronium ions**, the anion of the acid in equilibrium with water, and the unionized acid.

**example.**

$$\underset{\text{Ethanoic acid (acetic acid)}}{CH_3COOH_{(aq)}} + H_2O_{(l)} \rightleftharpoons \underset{\text{Ethanoate ion (acetate ion)}}{CH_3COO^-_{(aq)}} + H_3O^+_{(aq)}$$

- **Carboxylic acids can ionize in water solution (why)?**
  **because** the two oxygen atoms are **highly electronegative** and attract electrons away from the hydrogen atom in the –OH group. As a result, the hydrogen proton can transfer to another atom that has a pair of electrons not involved in bonding, such as the oxygen atom of a water molecule.

5) Aqueous solution of carboxylic acids **turn blue litmus** papert o **red**
6) They have **a sour taste.**

## ▪ Uses of carboxylic acids .

- **acetic acid** found in **vinegar**.
- formic acid Some insects produce it as a defense mechanism
  **example** :Stinging ants defend themselves with a venom that contains formic acid.

---

## ▪ Organic Compounds Derived from Carboxylic Acids:

✓ Several classes of organic compounds have structures in which the **hydrogen** or the **hydroxyl group** of a **carboxylic acid** is replaced by a different atom or group of atoms.

✓ **The two most common classes are**
- **Esters**
- **amides.**

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# Esters

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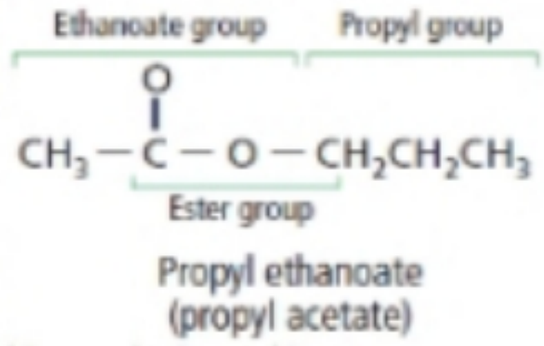
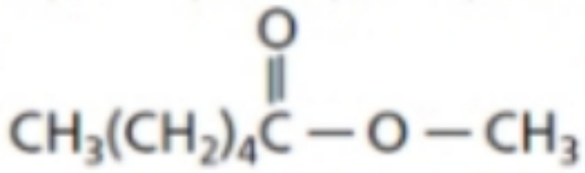
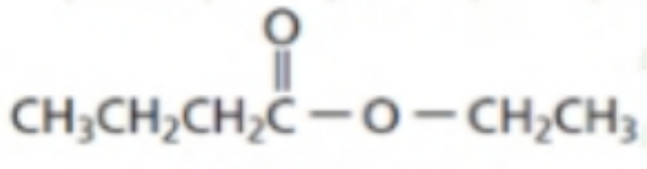
- ✓ **the general formula** : 
- ✓ where * represents an **alkyl group** or a **hydrogen atom** or **aril group**
- ✓ **the function group :** 
- ✓ **the simplest ketones is :** methyl methanoate (**methyl formate**) $HCOOCH_3$

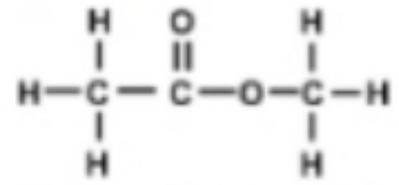
## ▪ Naming of eaters :




- ✓ The name of an ester is formed by writing the name of the alkyl group followed by the name of the acid with the **-ic** acid ending replaced by **–ate**.
- ✓ The name shown in parentheses is based on the name **acetic acid** the common name for ethanoic acid.


