

## تجميعية مراجعة وفق الهيكل الوزاري الخطة C



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موقع المناهج ← المناهج الإماراتية ← الصف الثاني عشر المتقدم ← كيمياء ← الفصل الثالث ← ملفات متنوعة ← الملف

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المزيد من مادة  
كيمياء:

إعداد: معاذ عز

### التواصل الاجتماعي بحسب الصف الثاني عشر المتقدم



صفحة المناهج  
الإماراتية على  
فيسبوك

الرياضيات

اللغة الانجليزية

اللغة العربية

التربية الاسلامية

المواد على تلغرام

### المزيد من الملفات بحسب الصف الثاني عشر المتقدم والمادة كيمياء في الفصل الثالث

حل مراجعة امتحانية شاملة وفق الهيكل الوزاري منهج بريدج الخطة 101-M

1

الهيكل الوزاري الجديد 2025 منهج بريدج الخطة 101-C

2

الهيكل الوزاري الجديد 2025 منهج انسباير الخطة 101-C

3

حل أسئلة الامتحان النهائي القسم الالكتروني

4

أسئلة الامتحان النهائي القسم الالكتروني بدون الحل

5

معاد عز Mouad Azz

# ***Chemistry EOT3 12 Advanced-C 2024-2025***



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By: Mr Mouad Azz معاد عز



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# Chemistry EOT3 12 Advanced-C 2024-2025

**Part 1:**  
**(Q1 to Q3)**  
**(Q11 to Q12)**



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By: Mr Mouad Azz معاد عز



- (1) Identify the main (general) characteristic of an organic compound.
- (2) Differentiate between the reactivity of saturated hydrocarbons (alkanes) and unsaturated hydrocarbons (alkenes and alkynes) using reaction bromine water.



# Organic chemistry

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- organic compound is applied to all carbon-containing compounds with the primary exceptions of **carbon oxides**, **carbides**, and **carbonates**, which are considered **inorganic**.
- Because there are so many organic compounds, an entire branch of chemistry, called **Organic Chemistry**, is devoted to their study.

## Organic vs Inorganic Compounds

Organic compounds contain carbon, usually bonded to hydrogen.



DNA



Sugar



Methane



Ethanol

Inorganic compounds usually don't contain carbon.



Table Salt



Hydrochloric Acid



Quartz



Carbon Dioxide

Inorganic carbon compounds include carbon dioxide and some carbonates, cyanides, and carbides.

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# Organic Compounds.

Compounds Of **Carbon** Are Known As Organic Compounds

**Organic compound** is applied to all carbon-containing compounds with the primary **exceptions** of carbon oxides, carbides, and carbonates, **which are considered inorganic**.

Organic	Inorganic
Carbon-containing compounds ( Carbon-Hydrogen bond)	<u>Carbon Oxides (i.e., CO<sub>2</sub>, CO)</u>
	<u>Carbides (i.e., SiC, metal with carbon)</u>
	<u>Carbonates (i.e., Sodium carbonates Na<sub>2</sub>CO<sub>3</sub>, Calcium carbonate CaCO<sub>3</sub>)</u>

# Activity

Classify the compounds to organic or inorganic compounds?

A.  $\text{H}_2\text{O}$

Inorganic

B.  $\text{C}_2\text{H}_6$

Organic

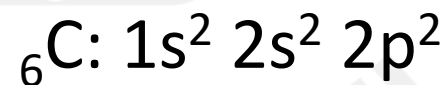
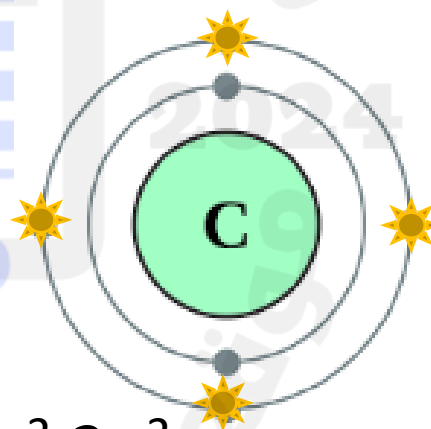
C.  $\text{CO}$

Inorganic



# Why can Carbon atom form so many different organic compounds?

- **1.** a carbon atom has four electrons in its outer energy level (**4 valence electrons**).
- Carbon can share **4 valence electrons**, thus it can make a total of 4 covalent bonds

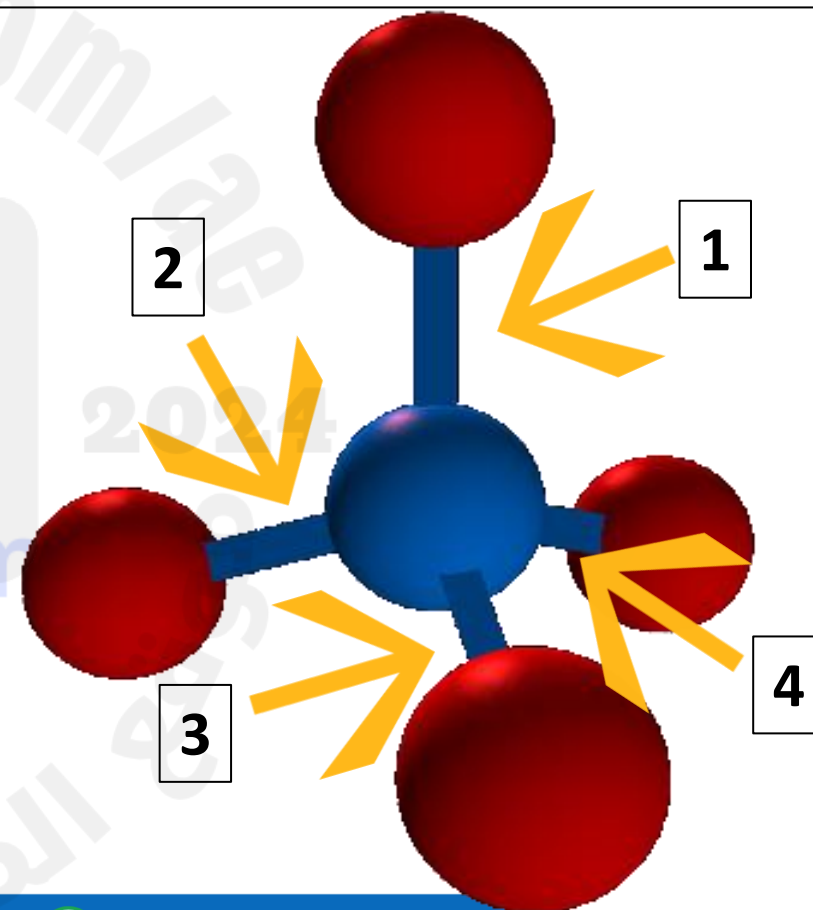




Why can Carbon atom form so many different organic compounds?

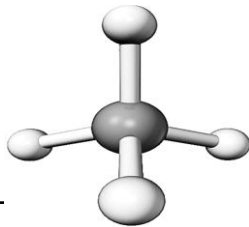
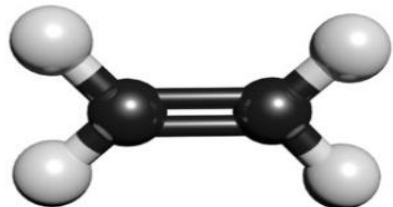
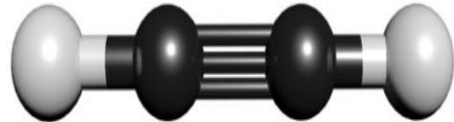
- **2.** a carbon atom can form four covalent bonds with atoms of carbon or with other elements **because it has 4 valence electrons.**

Recall: covalent bond is formed when two atoms share pair of electrons.



Why can Carbon atom form so many different organic compounds?

- 3. Carbon can form single, double, or triple covalent bonds.

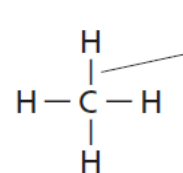
Type of bonding	Bond structure	Example	3D pic
Single	$\begin{array}{c}   \\ -C- \\   \end{array}$	Methane $\begin{array}{c} H \\   \\ H-C-H \\   \\ H \end{array}$	
Double	$\begin{array}{c} \diagup \\ C= \\ \diagdown \end{array}$	Ethene $\begin{array}{cc} H & H \\ & \diagdown \diagup \\ & C=C \\ & \diagup \diagdown \\ H & H \end{array}$	
Triple	$-C\equiv$	Ethyne $H-C\equiv C-H$	

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## Models of Methane

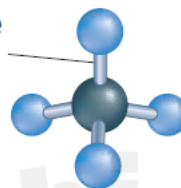
 $\text{CH}_4$ 

Molecular formula



Structural formula

Denotes a single covalent bond



Ball-and-stick model



Space-filling model

■ **Figure 21.4** Chemists use four different models to represent a methane ( $\text{CH}_4$ ) molecule. Refer to page 968 for a key to atom color conventions.

**Models and hydrocarbons** Chemists represent organic molecules in a variety of ways. Figure 21.4 shows four different ways to represent a methane molecule. Covalent bonds are represented by a single straight line, which denotes two shared electrons. Most often, chemists use the type of model that best shows the information they want to highlight.

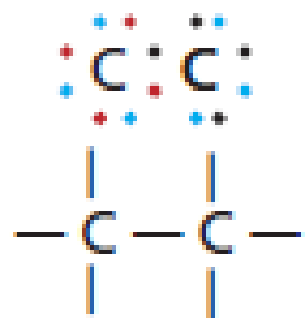
As shown in Figure 21.4, molecular formulas give no information about the geometry of the molecule. A structural formula shows the general arrangement of atoms in the molecule but not the exact, three dimensional geometry. The ball-and-stick model demonstrates the geometry of the molecule clearly, but the space-filling model gives a more realistic picture of what a molecule would look like if you could see it. Keep in mind as you look at the models that the atoms are held closely together by electron-sharing bonds.

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# Lewis structures and structural formulas

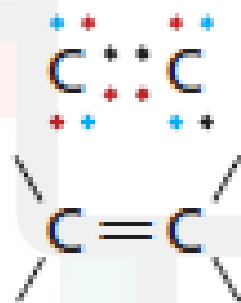
- Carbon can bond to other carbon atoms in double and triple bonds. These Lewis structures and structural formulas show two ways to denote double and triple bonds

One shared pair



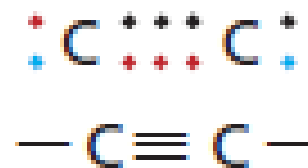
Single covalent bond

Two shared pairs



Double covalent bond

Three shared pairs



Triple covalent bond

- and • = carbon electrons
- = electron from another atom

# Hydrocarbons

## → Bonding in hydrocarbons:

- Saturated
- unsaturated

### Note:

the ending *-ane* indicates a single bonds only,  
The ending *-ene* indicates a double bond,  
and *-yne* indicates a triple bond.

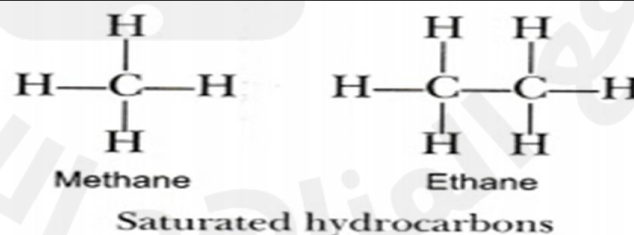
### Note:

the term “unsaturated” means more  
hydrogen atoms may be added to  
the hydrocarbon to make it saturated.

## Bonding in hydrocarbons

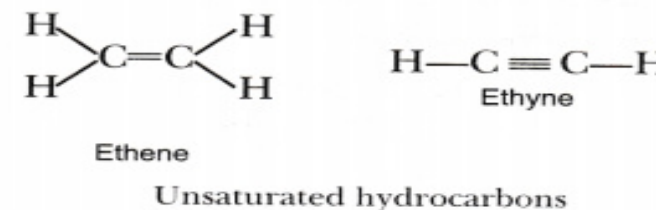
### Single Bonds

### Saturated Hydrocarbons



### Multiple Bonds

### Unsaturated Hydrocarbons





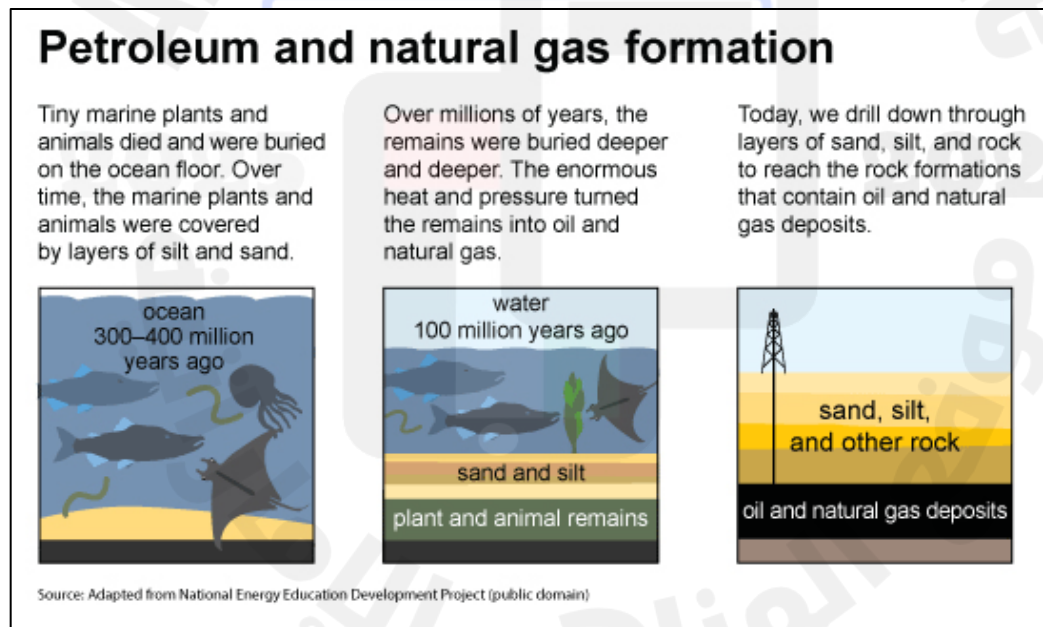
**Reacting with Bromine:** Double and triple bonds  
(Unsaturated hydrocarbons)

**Not reacting with bromine** (single bonds): saturated hydrocarbons

**(3)** Describe the process used to separate petroleum compounds by explaining the physical property used during the process

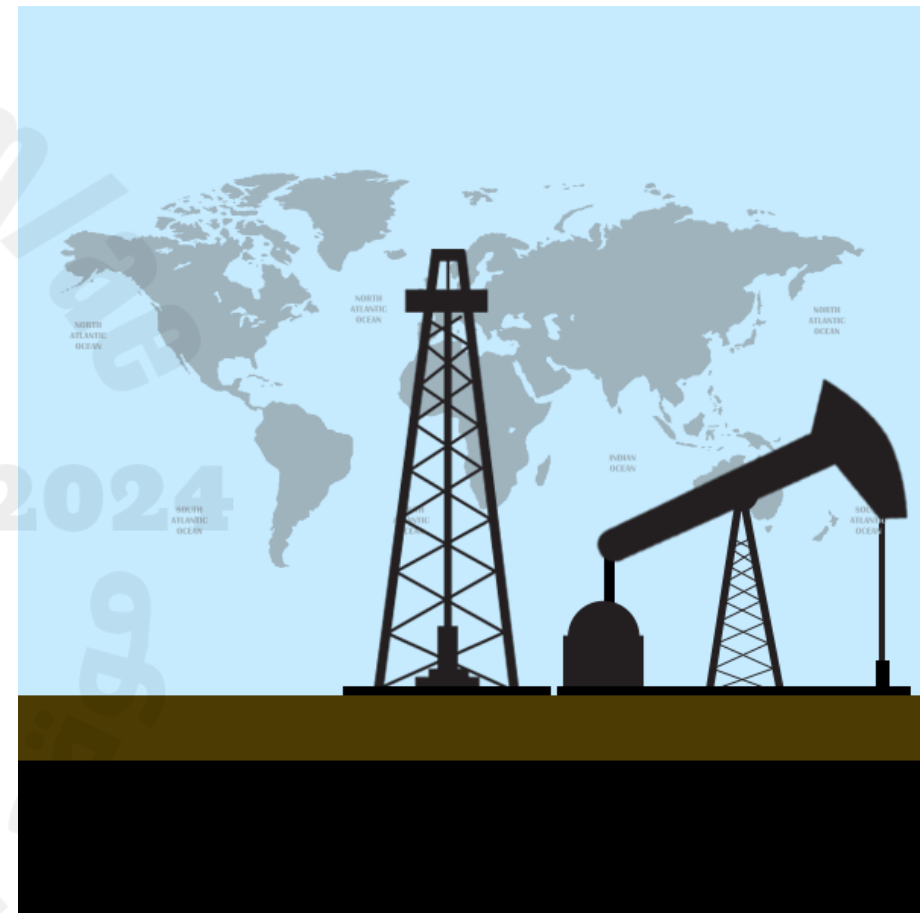
# Applications: Refining Hydrocarbons

- many hydrocarbons are obtained from a fossil fuel called **petroleum**.
  - Natural gas**, which formed at the same time and in the same way as petroleum, is usually found with petroleum deposits. Natural gas is composed primarily of **methane**, but it also contains small amounts of other hydrocarbons that have **from two to five carbon atoms**.
- تكرير أو تنقية = Refining