Methyl hexanoate

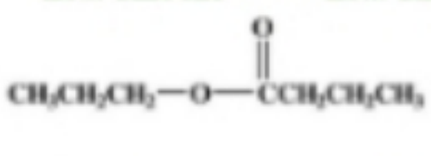

Ethyl butanoate

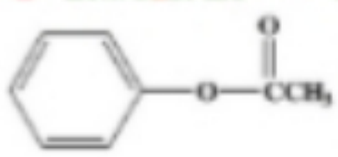

Methyl ethanoate ($CH_3COOCH_3$)

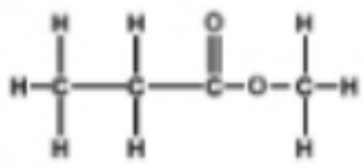
**Examples :**

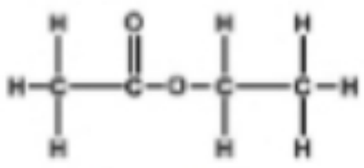
**Application :**

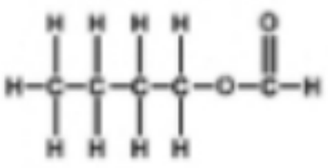
**1-Name the following compounds**

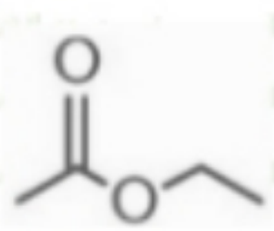


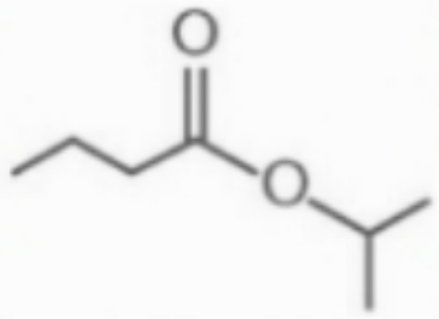


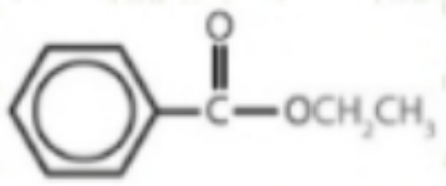


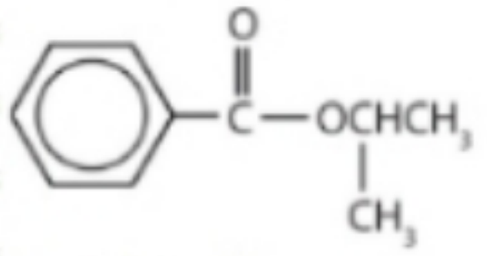










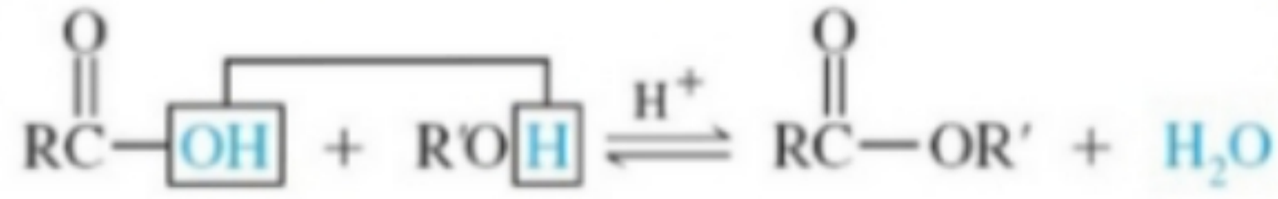


**2-draw the structure of the following compounds :**

a. hexyl methanoate  b. isopropyl hexanoate  c.ethyl butanoate

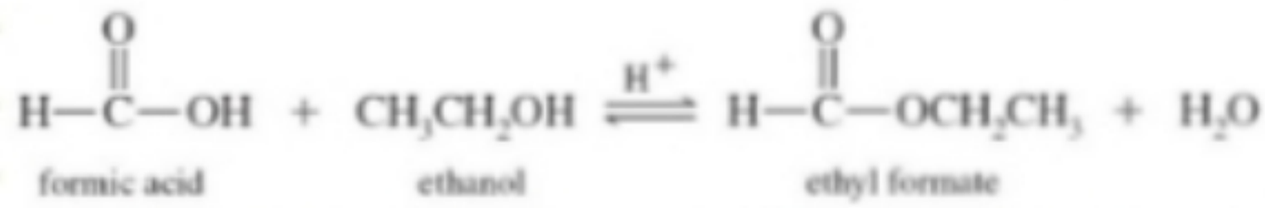
## ▪ Easter formation :

Can be prepared by a reacting a carboxylic acid and alcohol in the presence of a strong acid as a catalyst **(codensation reaction )**



carboxylic acid + alcohol ⇌ ester + $H_2O$

(R can be H, alkyl, or Ar, but R′ cannot be H)



formic acid + ethanol ⇌ ethyl formate + $H_2O$

## ▪ Properties of easters :

- ✓ Esters are **polar molecules** and many are **volatile** and **sweet-smelling**.
- ✓ Many kinds of esters are found in the **natural fragrances** and flavors of flowers and fruits Natural flavors, such as: apple or banana, result from mixtures of many different organic molecules, including esters, but some of these flavors can be imitated by a single ester structure.

- ✓ Esters are responsible for the **flavors and aromas of many fruits**

example

- The aroma of strawberries is due in part to methyl hexanoate.
- the aroma of pineapple is due to Ethyl butanoate
- Most natural aromas and flavors are mixtures of esters, aldehydes, and alcohols.

## ▪ Uses of easters :

- ✓ **esters are manufactured for use as:**
  - flavors in many foods
  - beverages
  - as fragrances in candles, perfumes, and other scented items.
  - Plastic (poly ester): codensation reaction between diol and




Experimen

## Make an Ester

**How can you recognize an ester?**

**Procedure**

**1.** Read and complete the lab safety form.

**2.** Prepare a hot-water bath by pouring 150 mL of **tap water** into a **250-mL beaker.** Place the beaker on a **hot plate** set to medium.

**3.** Use a **balance** and **weighing paper** to measure 1.5 g of **salicylic acid.** Place the salicylic acid in a **small test tube** and add 3 mL of **distilled water.** Use a **10-mL graduated cylinder** to measure the water. Then add 3 mL of **methanol.** Use a **Beral pipette** to add 3 drops of **concentrated sulfuric acid** to the test tube.

**WARNING:**

- **Concentrated sulfuric acid can cause burns.**
- **Methanol fumes are explosive—keep away from open flame.**
- **Handle chemicals with care.**

**4.** When the water is hot but not boiling, place the test tube in the bath for 5 min. Use a **test-tube clamp** to remove the test tube from the bath and place in a **test-tube holder** until needed.