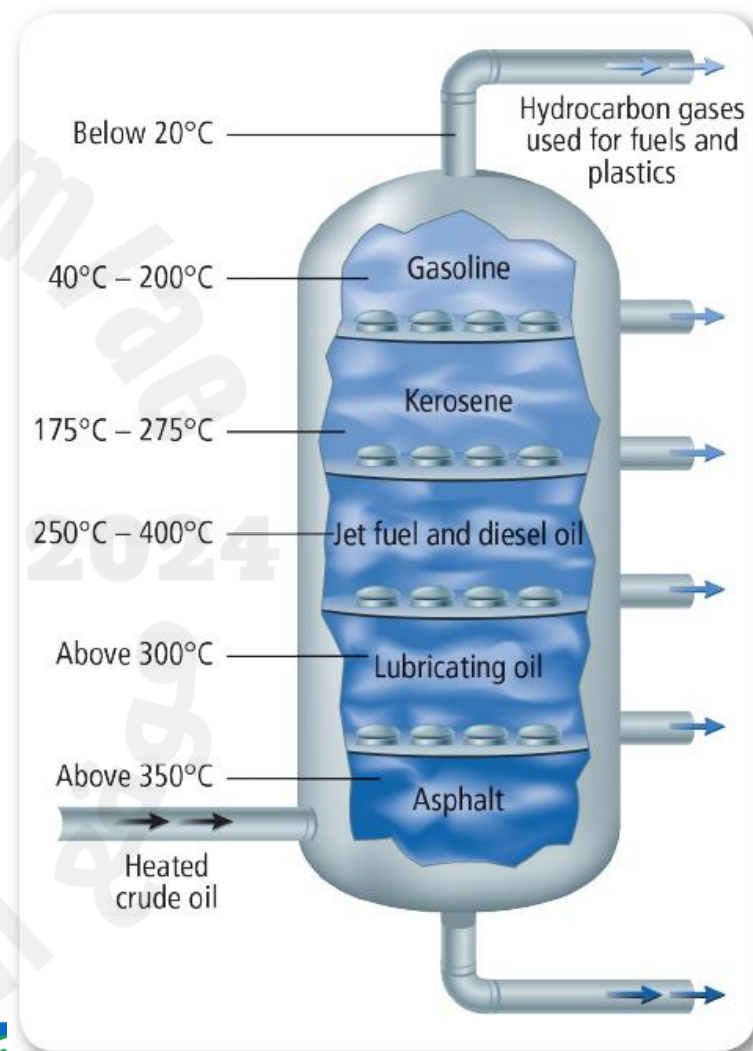
# Refining Hydrocarbons: Fractional distillation

- Unlike natural gas, petroleum is a complex mixture containing more than a thousand different compounds. For this reason, raw petroleum, sometimes called crude oil.
- Petroleum (crude oil) is separated into simpler components or fractions. Separation is carried out in a process called **fractional distillation**, also called fractionation, which involves boiling the petroleum and collecting components or fractions as they condense at different temperatures.



# Refining Hydrocarbons: Fractional distillation

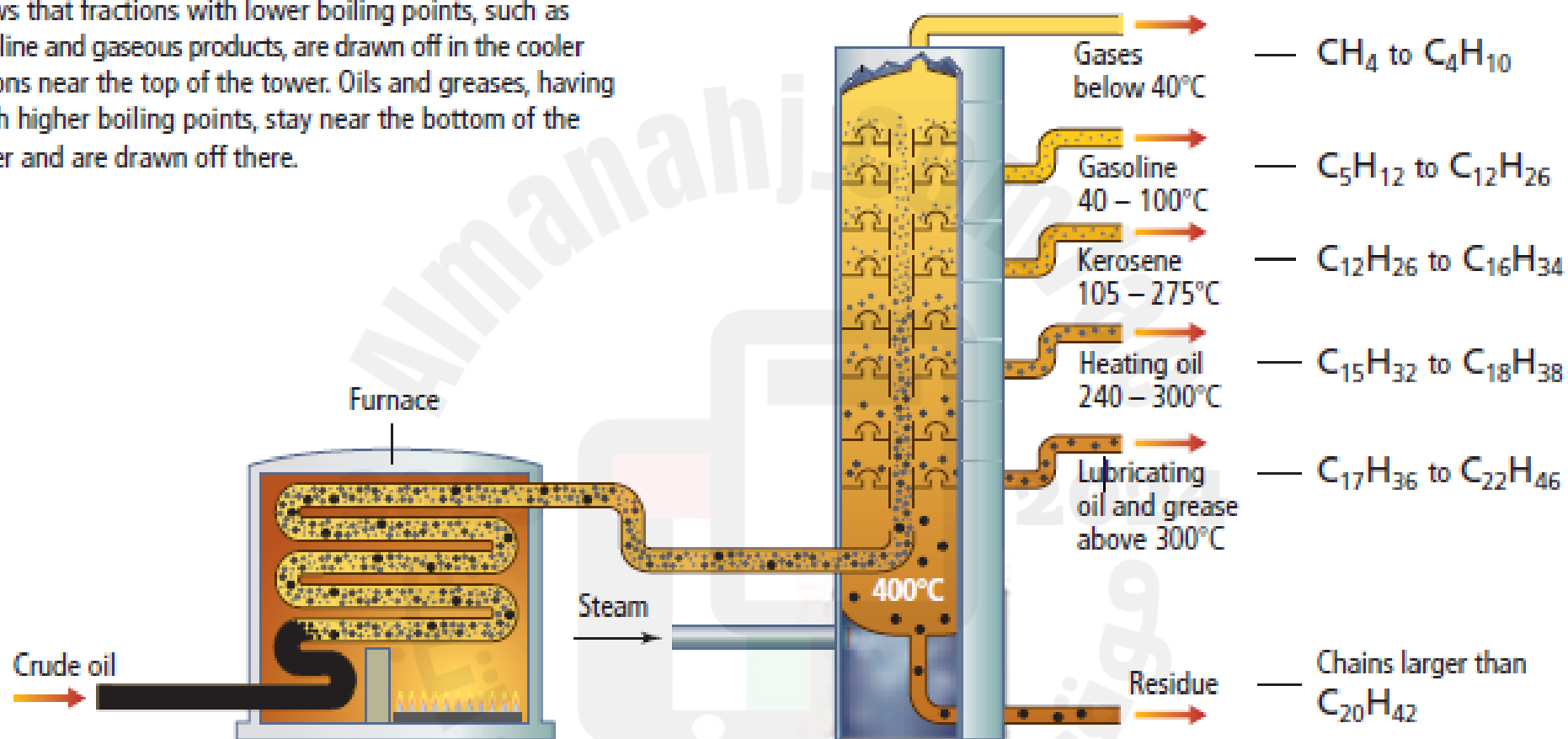
- Fractional distillation is done in a **fractionating tower** similar to the one shown in figure.
- The temperature inside the fractionating tower is controlled so that it remains near  $400^{\circ}\text{C}$  at the bottom, where the petroleum is boiling, and gradually decreases toward the top.
- The condensation temperatures (boiling points) generally decrease as molecular mass decreases. Therefore, as the vapors travel up through the column, the hydrocarbons condense and are drawn off, as shown in figure.





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■ **Figure** This diagram of a fractionating tower shows that fractions with lower boiling points, such as gasoline and gaseous products, are drawn off in the cooler regions near the top of the tower. Oils and greases, having much higher boiling points, stay near the bottom of the tower and are drawn off there.

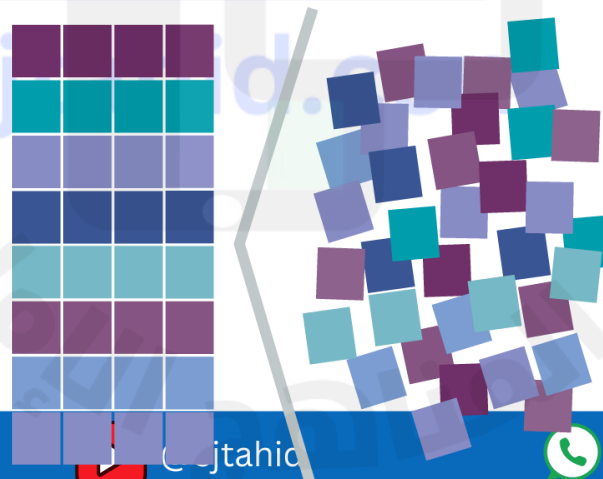


A furnace heats the crude oil to boiling, and the resulting gases travel to the tower.

The molecular mass of the hydrocarbon determines how high it rises in the tower.

# Refining Hydrocarbons: Fractional distillation

- Many years ago, petroleum chemists and engineers developed a process to help match the supply with the demand. This process in which heavier fractions are converted to gasoline by breaking their large molecules into smaller molecules is called **cracking**.
- **Cracking** is done in the **absence of oxygen** and in the **presence of a catalyst**.
- In addition to breaking heavier hydrocarbons into molecules of the size range needed for **gasoline**, cracking also produces starting materials for the synthesis of many different products, including **plastic products, films, and synthetic fabrics**.



# Refining Hydrocarbons: Rating gasoline

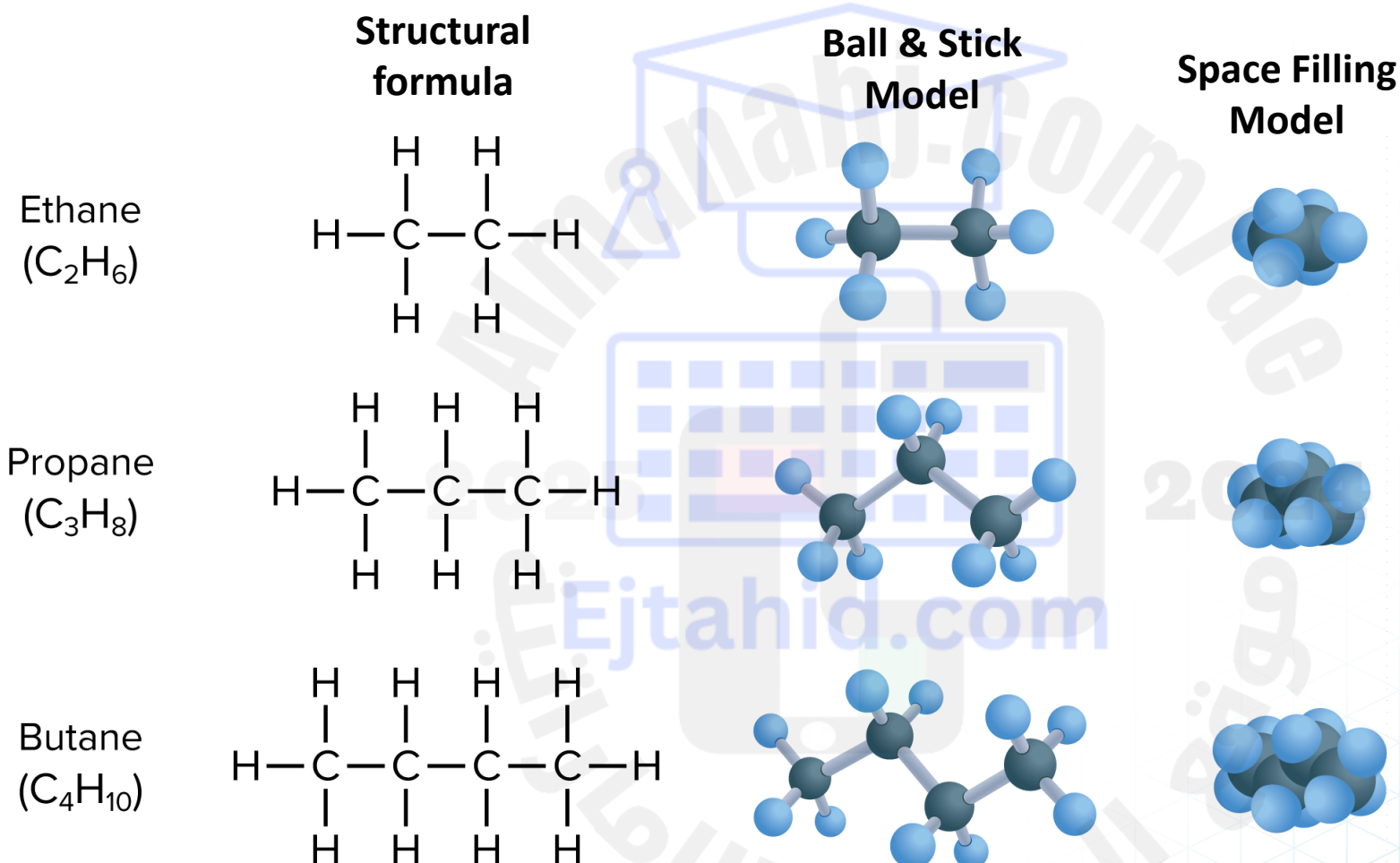
- The gasoline fraction that is distilled from petroleum is modified by adjusting its composition and adding substances to improve its performance in today's automobile engines and to reduce pollution from car exhaust.
- Most **straight-chain hydrocarbons** burn unevenly and tend to ignite from heat and pressure before the piston is in the proper position and the spark plug fires. This early ignition causes a rattling or pinging noise called knocking.
- In the late 1920s, an antiknock, or octane rating, system for gasoline was established, resulting in the octane ratings posted on gasoline pumps like those shown in the figure



- (4) Use IUPAC system to name aliphatic alkanes (straight chain, branched, non-substituted and substituted)
- (5) Use IUPAC system to name cycloalkanes (non-branched, branched, non-substituted and substituted)
- (6) Explain the physical properties of alkanes (polarity, solubility, and hydrogen bonding)

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**Alkanes** are hydrocarbons that have only single bonds between atoms.





The names of **alkanes** end in **-ane**.

Alkanes **with five or more carbons** in a chain have names that use a prefix derived from the Greek or Latin word for the number of carbons in each chain.

- Example: *pentane*

**Table 2 First Ten of the Alkane Series**

Name	Molecular Formula	Condensed Structural Formula
Methane	CH <sub>4</sub>	CH <sub>4</sub>
Ethane	C <sub>2</sub> H <sub>6</sub>	CH <sub>3</sub> CH <sub>3</sub>
Propane	C <sub>3</sub> H <sub>8</sub>	CH <sub>3</sub> CH <sub>2</sub> CH <sub>3</sub>
Butane	C <sub>4</sub> H <sub>10</sub>	CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>3</sub>
<u>Pentane</u>	C <sub>5</sub> H <sub>12</sub>	CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>3</sub>
<u>Hexane</u>	C <sub>6</sub> H <sub>14</sub>	CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>3</sub>
<u>Heptane</u>	C <sub>7</sub> H <sub>16</sub>	CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>3</sub>
<u>Octane</u>	C <sub>8</sub> H <sub>18</sub>	CH <sub>3</sub> (CH <sub>2</sub> ) <sub>6</sub> CH <sub>3</sub>
<u>Nonane</u>	C <sub>9</sub> H <sub>20</sub>	CH <sub>3</sub> (CH <sub>2</sub> ) <sub>7</sub> CH <sub>3</sub>
<u>Decane</u>	C <sub>10</sub> H <sub>22</sub>	CH <sub>3</sub> (CH <sub>2</sub> ) <sub>8</sub> CH <sub>3</sub>

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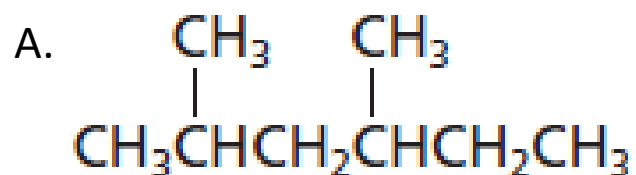
- A series of compounds that differ from one another by a repeating unit is called a **homologous series**.
- A homologous series has a fixed numerical relationship among the numbers of atoms. **For alkanes**, the **relationship between the numbers of carbon and hydrogen atoms can be expressed as  $C_nH_{2n+2}$** , where  **$n$**  is equal to the number of **carbon atoms** in the alkane.
- For example, heptane has **seven carbon** atoms, so its formula is  **$C_7H_{2(7)+2}$** , or  **$C_7H_{16}$** .