**5.** Place a **cotton ball** in a **petri dish half.** Pour the contents of the test tube onto the cotton ball

6. Record your observation of the odor of the product.

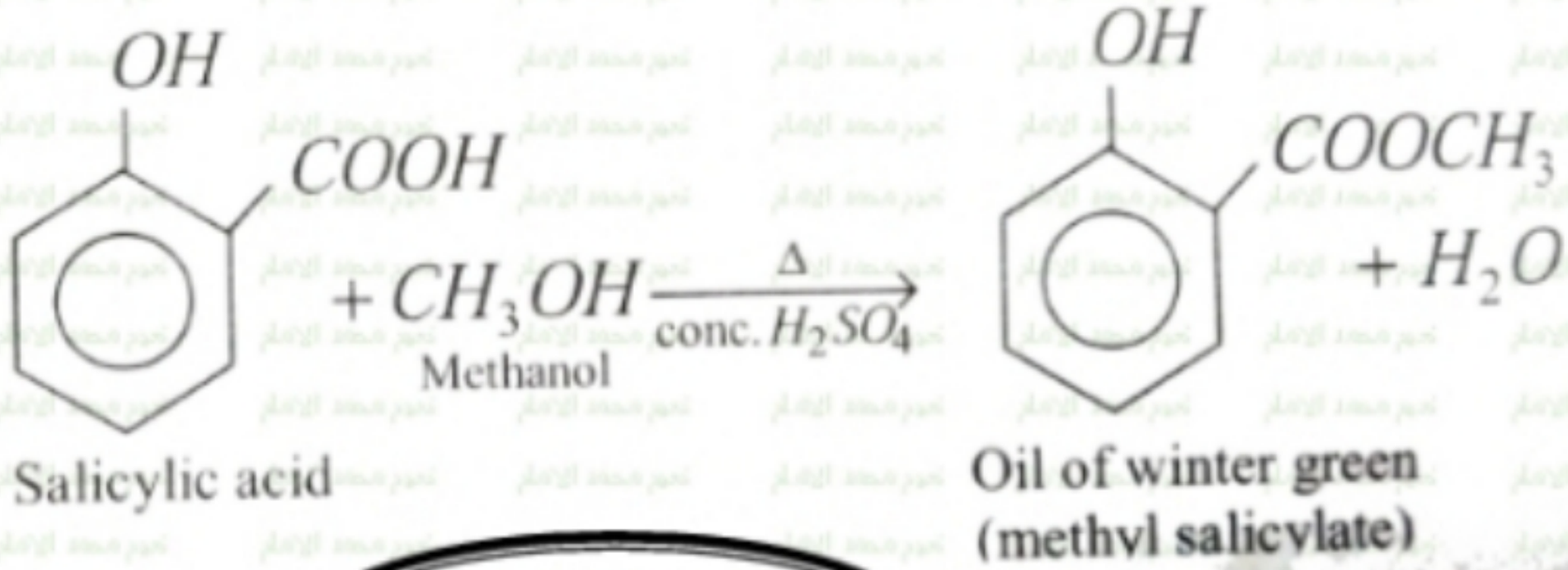
**Analysis**

1. **Name** The common name of the ester that you produced is oil of wintergreen. **Methyl salicylate**
2. Name some products that you think could contain the ester. **Mint candy(sweet) / gum**
3. **Evaluate** the advantages and disadvantages of using synthetic esters in consumer products as compared to using natural esters

   **advantages**: Synthetic esters are **produced more efficiently** and with **lower costs** than natural esters.

   **The disadvantages** are: the **smells** (odor)of synthetic esters **differ slightly** from natural esters **because** they contain other compounds.

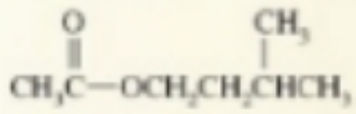
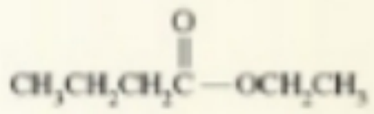
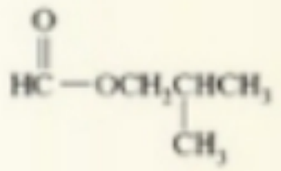
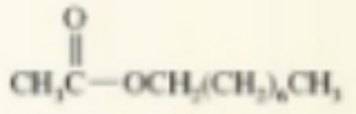
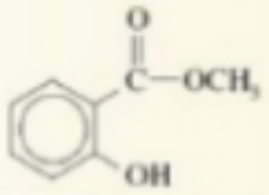
## Esterificatin (condensation reaction )




Salicylic acid

Oil of winter green
(methyl salicylate)

**Table 24.3 Formulas, Names, and Odors of Selected Esters**

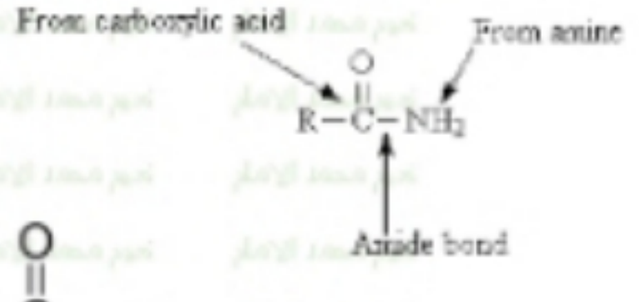
| Formula | IUPAC name | Common name | Odor or flavor |
|---|---|---|---|
|  | Isopentyl ethanoate | Isoamyl acetate | Banana, pear |
|  | Ethyl butanoate | Ethyl butyrate | Pineapple |
|  | Isobutyl methanoate | Isobutyl formate | Raspberry |
|  | Octyl ethanoate | Octyl acetate | Orange |
|  | Methyl 2-hydroxybenzoate | Methyl salicylate | Wintergreen |

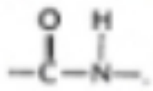
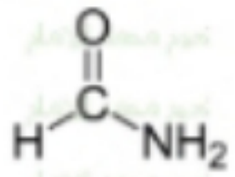


# Amides

- ✓ **the general formula** 

  where * represents an **alkyl group** or a **hydrogen atom** or **aril group**

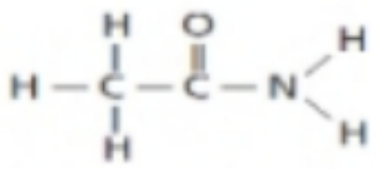


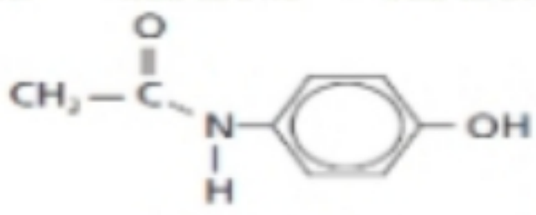

- ✓ **the function group :** 
- ✓ **the simplest ketones is :** methanamid (formamide) 