- Carbon atoms can bond to one, two, three, or four other carbon atoms, making a variety of branched-chain alkanes possible.
- A straight-chain and a branched-chain alkane can have the same molecular formula, **but their structural arrangements are different.**
- The **order and arrangement of atoms** in an organic molecule **determine its identity.**

# Your Turn!

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- Use the IUPAC rules to name the following structures.

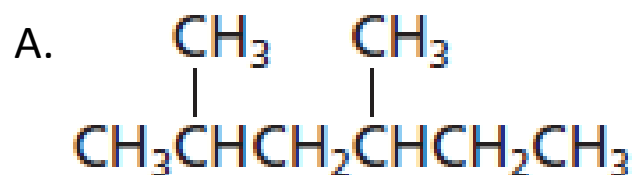


**2,4-dimethylhexane**

# Your Turn!

معاد عز Mouad Azz

- Use the IUPAC rules to name the following structures.



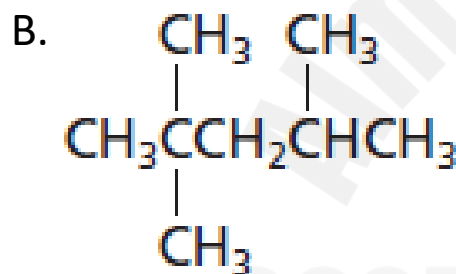
**2,4-dimethylhexane**



# Your Turn!

معاد عز Mouad Azz

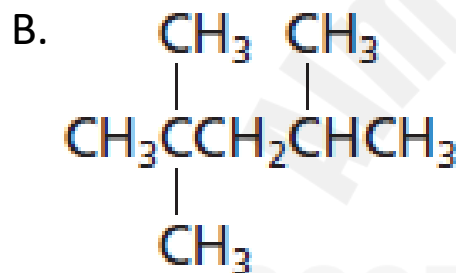
- Use the IUPAC rules to name the following structures.



# Your Turn!

معاد عز Mouad Azz

- Use the IUPAC rules to name the following structures.

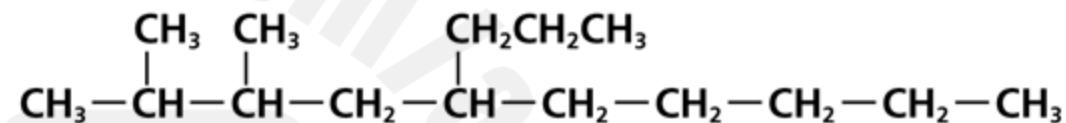


# Plenary Page 224

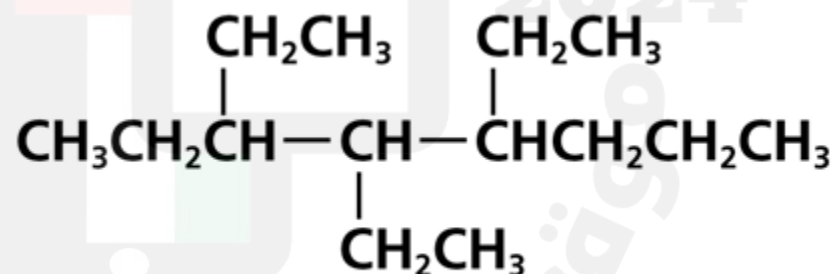
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Draw the structures of the following branched-chain alkanes.

- a. 2,3-dimethyl-5-propyldecane



- b. 3,4,5-triethyloctane

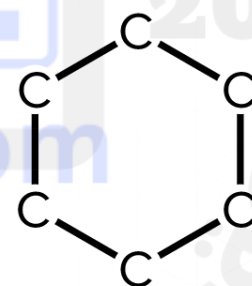
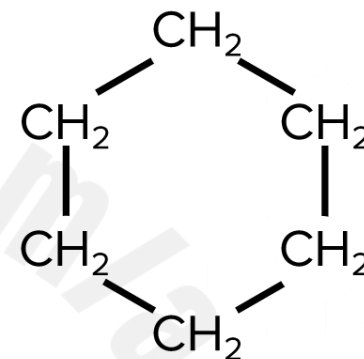


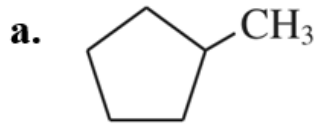
- An organic compound that contains a hydrocarbon ring is called a **cyclic hydrocarbon**. (Cyclic = ring-like structure)
- Cyclic hydrocarbons that contain **only single bonds** are called **cycloalkanes**. Example: cyclohexane
- The relationship between numbers of carbon and hydrogen atoms in cycloalkanes can be expressed as:  $C_nH_{2n}$

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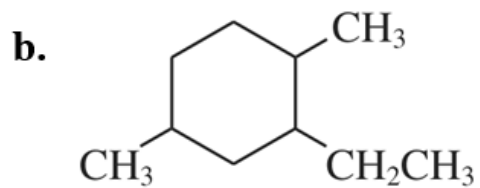
## Cycloalkanes

Cyclic hydrocarbons such as cyclohexane are represented by **condensed**, **skeletal**, and **line structures**.

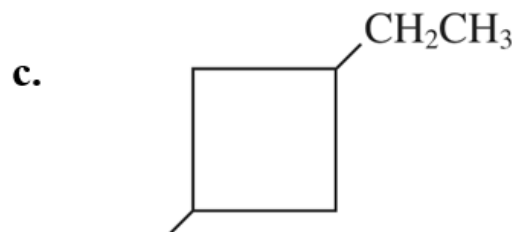




**methylcyclopentane**



**2-ethyl-1,4-dimethylcyclohexane**

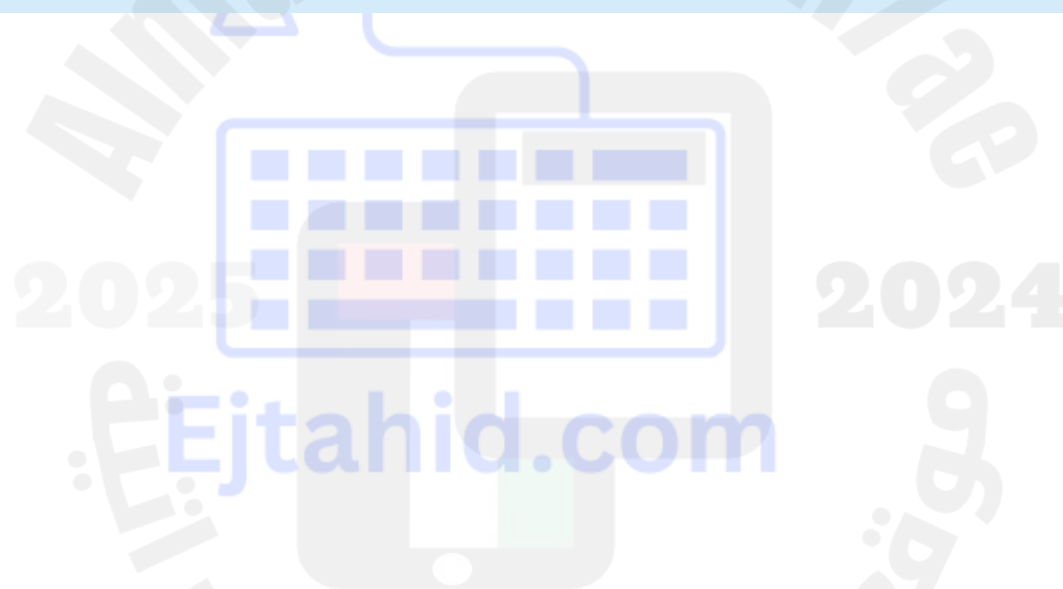


**1,3-diethylcyclobutane**



**11. CHALLENGE** Draw the structures of the following cycloalkanes.

- a. 1-ethyl-3-propylcyclopentane
- b. 1,2,2,4-tetramethylcyclohexane



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## Properties of Alkanes

- The structure of a molecule affects its properties.
- Alkanes are nonpolar. They have little intermolecular attraction and do not form hydrogen bonds like water.**
- As a result, **they boil and melt at lower temperatures than water.**
- Also, they are more soluble in solvents composed of nonpolar molecules than in water.

Table 4 Comparing Physical Properties		
Substance and formula	Water (H <sub>2</sub> O)	Methane (CH <sub>4</sub> )
Molecular mass	18 amu	16 amu
State at room temperature	liquid	gas
Boiling point	100°C	−162°C
Melting point	0°C	−182°C

# Properties of Alkanes: Chemical properties

- The main chemical property of alkanes is their **low reactivity**. Why?
- Molecules such as alkanes, in which atoms are connected by **nonpolar bonds**, have no charge. As a result, they have little attraction for ions or polar molecules.
- The low reactivity of alkanes can also be attributed to the **relatively strong C–C and C–H bonds**.



■ **Figure 21.11** Many solvents—used as thinners for paints, coatings, waxes, photocopier toners, adhesives, and printer press inks—contain alkanes and cycloalkanes.

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- (7) Distinguish between alkanes, alkenes, and alkynes in terms of the number of bonds, general formula, number of carbon atoms, number of hydrogen atoms, and examples of each.
- (8) Write molecular formulas for examples of alkanes, alkenes, and alkynes using general formulas.
- (9) Use IUPAC system to name alkenes (straight chain, branched, non-substituted and substituted).
- (10) Draw the structure of an alkyne given its IUPAC name

# Alkenes

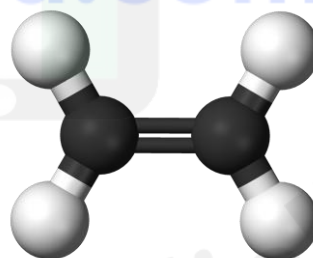
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- Alkenes are hydrocarbons that contain **at least one double bond**.

Because an alkene must have a double bond between carbon atoms, **there is no 1-carbon alkene.**

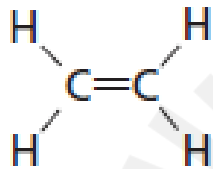
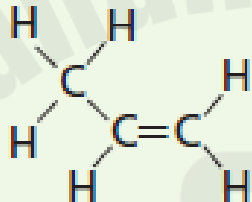
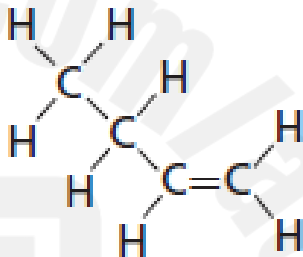
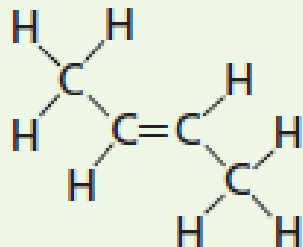
The simplest alkene has two carbon atoms double bonded to each other.

The remaining four electrons—two from each carbon atom—are shared with four hydrogen atoms to give the molecule ethene ( $C_2H_4$ ).



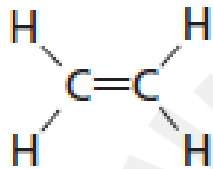
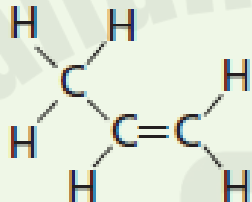
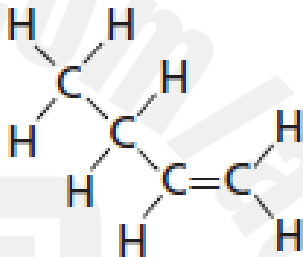
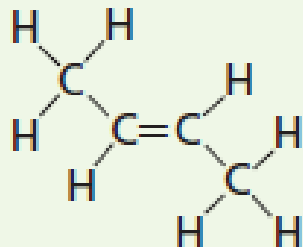
The smallest Alkene  
"Ethene"



Name	Ethene	Propene	1-Butene	2-Butene
Molecular formula	$C_2H_4$	$C_3H_6$	$C_4H_8$	$C_4H_8$
Structural formula				
Condensed structural formula	$CH_2=CH_2$	$CH_3CH=CH_2$	$CH_3CH_2CH=CH_2$	$CH_3CH=CHCH_3$

From the table, deduce the general formula of an alkene with only one double bond.

## معاد عز Mouad Azz

Name	Ethene	Propene	1-Butene	2-Butene
Molecular formula	$C_2H_4$	$C_3H_6$	$C_4H_8$	$C_4H_8$
Structural formula				
Condensed structural formula	$CH_2=CH_2$	$CH_3CH=CH_2$	$CH_3CH_2CH=CH_2$	$CH_3CH=CHCH_3$

You can conclude from the table; you will see that each molecular formulas for the substances shown in the table, has twice as many hydrogen atoms as carbon atoms,

The general formula for the series is  $C_nH_{2n}$ . **This formula is true for alkenes with only one double bond.**

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## Alkenes

- Unsaturated hydrocarbons that contain one or more double covalent bonds between carbon atoms in a chain are called **alkenes**.
- **For alkenes with only one double bond**, the relationship between the numbers of carbon and hydrogen atoms can be expressed as:  $C_nH_{2n}$

# Activity

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The general formula for non-cyclic (Straight chain) alkenes is



# Activity

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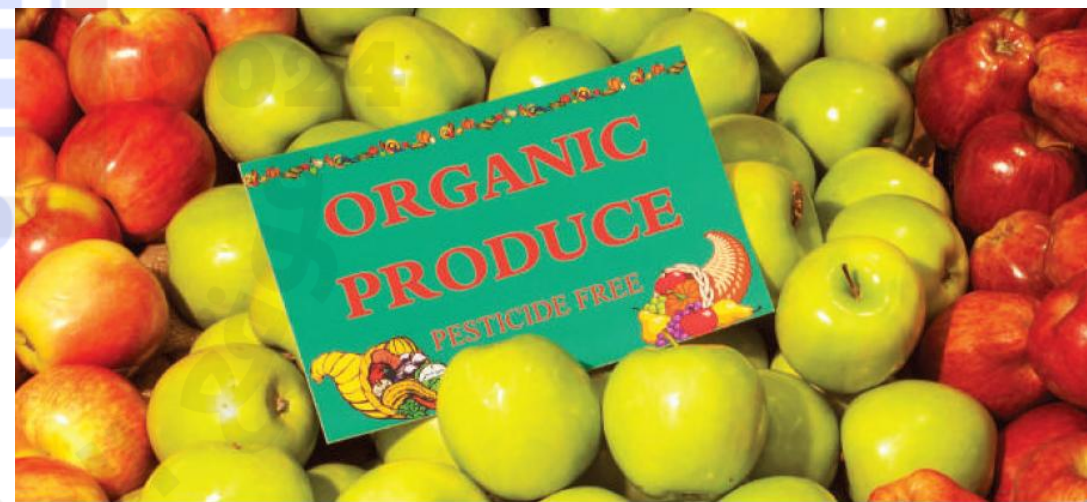
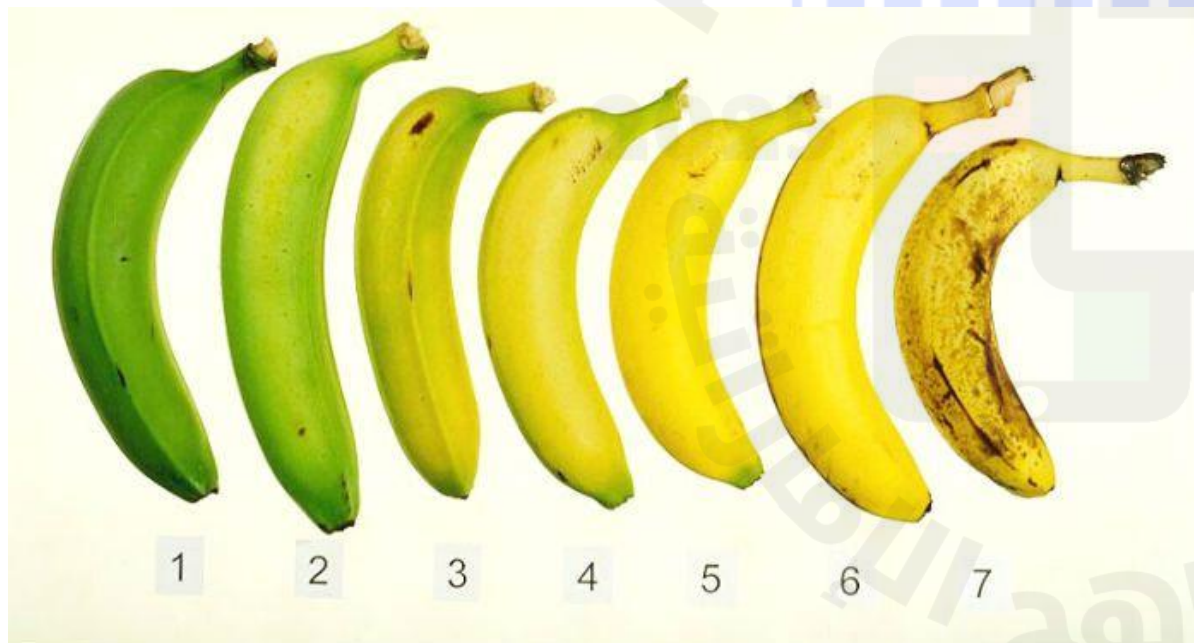
The formula  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}=\text{CH}_2$  represents an

- a. alkane.
- b. alkyne.
- c. alcohol.
- ☒ d. alkene.

# Uses of alkenes

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- Several alkenes occur naturally in living organisms. For example, **ethene is a hormone** produced naturally by plants. It causes fruit to ripen and plays a part in causing **leaves to fall** from deciduous trees in **preparation for winter**.
- The fruits in grocery stores **ripen artificially** when they are exposed to **ethene**.





# Uses of alkenes

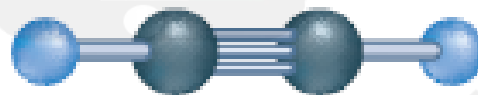
معاد عز Mouad Azz

- **Ethene** is also the starting material for the synthesis of the **plastic polyethylene**, which is used to manufacture many products, including plastic bags, rope, and milk jugs.
- Other alkenes are responsible for the scents of lemons, limes, and pine trees.



# Alkyne

- **Alkynes** are **Unsaturated hydrocarbons** that contain at least one **triple bond**.
- The simplest and most used alkyne is **ethyne** (  $\text{C}_2\text{H}_2$  ), which is widely known by its **common name acetylene**.



Models of ethyne (acetylene)

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# Examples of Alkynes

Name	Molecular Formula	Structural Formula	Condensed Structural Formula
Ethyne	$C_2H_2$	$H-C \equiv C-H$	$CH \equiv CH$
Propyne	$C_3H_4$	$  \begin{array}{c}  H \\    \\  H-C \equiv C-C-H \\    \\  H  \end{array}  $	$CH \equiv CCH_3$
1-Butyne	$C_4H_6$	$  \begin{array}{c}  H \quad H \\    \quad   \\  H-C \equiv C-C-C-H \\    \quad   \\  H \quad H  \end{array}  $	$CH \equiv CCH_2CH_3$
2-Butyne	$C_4H_6$	$  \begin{array}{c}  H \quad H \\    \quad   \\  H-C-C \equiv C-C-H \\    \quad   \\  H \quad H  \end{array}  $	$CH_3C \equiv CCH_3$

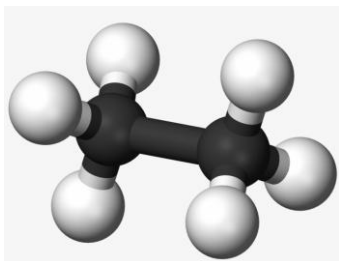
# Check

معاد عز Mouad Azz

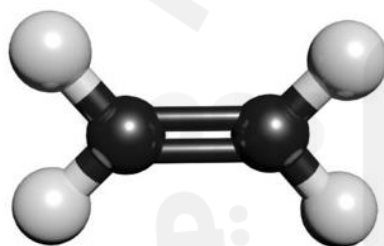
- What is the name of the alkyne with the formula  $C_2H_2$ ?
  - a. ethane
  - b. ethene
  - c. ethyne
  - d. ethylene

# Naming Alkenes (with 2 or 3 carbons)

- Alkenes are named in much the same way as alkanes.
- Their names are formed by changing the *-ane* ending of the corresponding alkane to *-ene*.

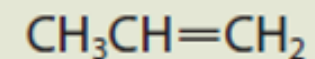
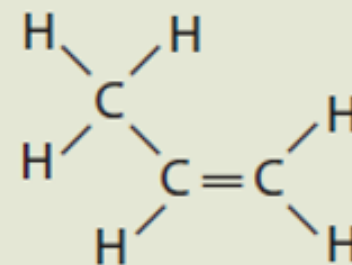


Alkane: Ethane  $C_2H_6$



Alkene: Ethene  $C_2H_4$

Propene



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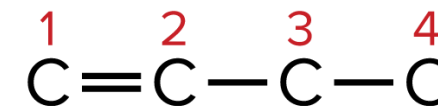


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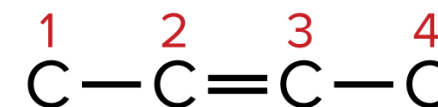


## Naming Alkenes (with 4 or more carbons)

- To name alkenes with four or more carbons in the chain, it is necessary to specify the location of the double bond, fig. 21.12.
- This is done by **numbering the carbons in the parent chain**, starting at the end of the chain that **will give the first carbon in the double bond the lowest number**. Then, use only that number in the name.



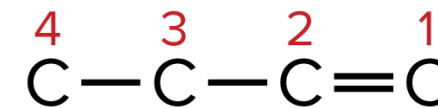
1-Butene



2-Butene



3-Butene

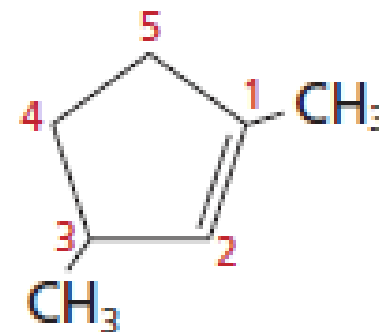


1-Butene

a. Straight-chain alkenes

# Naming Alkenes (Cyclic Alkenes)

- Cyclic alkenes or cycloalkenes** are named in much the same way as cyclic alkanes; however, **carbon number 1 must be one of the carbons connected by the double bond**. In the figure, note the numbering in the compound.



b. Cyclic alkenes

- The name of this compound is **1,3-dimethylcyclopentene**.

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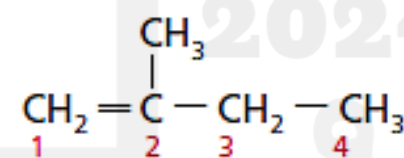


# Naming branched-chain alkenes

When naming branched chain alkenes, follow the IUPAC rules for naming branched-chain alkanes, but with two exceptions:

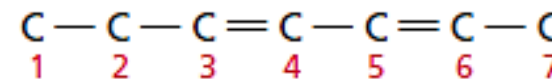
1. First, in alkenes, **the parent chain is always the longest chain that contains the double bond**, whether or not it is the longest chain of carbon atoms.
2. Second, **the position of the double bond**, not the branches, determines how the chain is numbered.

The positions of the double bonds in alkenes are numbered in a way that gives the **lowest set of numbers**. This is true of both branched and straight chain alkenes.

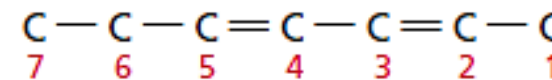


2-methylbutene

a. Single double bond



or



2,4-heptadiene

b. Two double bonds

# Naming branched-chain alkenes

- For alkenes with **more than one double bond**, you must indicate the position of the double bond(s) using a prefix (***di-***, ***tri-***, etc.) before the suffix *-ene*.

Example: 2,4-heptadiene

- The positions of the bonds are numbered to give the lowest set of numbers.



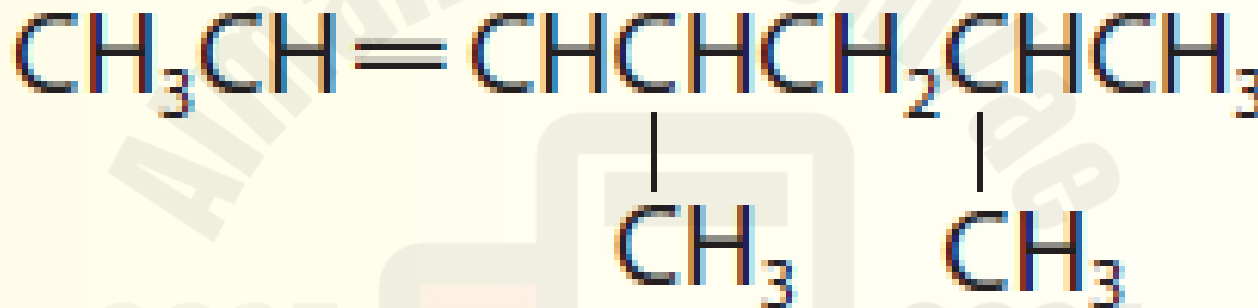
## NAMING BRANCHED-CHAIN ALKENES (Page 231)

### IN-CLASS EXAMPLE

Use with Example Problem 3.

#### **Problem**

Name the alkene shown.



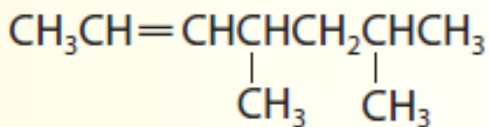
## NAMING BRANCHED-CHAIN ALKENES (Page 231)

### IN-CLASS EXAMPLE

*Use with Example Problem 3.*

#### Problem

Name the alkene shown.



#### Response

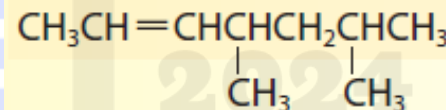
##### ANALYZE THE PROBLEM

You are given a branched-chain alkene that contains one double bond and two alkyl groups. Follow the IUPAC rules to name the organic compound.

##### SOLVE FOR THE UNKNOWN

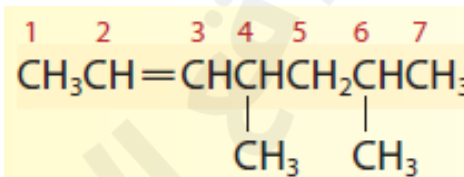
**Step 1.** The longest continuous-carbon chain that includes the double bond contains seven carbons. The 7-carbon alkane is heptane, but the name is changed to heptene because a double bond is present.

- Heptene parent chain



**Step 2.** Number the chain to give the lowest number to the double bond.

- 2-heptene parent chain

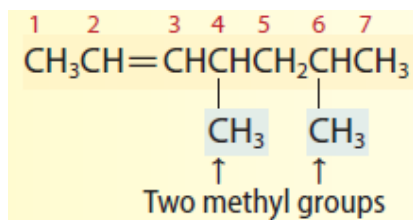


## NAMING BRANCHED-CHAIN ALKENES

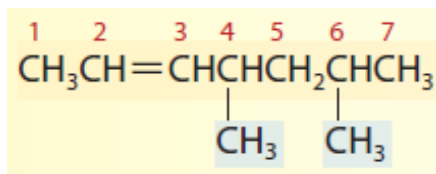
## IN-CLASS EXAMPLE

**Step 3.** Name each substituent.

- Each substituent is a methyl group.

**Step 4.** Determine how many of each substituent is present, and assign the correct prefix to represent that number. Then, include the position numbers to get the complete prefix.

- 2-heptene parent chain
- Two methyl groups at Positions 4 and 6
- Prefix is 4,6-dimethyl

**Step 5.** The names of substituents do not have to be alphabetized because they are the same. Apply the complete prefix to the name of the parent alkene chain. Use commas between numbers, and hyphens between numbers and words. Write the name 4,6-dimethyl-2-heptene.

## EVALUATE THE ANSWER

The longest carbon chain includes the double bond, and the position of the double bond has the lowest possible number.

Correct prefixes and alkyl group names designate the branches.

# Check

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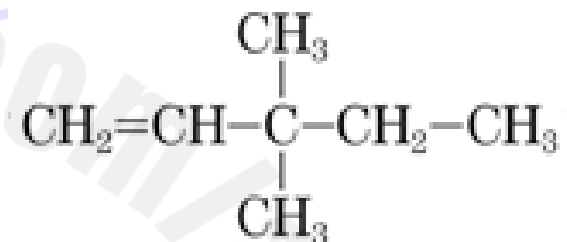
Name the alkene with the formula  $\text{CH}_3\text{CHCH}_2$ .

- a. ethene
- b. cyclopropene
- ☒ c. 1-propene
- d. 2-propene

# Check

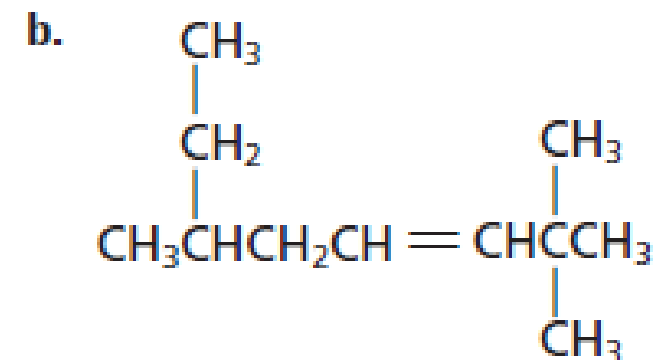
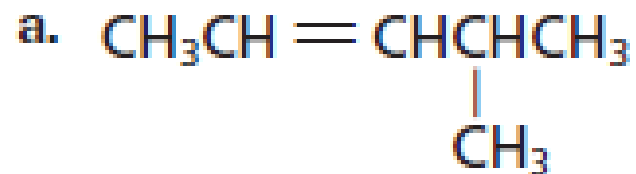
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What is the correct IUPAC name for



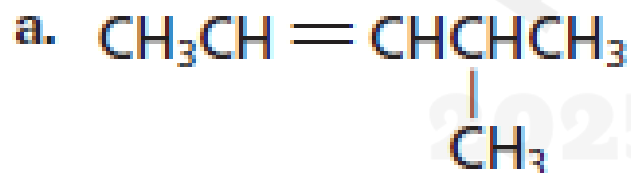
- a. 1-pentene
- b. 4-pentene
- ☒ c. 3,3-dimethyl-1-pentene
- d. 3,3-dimethyl-4-pentene

Use the IUPAC rules to name the following structures.



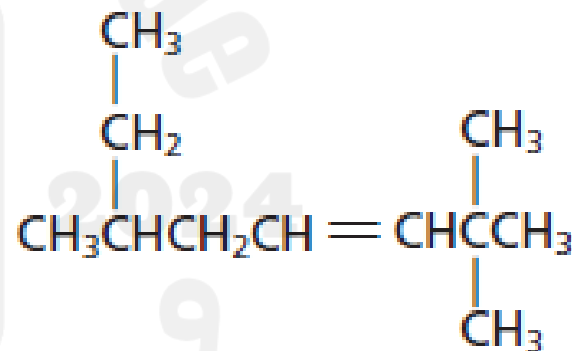
# Practice Problems Page 232

Use the IUPAC rules to name the following structures.



4-methyl-2-pentene

b.

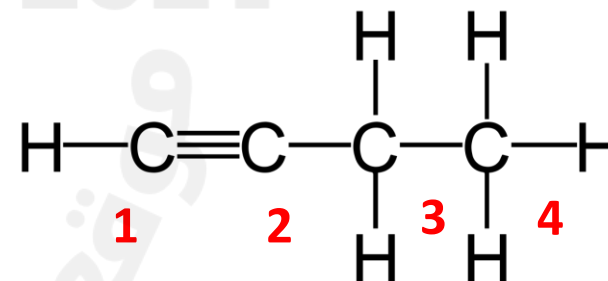
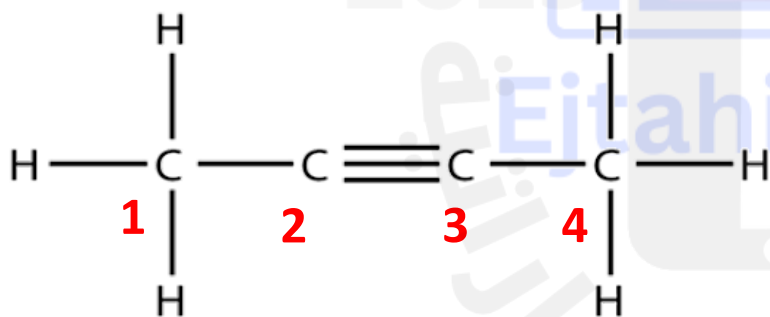


2,2,6-trimethyl-3-octene



# Naming alkynes

- Straight-chain alkynes and branched-chain alkynes are named in the same way as alkenes. The only difference is that the name of the parent chain ends in **-yne** rather than **-ene**.
- Alkynes with **one triple covalent bond** form a homologous series with the general formula  $C_nH_{2n-2}$ .