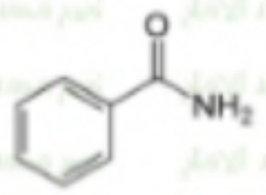
- **Naming of amides :**
  - ✓ Amides are named by writing the name of the alkane with the same number of carbon atoms, and then replacing the final **-e** with **-amide**.
  - ✓ The amide functional group is found repeated many times in natural proteins and some synthetic materials.

**Example:**

- **Acetaminophen** : that the amide (–NH–) group connects a carbonyl group and an aromatic group.
- **caramide ($NH_2CONH_2$) or urea** as it is commonly known


Ethanamide (acetamide)


Acetaminophen


benzamide

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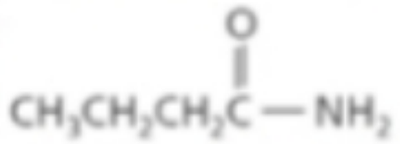
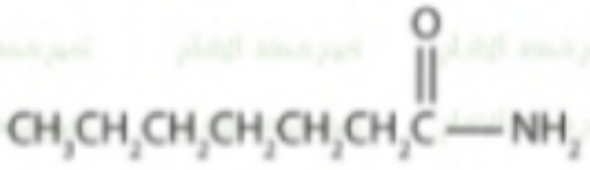
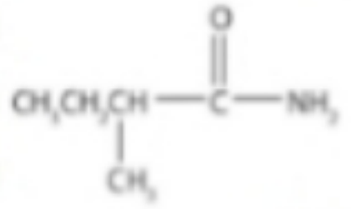
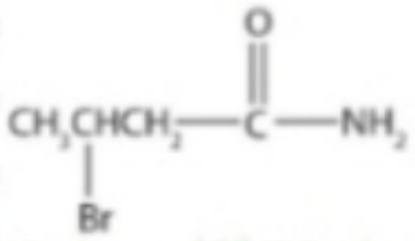
## Applications :

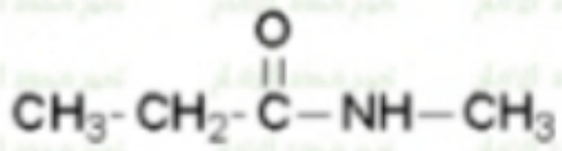
**1-name the fellowing compound :**





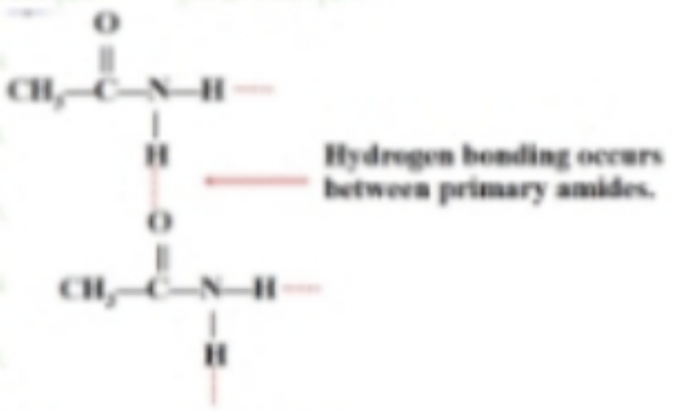






**2-draw structural formula of the following compounds :**

Octanoamide  pentan amide  propanamide




- **Properties of amide :**

**a. solubility in water :**

- ✓ smallest carbon chain of amides dissolve in water(why) because it can make hydrogen bond with water