# Check

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- What is the name of the alkyne with the formula  $C_2H_2$ ?
  - a. ethane
  - b. ethene
  - c. ethyne
  - d. ethylene

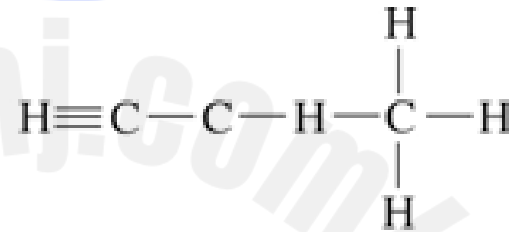
# Check

معاد عز Mouad Azz

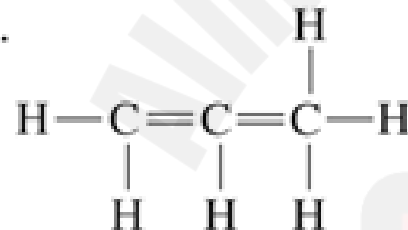
A.



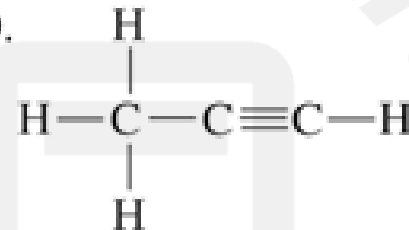
B.



C.



D.



Which of the figures above is the structural formula for **propyne**?

A

B

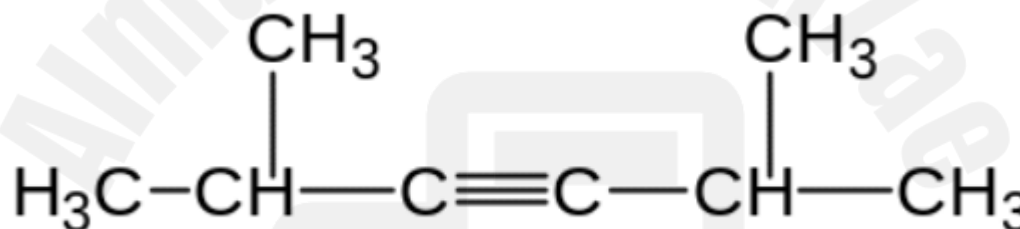
C

D

# Check





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- What is the name of this hydrocarbon?



**2,5-dimethyl-3-hexyne**


Why are simple **alkynes like ethyne** often used as a starting material for manufacturing plastics?


-  Alkynes are never used in manufacturing.
-  They have properties that are very different from alkenes, which cannot be used.
-  They are insoluble in nonpolar compounds.
-  D Their triple bond makes them highly reactive. CORRECT


1. Which of the following is NOT true of alkenes?


- ☒ A They are saturated. **CORRECT**
- ☐ They have at least one double bond.
- ☐ They can have a cyclic structure.
- ☐ There are no one-carbon alkenes.

2. Which of the following is a correctly named alkene?

 1,3-butane

 1,3-butene

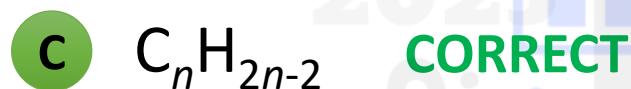
 3-butene


 D 1-butene

CORRECT



4. Identify the relationship between the number of carbon and hydrogen atoms in alkynes with one triple bond?



 There no relationship between the number of carbon and hydrogen atoms.

## Check Your Progress

## Summary

- Alkenes and alkynes are hydrocarbons that contain at least one double or triple bond, respectively.
- Alkenes and alkynes are nonpolar compounds with greater reactivity than alkanes but with other properties similar to those of alkanes.

## Demonstrate Understanding

- Describe** how the molecular structures of alkenes and alkynes differ from the structure of alkanes.
- Identify** how the chemical properties of alkenes and alkynes differ from those of alkanes.
- Name** the structures shown using IUPAC rules.
  - $$\begin{array}{c} \text{CH}_3 \\ | \\ \text{CH} \equiv \text{CCH}_2 \end{array}$$
  - $$\begin{array}{c} \text{CH}_3 \\ | \\ \text{CH}_3\text{CH}_2\text{CHCH}=\text{CHCH}_2\text{CH}_3 \end{array}$$
- Draw** the molecular structure of 4-methyl-1,3-pentadiene and 2,3-dimethyl-2-butene.
- Infer** how the boiling and freezing points of alkynes compare with those of alkanes with the same number of carbon atoms. Explain your reasoning, then research data to see if it supports your idea.
- Predict** What geometric arrangements would you expect from the bonds surrounding the carbon atom in alkanes, alkenes, and alkynes? (*Hint: VSEPR theory can be used to predict the shape.*)

19. **Describe** how the molecular structures of alkenes and alkynes differ from the structure of alkanes.

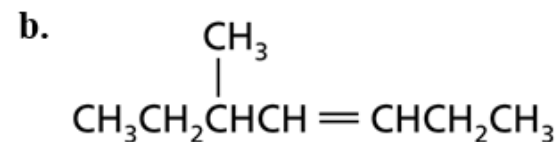
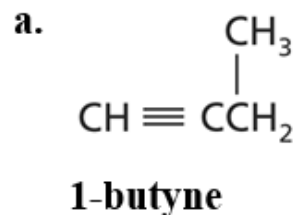
**Alkanes have single bonds in their structure.**

**Alkenes have at least one double bond in their structure. Alkynes have at least one triple bond in their structure.**

20. **Identify** how the chemical properties of alkenes and alkynes differ from those of alkanes.

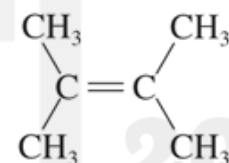
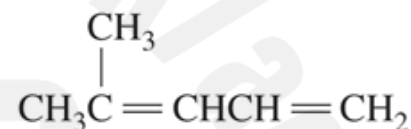
**Alkenes and alkynes are much more reactive than alkanes. This is because they have regions of concentrated electron density that attract reactants of opposite charge.**

21. **Name** the structures shown using IUPAC rules.



**5-methyl-3-heptene**

22. **Draw** the molecular structures of 4-methyl-1,3-pentadiene and 2,3-dimethyl-2-butene.



23. **Infer** how the boiling and freezing points of alkynes compare with those of alkanes with the same number of carbon atoms. Explain your reasoning, then look up data to see if it supports your idea.

**Because alkynes are slightly more polar, they generally have higher melting and boiling points than alkanes. Data support this hypothesis.**

**24. Predict** What geometric arrangement would you expect from the bonds surrounding the carbon atoms in alkanes, alkenes, and alkynes? *Hint: VSEPR theory can be used to predict the shape.*

**VSEPR theory predicts the following geometric bond arrangements. alkane: tetrahedral shape; alkene: trigonal planar shape; alkyne: linear shape**

**(11)** Write possible structural isomers of alkanes, alkenes and alkynes.

**(12)** Describe the difference between cis- and trans-isomers in terms of geometrical arrangements.

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# Introduction

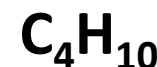
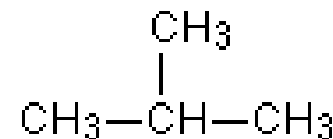
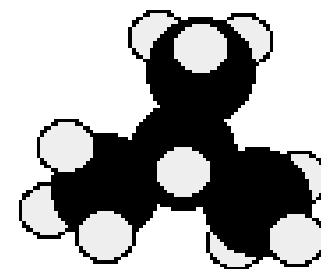
## • Hydrocarbon Isomers:

- Some hydrocarbons have the same molecular formula but have different molecular structures.

Have you ever met a **pair of identical twins**?

Identical twins have the same genetic makeup, yet they are two separate individuals with different personalities.

**Isomers** are similar to twins—they have the same molecular formula, but different molecular structures and properties.





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## Structural Isomers

- **Isomers** are two or more compounds that have the same molecular formula but different molecular structures.
- There are two main classes of isomers:
  - **structural isomers**
  - **Stereoisomers**
    - **Geometric Isomers**
    - **Optical Isomers**




1. What is the name of two or more compounds with the same molecular formulas but different molecular structures?

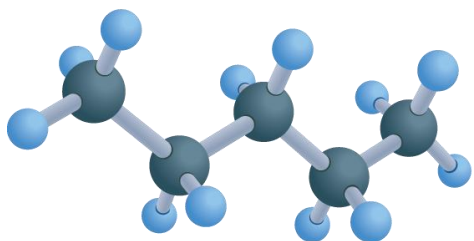
 telomeres

 chiral molecules

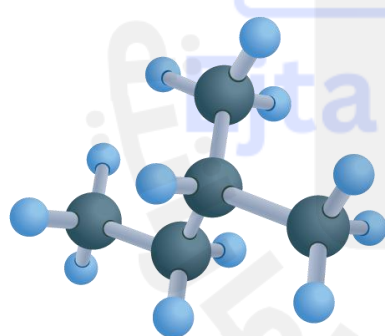
 isomers **CORRECT**

 Compounds with the same molecular formulas never have different molecular structures.

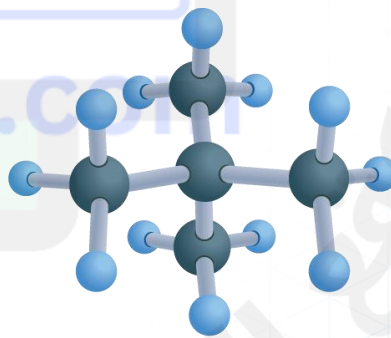
- **Structural isomers** have the same chemical formula, but their atoms are bonded in different arrangements.
- Structural isomers have different chemical and physical properties.
- The structure of a substance determines its properties.

**Pentane**

bp = 36°C

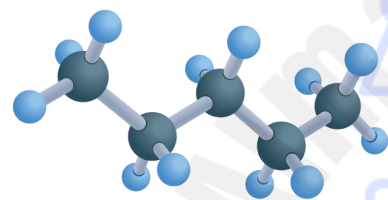
**2-Methylbutane**

bp = 28°C

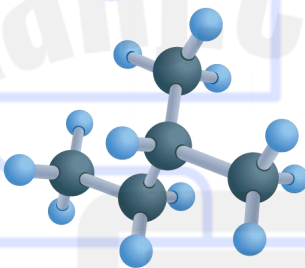
**2,2-Dimethylpropane**

bp = 9°C

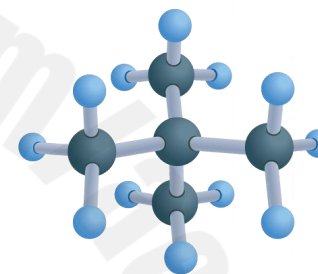
2. What is the best name for the molecules shown below?



**Pentane**  
bp = 36°C



**2-Methylbutane**  
bp = 28°C



**2,2-Dimethylpropane**  
bp = 9°C

1

isomers

3

stereoisomers

2

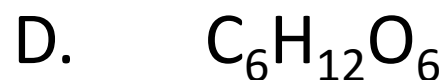
Structural isomers

4

geometric isomers

# Check

- Which of the following compounds cannot have different structural isomers?





## Pentane

**Figure 17** These compounds with the same molecular formula,  $C_5H_{12}$ , are structural isomers. Note how their boiling points differ.



Pentane  
bp =  $36^{\circ}\text{C}$



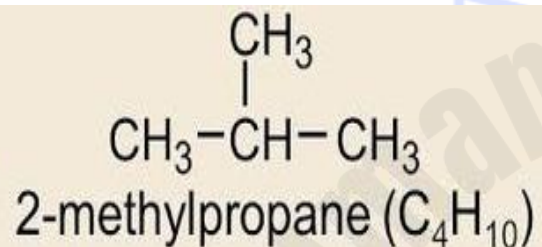
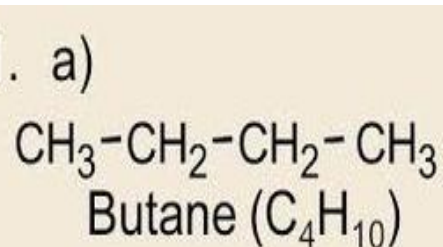
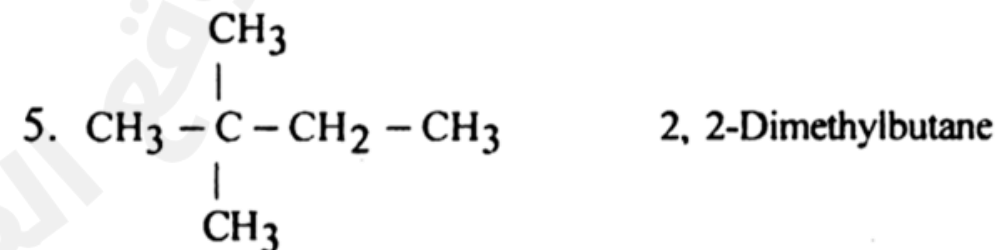
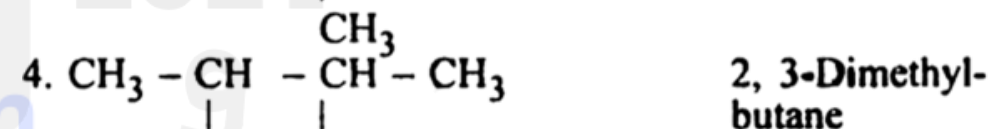
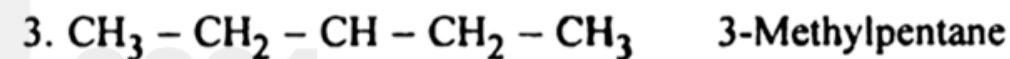
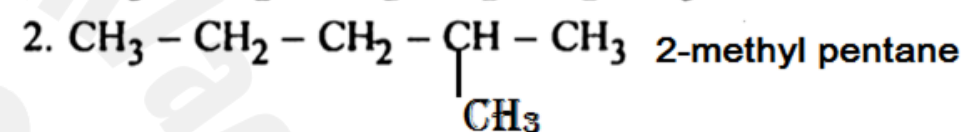
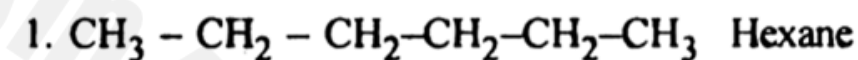
2-Methylbutane  
bp =  $28^{\circ}\text{C}$



2,2-Dimethylpropane  
bp =  $9^{\circ}\text{C}$

**Butane**

1. a)

**Formulae****IUPAC names****Pentane**

■ **Figure 17** These compounds with the same molecular formula,  $\text{C}_5\text{H}_{12}$ , are structural isomers. Note how their boiling points differ.



Pentane  
bp =  $36^\circ\text{C}$



2-Methylbutane  
bp =  $28^\circ\text{C}$

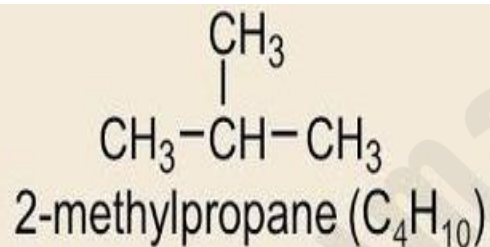
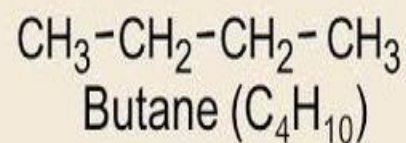


2,2-Dimethylpropane  
bp =  $9^\circ\text{C}$



**Butane**

1. a)

**Pentane**

■ **Figure 17** These compounds with the same molecular formula,  $\text{C}_5\text{H}_{12}$ , are structural isomers. Note how their boiling points differ.



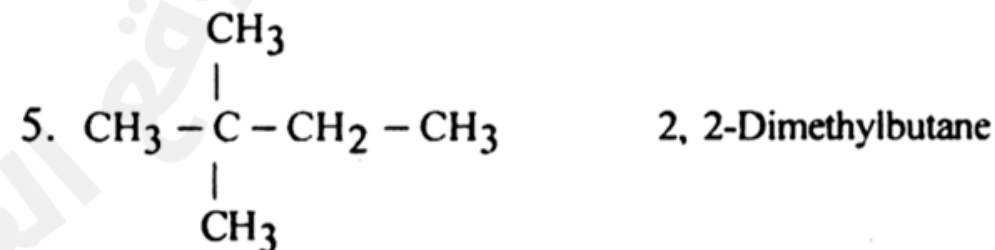
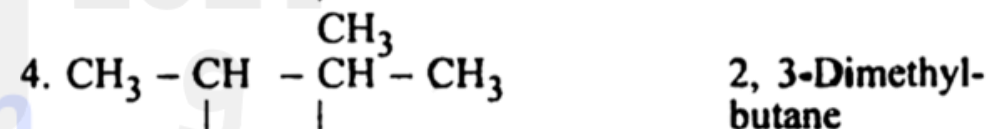
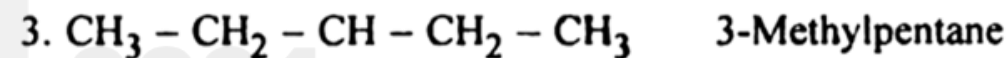
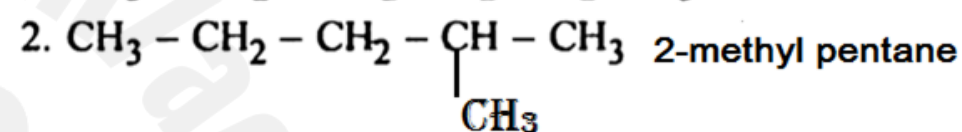
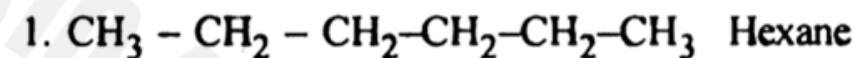
Pentane  
bp =  $36^\circ\text{C}$



2-Methylbutane  
bp =  $28^\circ\text{C}$



2,2-Dimethylpropane  
bp =  $9^\circ\text{C}$

**Formulae****IUPAC names**

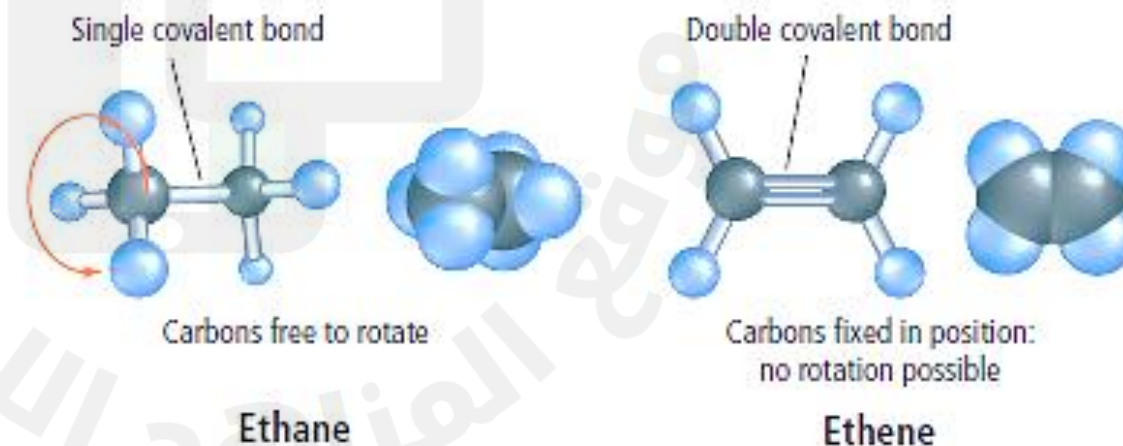
# Stereoisomers

معاد عز Mouad Azz

- are isomers in which all atoms are bonded in the same order **but are arranged differently in space.**
- There are two types of stereoisomers:
  - **Geometric isomers.**
  - Optical Isomers: “Chirality”, mirror images (right- and left-handed form).

The **single-bonded carbons** in ethane are free to rotate around the bond.

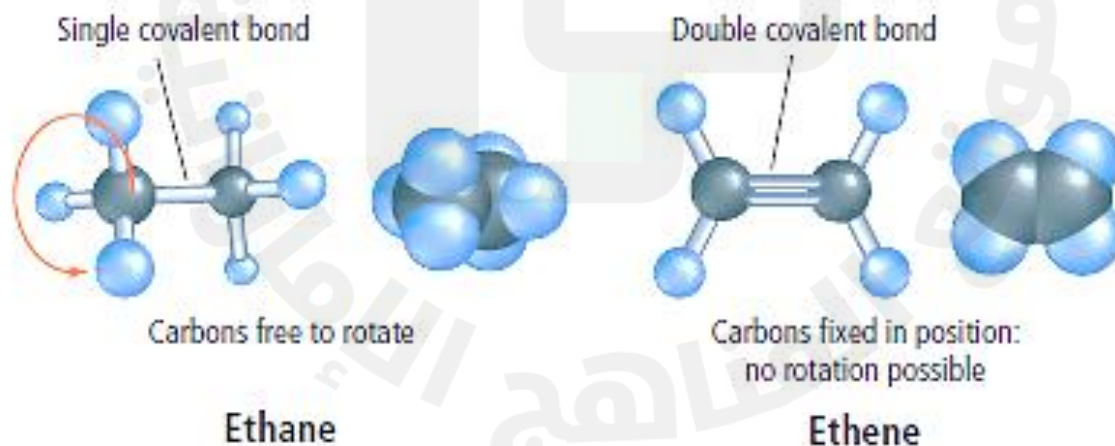
The **double-bonded carbons** in ethene resist being rotated.





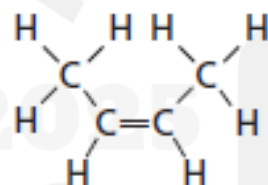
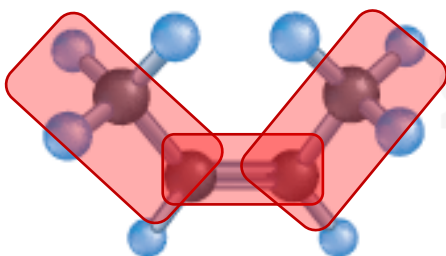
# Stereoisomers

- here are two types of stereoisomers:
- One type occurs in **alkenes**, which contain **double bonds**. Two carbon atoms with a single bond between them can rotate freely in relationship to each other.
- However, when a second covalent bond (**double bond**) is present, the carbons can no longer rotate; they are locked in place.



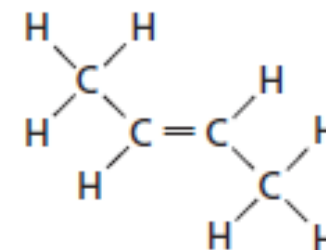
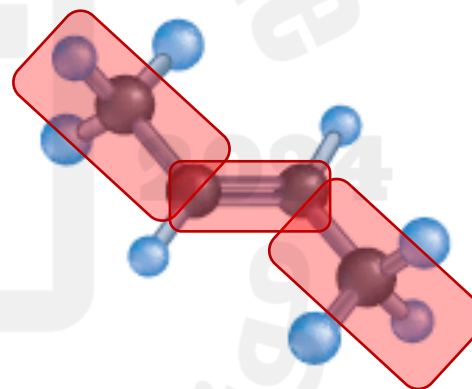
# Geometric isomers

Isomers resulting from different arrangements of groups around a double bond are called **geometric isomers**.



*cis*-2-Butene (C<sub>4</sub>H<sub>8</sub>)  
mp = -139°C  
bp = 3.7°C

*cis*-



*trans*-2-Butene (C<sub>4</sub>H<sub>8</sub>)  
mp = -106°C  
bp = 0.8°C

*trans*-

3. Which term that means *across from* is used to describe and name stereoisomers?

A trans

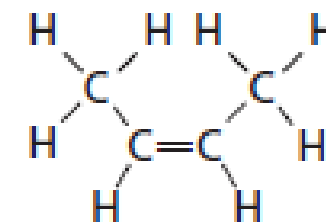
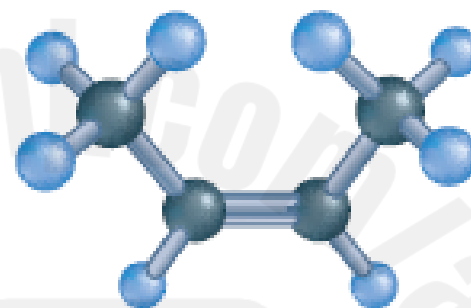
C levo

B levo

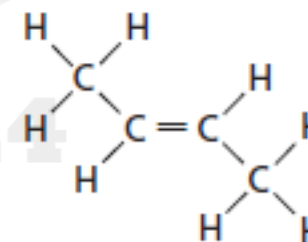
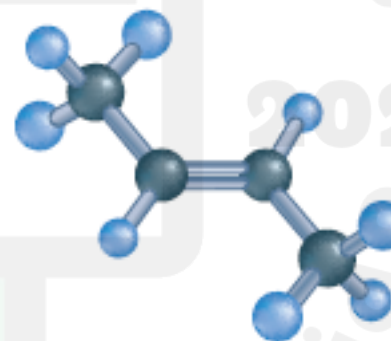
D cis

Isomers resulting from different arrangements of groups around a double bond are called **geometric isomers**.

- **Cis** means the branches are on the same side, of the double bond
- **trans** means the branches are across from each other.



*cis*-2-Butene ( $C_4H_8$ )



*trans*-2-Butene ( $C_4H_8$ )  
mp =  $-106^\circ\text{C}$   
bp =  $0.8^\circ\text{C}$

Geometric isomers have different physical and chemical properties.

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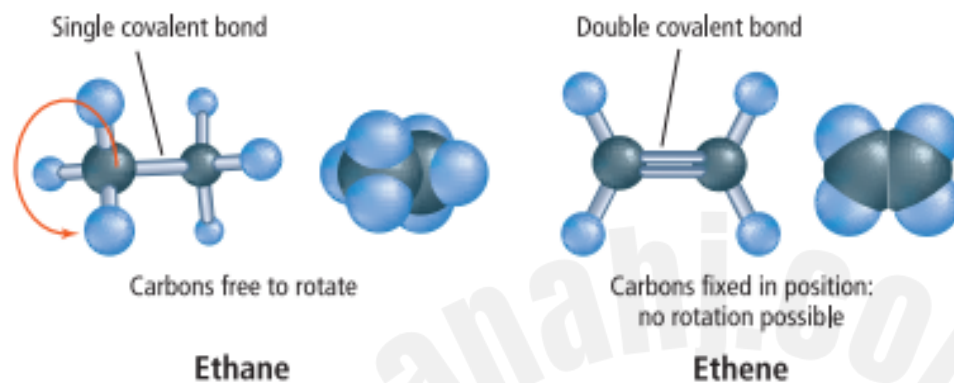
## Stereoisomers





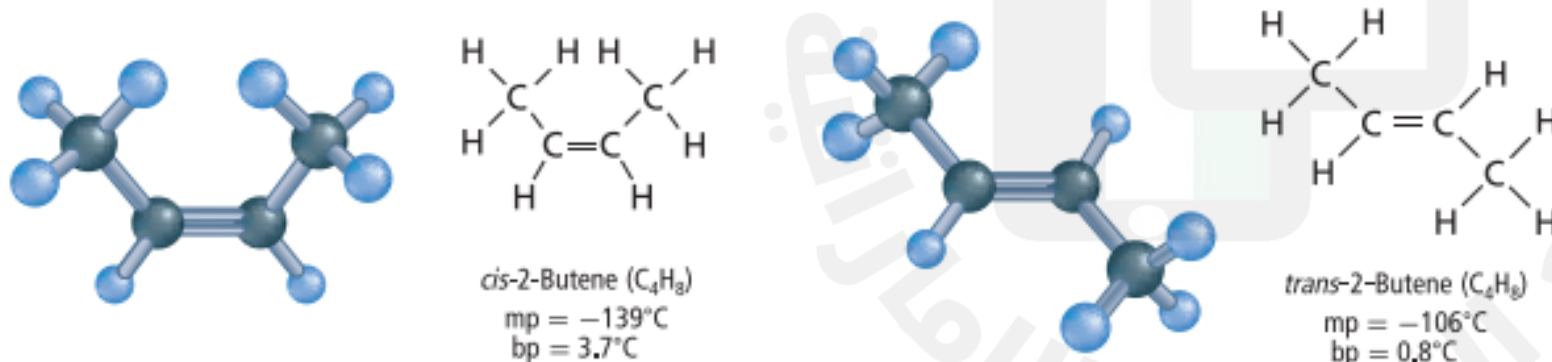
■ **Figure 18** The single-bonded carbons in ethane are free to rotate around the bond. The double-bonded carbons in ethene resist being rotated.

**Explain** How do you think this difference in ability to rotate would affect atoms or groups of atoms bonded to single-bonded and double-bonded carbon atoms?



Double bonded compounds only  
show geometric isomerism

■ **Figure 19** These isomers of 2-butene differ in the arrangement in space of the two methyl groups at the ends. The double-bonded carbon atoms cannot rotate with respect to each other, so the methyl groups are fixed in one of these two arrangements.





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# **Chemistry EOT3 12 Advanced-C 2024-2025**

**Part 2  
(Q4 to 10)  
Q(13 to 25)**



12-C

EOT3| Chemistry| 12Adv| Plan-C



Mouad Azz

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**Chemistry EOT3**  
**12 Advanced-C**  
**2024-2025**  
**Part 2(Q13-Q25)**

By: Mr Mouad Azz معاذ عز





(13) Use IUPAC system to name the aromatic compounds.

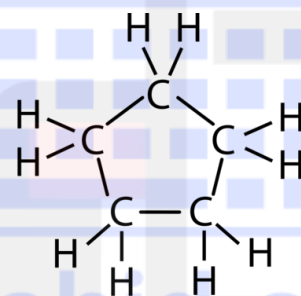
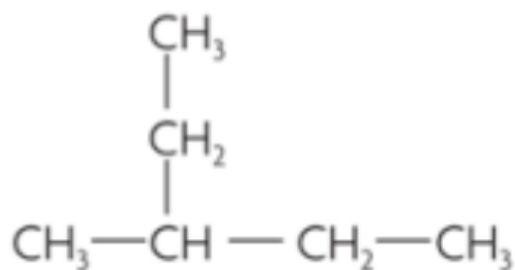
معاد عز Mouad Azz

Match each keyword with its proper structure below

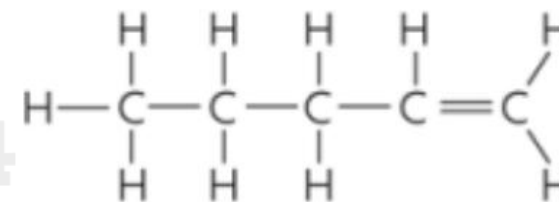
Ring/cyclic structure

Straight-chain

Branched chain

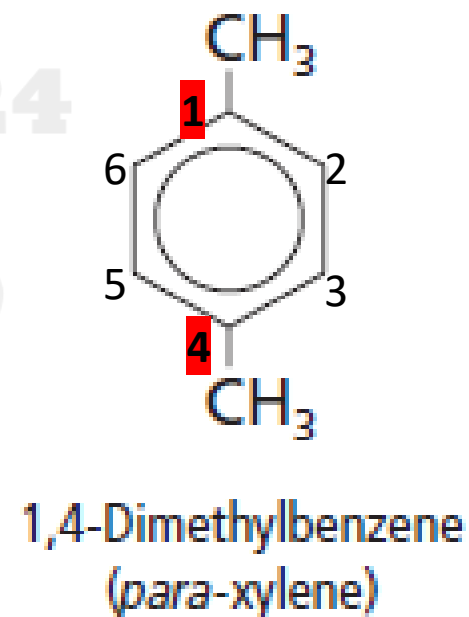
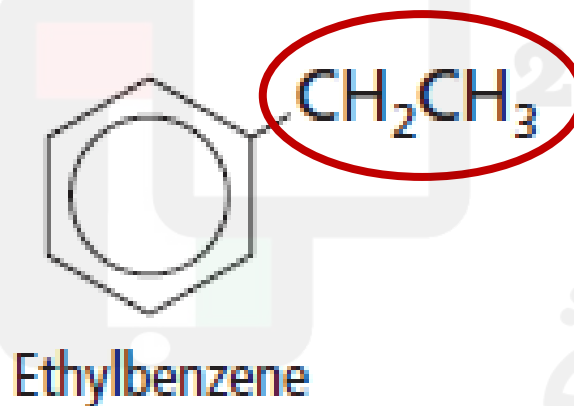
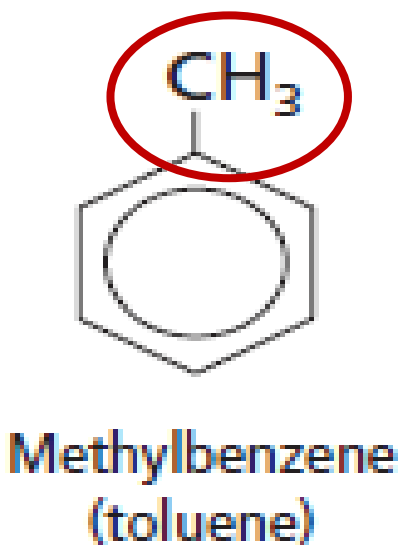


cyclopentane



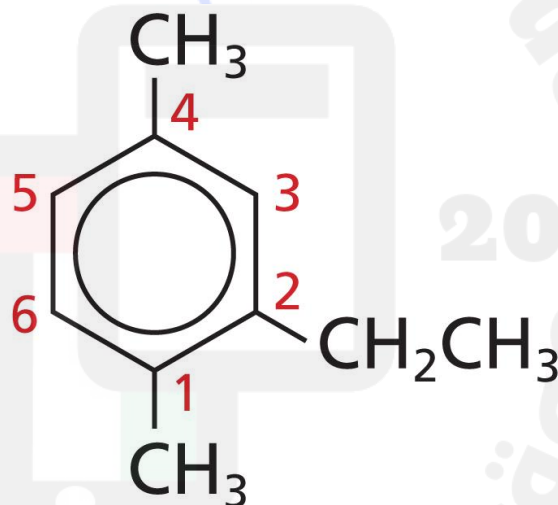
# Naming substituted aromatic compounds

- **Substituted benzene compounds** are named in the same way as **cyclic alkanes**.
- For example, **ethylbenzene** has a 2-carbon ethyl group attached, and 1,4-dimethylbenzene, also known as *para*-xylene, has two methyl groups attached at Positions 1 and 4.