**b. boiling point :**

- ✓ have high boiling point because it make hydrogen bond between its molecules

- **uses of amides :**

| Amide | Uses |
|---|---|
| acetaminophen | ✓ used a nonaspirin pain reliever containing. |
| **caramide** (Urea ) | ✓ is an end product in the metabolic **breakdown of proteins in mammals**.<br>✓ It is found in the **blood, bile**, **milk** and **perspiration of mammals**.<br>✓ **When proteins are broken down**:<br>• amino groups (**$NH_2$**) are **removed** from the amino acids.<br>• The amino groups are then **converted** to ammonia (**$NH_3$**) that are toxic to the body.<br>• The toxic ammonia is **converted** to **nontoxic urea in the liver.**<br>• The urea is **filtered out of the blood in the kidneys** and passed from the body in **urine**.<br>✓ **is a common commercial fertilizer(why)**<br>1) Because of the **high nitrogen content of urea**<br>2) it is **easily converted to ammonia in the soil**<br>✓ **used as a protein supplement for ruminant animals,** such as cattle and sheep.These animals use urea to produce proteins in their bodies. |

# Condensation Reactions

✓ Many laboratory syntheses and industrial processes involve the reaction of **two organic reactants** to form **a larger organic product.**

**Examples** :

1) . A common way to **synthesize an ester** is by a condensation reaction between a **carboxylic acid** and **an alcohol**.

**general equation.**

$$RCOOH + R'OH \rightarrow RCOOR' + H_2O$$

2) To **synthesize aspirin**, two organic molecules are combined in a condensation reaction to form a larger molecule.

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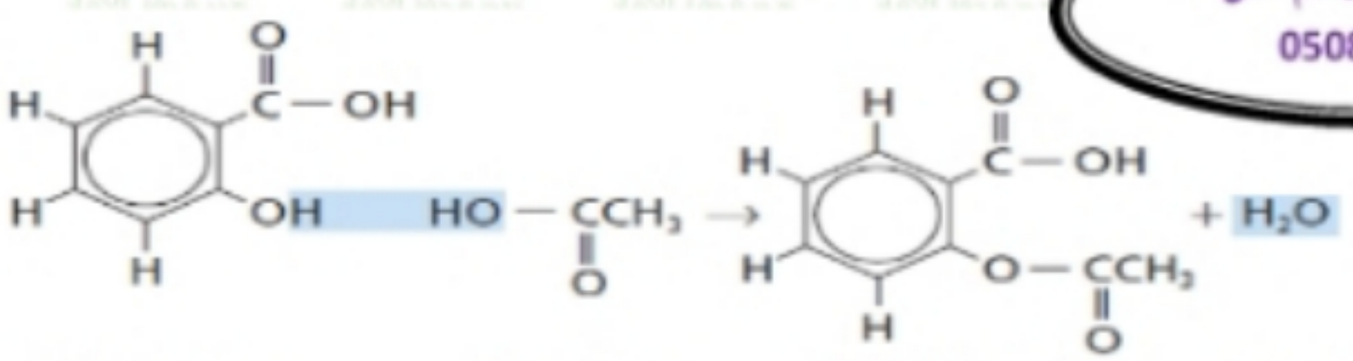

Salicylic acid | Acetic acid | Acetylsalicylic acid (aspirin) | Water

3) **The oil of wintergreen: between salicylic acid and methanol**

4) **Poly amide (nylon6,6): between adipic acid with 1,6-hexane di anine**

✓ Typically, the molecule lost is formed from one particle from each of the reactant molecules.

✓ In essence, a condensation **reaction is an elimination reaction** in which a bond is formed **between two atoms not previously bonded** to each other.

---

**Note**

1) hydrgen halide when increase the atomic radius of halogen the boiling point will dcrease Ex: **HF more higher boiling point than HI**
2) alkyl halide when increase the atomic radius of halogen the boiling point will decrease EX: **$CH_3F$ lower boiling point than $CH_3I$.**
3) When **alkane** react with **halgen**(halogenation ) will produce **alkyl halide**
4) When **alkyl halide** react with **NaOH** (basic medium) will produce **alcohol**
5) When **alkyl halide** react with ammonia **$NH_3$** will produce **amine**
6) When **alcohol** react with **carboxylic acid** (condensation reaction) will produce **ester**
7) When **amonia** or **primary amine** or **secondry amine** react with **carboxylic acid** (condensation reaction )will produce **amide**
8) Order the organic compound from high**Polarity(high boiling point to low b.p:**

Amide > Acid > Alcohol > Ketone ~ Aldehyde > Amine > Ester > Ether > Alkane

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