## Aromatic Compounds

Substituted benzene compounds are named in the same way as cycloalkanes.

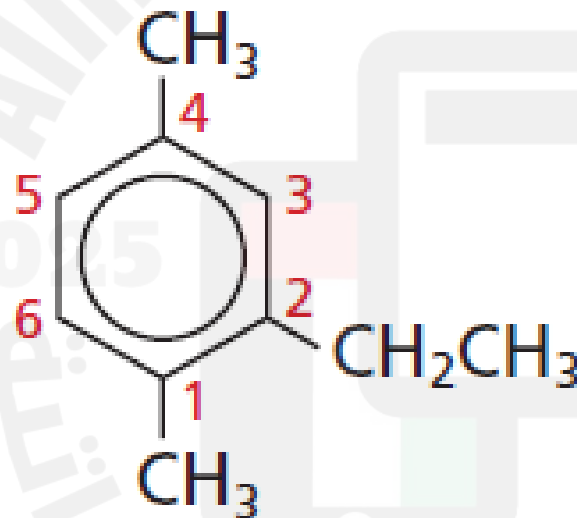


2-Ethyl-1,4-dimethylbenzene

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# Naming substituted aromatic compounds

- Substituted benzene rings are named in the same way as cyclic alkanes.



2-Ethyl-1,4-dimethylbenzene

## Naming substituted aromatic compounds

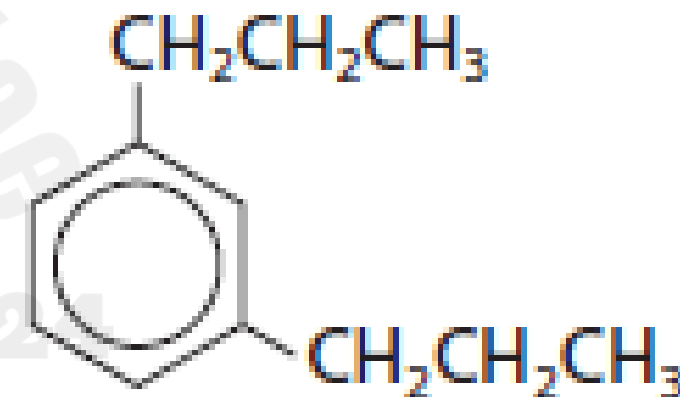
**Step 1.** Number the carbon atoms to give the lowest numbers possible.

**Step 2.** Determine the name of the substituents. If the same substituent appears more than once, add the **prefix** to show the **number of groups present**.

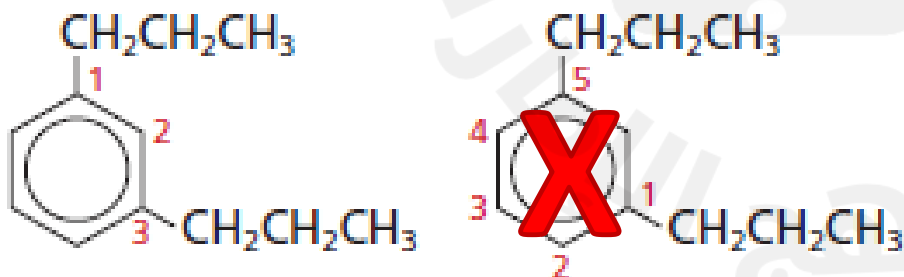
**Step 3.** Put the name together.

**Alphabetize** the substituent names, and use **commas** between numbers and **hyphens** between numbers and words.

Write the name as **1,3-dipropylbenzene**.



1,3-dipropylbenzene

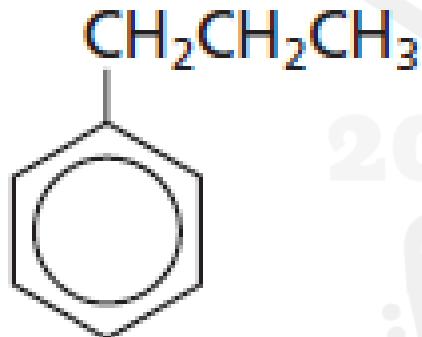


4. What is the name of the compound in which one ethyl group is attached to a benzene ring?

- A** diethylbenzene      **C** ethylbenzene
- B** 1-ethylbenzene      **D** toluene

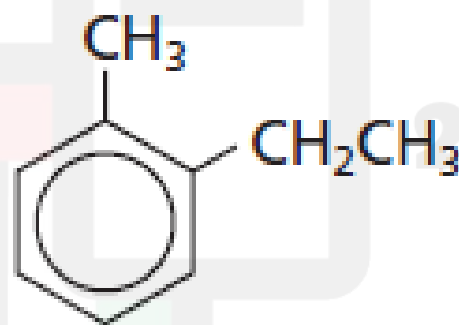
Name the following structures.

a.



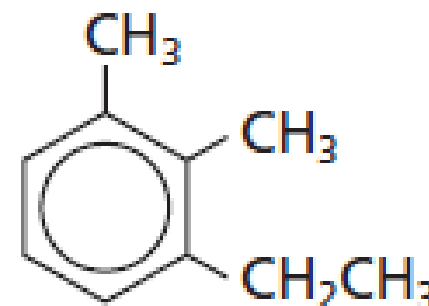
propylbenzene

b.



1-ethyl-2-methylbenzene

c.

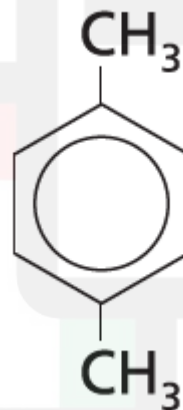


1-ethyl-2,3-dimethylbenzene

**Challenge** Draw the structure of 1,4-dimethylbenzene.



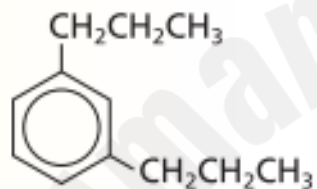
**Challenge** Draw the structure of 1,4-dimethylbenzene.



**Both are correct**

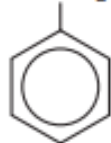
## EXAMPLE 4

**NAMING AROMATIC COMPOUNDS** Name the aromatic compound shown.



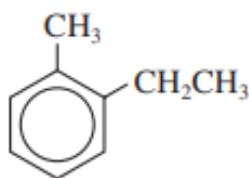
31. Name the following structures.

a.  $\text{CH}_2\text{CH}_2\text{CH}_3$



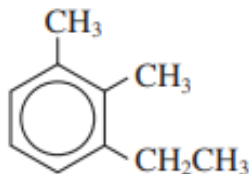
propylbenzene

b.  $\text{CH}_3$   
 $\text{CH}_2\text{CH}_3$



1-ethyl-2-methylbenzene

c.  $\text{CH}_3$   
 $\text{CH}_3$   
 $\text{CH}_2\text{CH}_3$



1-ethyl-2,3-dimethylbenzene

32. **Challenge** Draw the structure of 1,4-dimethylbenzene

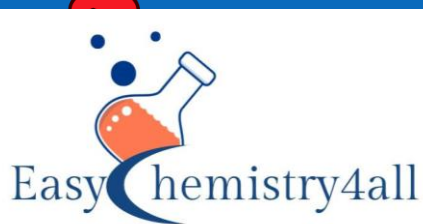




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**0557903129**

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**The End**

**My best wishes to you all 😊**

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**(14)** Identify general formula, molecular formula, structural formula and functional group for different families of organic compounds including alcohols, ethers, carbonyl containing compounds (carboxylic acids, ketones, aldehydes, esters), compounds containing nitrogen (amines and amides).

**(15)** Write the IUPAC name of alkyl halides and aryl halides.

**(16)** Explains the properties and uses of alkyl halides.

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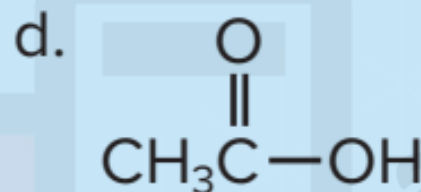
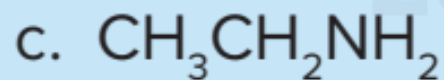
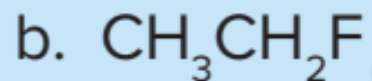
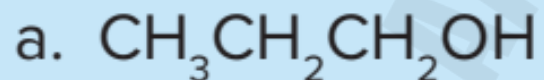
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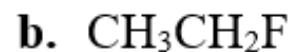
6. **Define** *functional group* and name the group present in each of the following structures. Name the type of organic compound each substance represents.



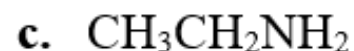
6. **Define** *functional group* and name the group present in each of the following structures. Name the type of organic compound each substance represents.



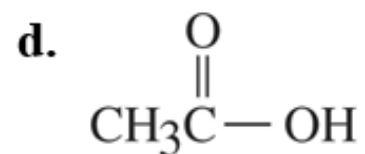
**hydroxyl group; alcohol**



**fluoro group; alkyl halide**



**amino group; amine**



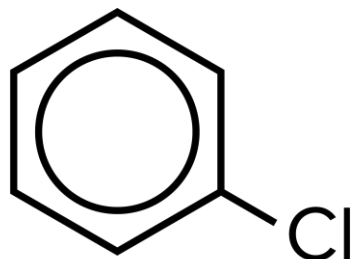
**carboxyl group; carboxylic acid**

**A functional group is an atom or group of atoms that reacts in a certain way.**

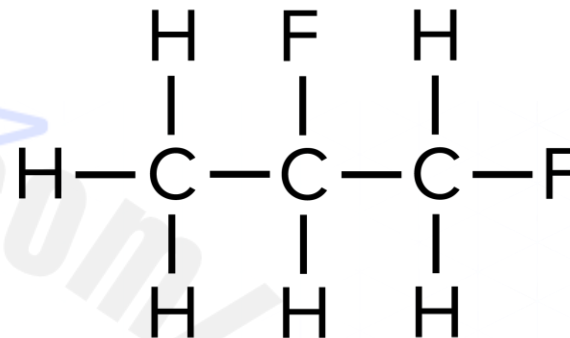
# Naming halocarbons

- 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**.

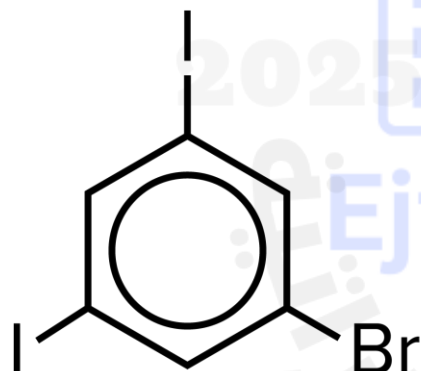
# Organic Compounds Containing Halogens



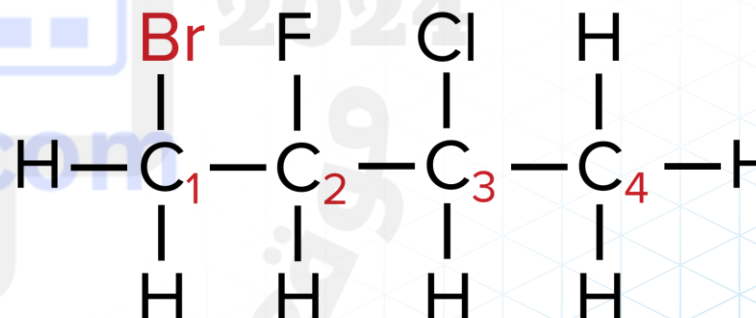
**Chlorobenzene**



**1,2-Difluoropropane**



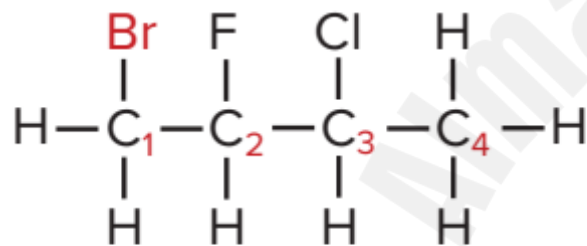
**1-Bromo-3,5-diiodobenzene**



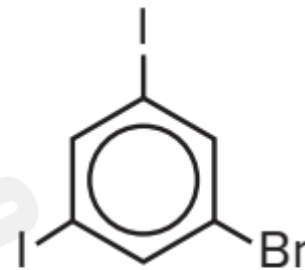
**1-Bromo-3-chloro-2-fluorobutane**



a

**1-Bromo-3-chloro-2-fluorobutane**

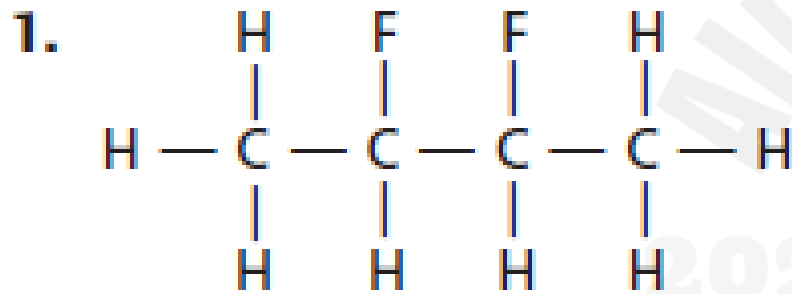
b

**Fluorobenzene****1-Bromo-3,5-diiodobenzene**

**Figure 4** Organic molecules containing functional groups are named based on their main-chain structure using IUPAC conventions.

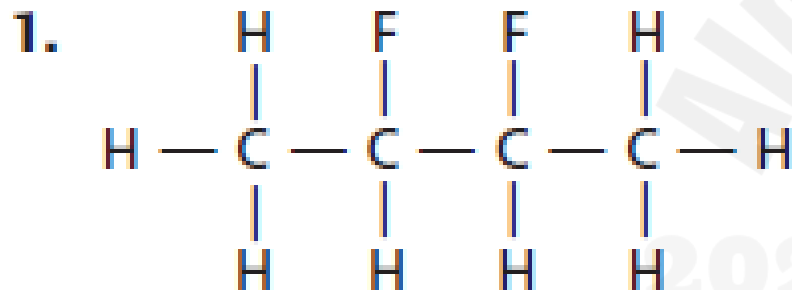
# Activity

Name the alkyl or aryl halide whose structure is shown.



# Activity

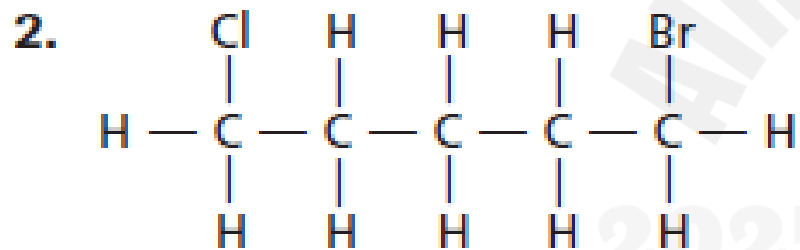
Name the alkyl or aryl halide whose structure is shown.



**2-fluorobutane**

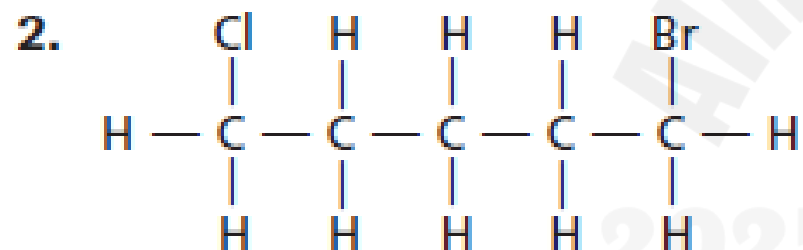
# Activity

Name the alkyl or aryl halide whose structure is shown.



# Activity

Name the alkyl or aryl halide whose structure is shown.

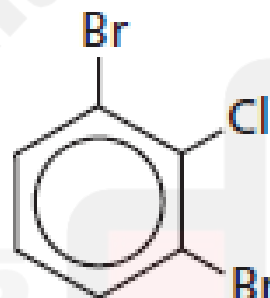


**1-bromo-5-chloropentane**

# Activity

Name the alkyl or aryl halide whose structure is shown.

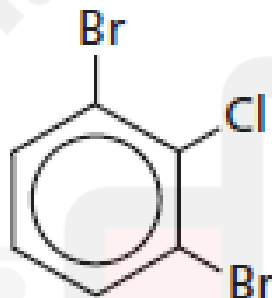
3.



# Activity

Name the alkyl or aryl halide whose structure is shown.

3.



**1,3-dibromo-2-chlorobenzene**



Table 2 A Comparison of Alkyl Halides and Their Parent Alkanes

Structure	Name	Boiling Point (°C)	Density (g/mL) in Liquid State
CH <sub>4</sub>	methane	-162	0.423 at -162°C (boiling point)
CH <sub>3</sub> Cl	chloromethane	-24	0.911 at 25°C (under pressure)
CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>3</sub>	pentane	36	0.626
CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> F	1-fluoropentane	62.8	0.791
CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> Cl	1-chloropentane	108	0.882
CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> Br	1-bromopentane	130	1.218
CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> I	1-iodopentane	155	1.516

*Increases*

*Increases*

17

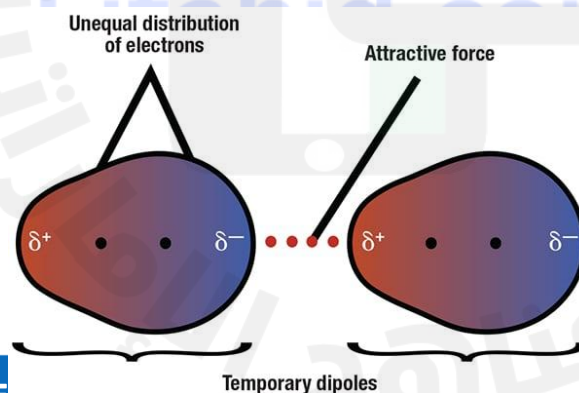
9	19.0
<b>F</b>	
Fluorine	
17	35.5
<b>Cl</b>	
Chlorine	
35	79.9
<b>Br</b>	
Bromine	
53	126.9
<b>I</b>	
Iodine	

## Organic Compounds Containing Halogens: Halocarbons

- The trend of increasing the boiling points and densities as the halogen changes from fluorine to chlorine, bromine, and iodine was observed in the table. **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**.



17

9	19.0
<b>F</b>	
Fluorine	
17	35.5
<b>Cl</b>	
Chlorine	
35	79.9
<b>Br</b>	
Bromine	
53	126.9
<b>I</b>	
Iodine	

## Organic Compounds Containing Halogens: Halocarbons

- 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.**

17

9	19.0
<b>F</b>	
Fluorine	
17	35.5
<b>Cl</b>	
Chlorine	
35	79.9
<b>Br</b>	
Bromine	
53	126.9
<b>I</b>	
Iodine	

4. **Compare and contrast** alkyl halides and aryl halides.
5. **Draw** structures for the following molecules.
  - a. 2-chlorobutane
  - b. 1,3-difluorohexane
  - c. 1,1,1-trichloroethane
  - d. 1-bromo-4-chlorobenzene

7. **Evaluate** How would you expect the boiling points of propane and 1-chloropropane to compare? Explain your answer.

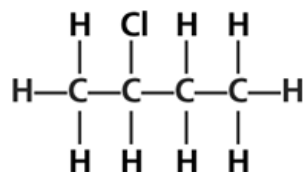
4. **Compare and contrast** alkyl halides and aryl halides.

**An alkyl halide is a substituted hydrocarbon that is covalently bonded to an aliphatic carbon atom.**

**An aryl halide is a substituted hydrocarbon that contains a halogen bonded to a benzene ring or other aromatic compound.**

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

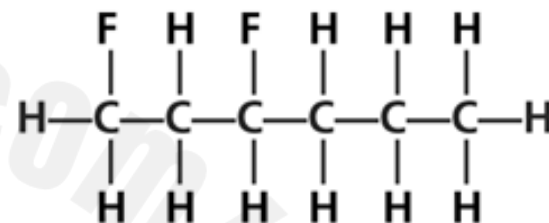
a. 2-chlorobutane



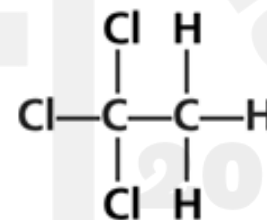
7. **Evaluate** How would you expect the boiling points of propane and 1-chloropropane to compare? Explain your answer.

**The boiling point of 1-chloropropane should be higher than that of propane. The molecules in 1-chloropropane should form more temporary dipoles than the molecules in propane.**

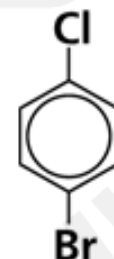
b. 1,3-difluorohexane



c. 1,1,1-trichloroethane



d. 1-chloro-4-bromobenzene





**An organic compound that contains a halogen is known as a(n) \_\_\_\_\_.**

- ☐ hydrocarbon
- ☐ oxycarbon
- ☐ alkalicarbon
- ☐ halocarbon

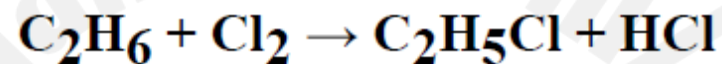
**An organic compound that contains a halogen bonded to a benzene ring is known as an \_\_\_\_\_.**

- ☐ alkyl halide
- ☐ alkane
- ☐ aryl halide
- ☐ alcohol

**When chlorine is added to an alkane, what name is used to identify that chlorine is present in the molecule?**

- ☐ chloride
- ☐ chlorine is never named in organic molecules
- ☐ chlorine
- ☐ chloro

**In the reaction shown below, ethane and chlorine gas yield chloroethane and hydrogen chloride.  
How do the properties of chloroethane compare to those of ethane?**



- ☐ Chloroethane is less dense and has a higher boiling point.
- ☐ Chloroethane is denser and has a lower boiling point
- ☐ Chloroethane is denser and has a higher boiling point
- ☐ Chloroethane is less dense and has a lower boiling point.

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## ***Solution***

halocarbon

aryl halide

chloro

Chloroethane is denser and has a higher boiling point



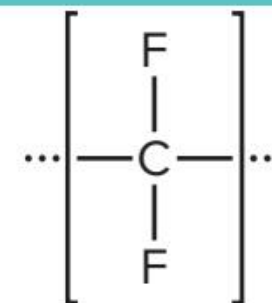
**Figure 5** shows an application of polytetrafluoroethene (PTFE), a plastic made from gaseous tetrafluoroethylene. A **plastic** is a polymer that can be heated and molded while relatively soft. Another plastic commonly called *vinyl* is polyvinyl chloride (PVC). It can be manufactured soft or hard, as thin sheets, or molded into objects.



### Get It?

**Explain** why alkyl halides are often used in the chemical industry as starting materials instead of alkanes.

**Figure 5** Polytetrafluoroethene (PTFE) is made up of hundreds of units. PTFE provides a nonstick surface for many kitchen items, including bakeware.



PTFE

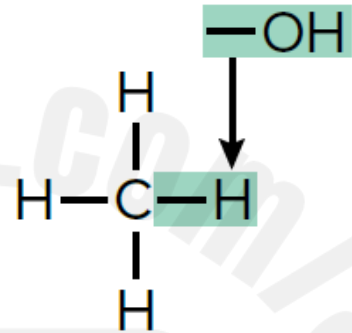
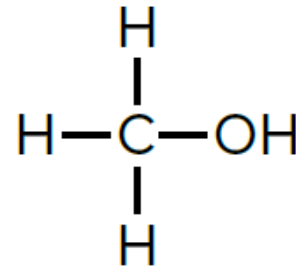


- (18) Explains the properties and uses of alcohols.
- (19) Draw the structure of an alcohol given its name.
- (20) Define ether while classifying it into symmetrical and asymmetrical ethers.
- (21) Mention some uses of amines and uses of amides.

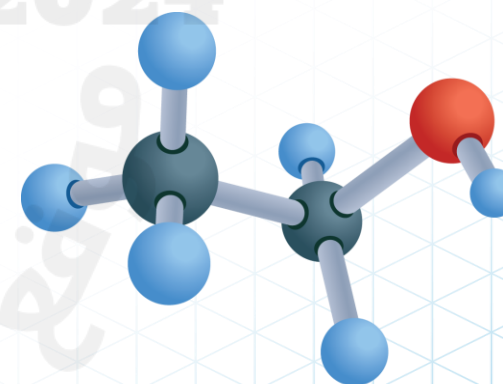
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- Oxygen commonly forms two covalent bonds to form a stable octet.
- An oxygen-hydrogen group covalently bonded to a carbon atom is called a **hydroxyl group**.
- An organic compound in which a hydroxyl group replaces a hydrogen is called an **alcohol**.

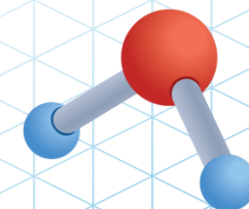
Table 3 Alcohols

General Formula	Simple Alcohol and Simple Hydrocarbon
$ROH$  R represents carbon chains or rings bonded to the functional group	<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  <p>Methane (<math>CH_4</math>)</p> <p><b>Alkane</b></p> </div> <div style="text-align: center;">  <p>Methanol (<math>CH_3OH</math>)</p> <p><b>Alcohol</b></p> </div> </div>

- Like water molecules, the **hydroxyl groups** of **alcohol molecules** are moderately **polar** and form hydrogen bonds.
- As a result, **alcohols are miscible with water** and are good solvents for other polar substances.
- **Alcohols have relatively high boiling points.**



Ethanol



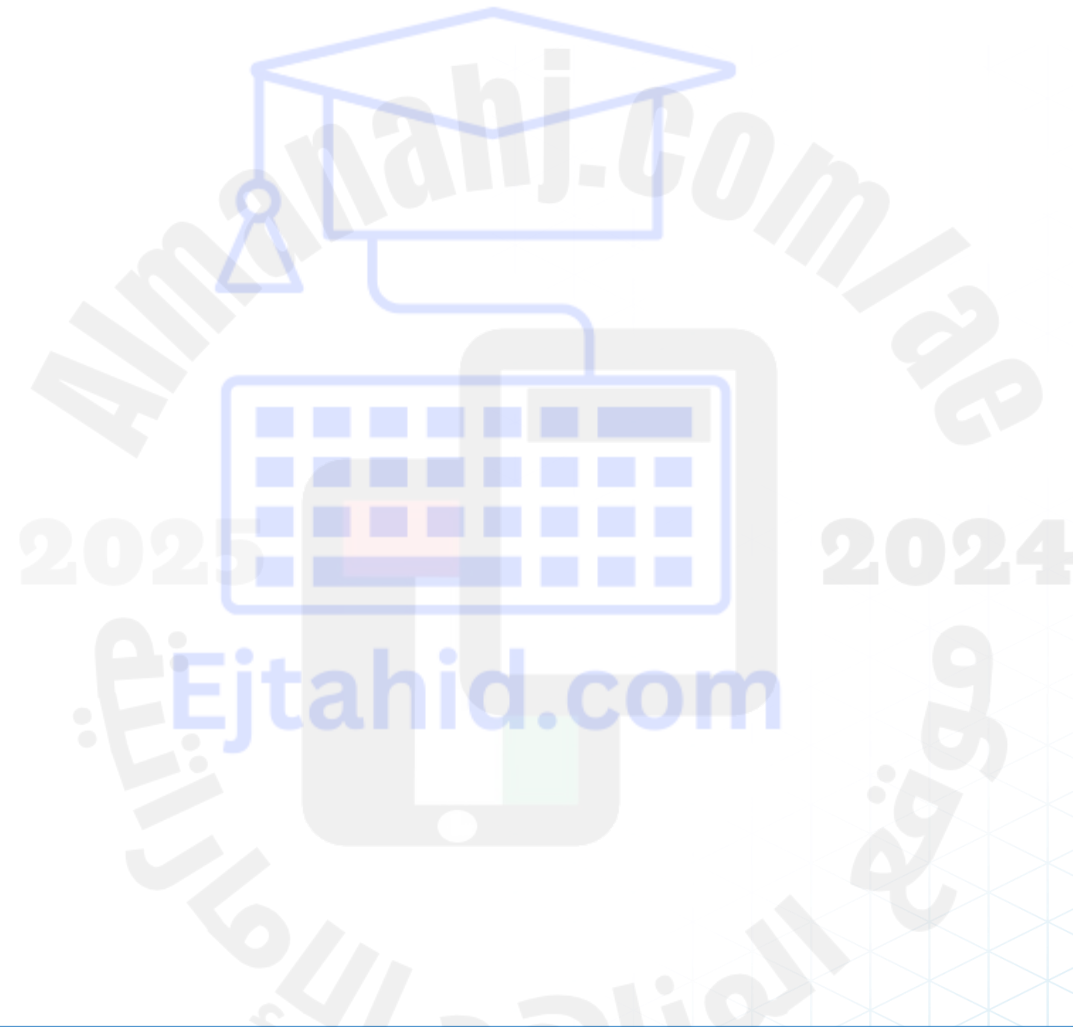
Water



## Naming Alcohols

- Alcohol names are based on the alkane names, with the ending *-ol*. There can be one or more hydroxyl groups; positions are specified with numbers.
- Methanol, or wood alcohol, is the simplest alcohol.
- Ethanol is the kind of alcohol found in alcoholic drinks.
- **Denatured alcohol** is ethanol with small amounts of noxious materials added to it.

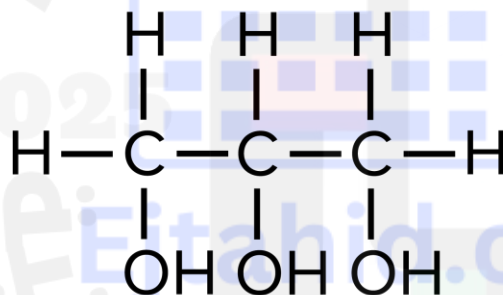
# Naming Alcohols



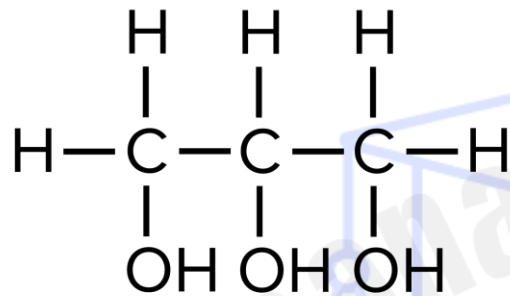


## Naming Alcohols

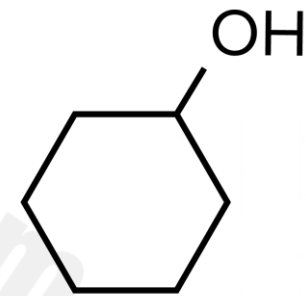
- A carbon chain can also have more than one hydroxyl group. To name these compounds, prefixes such as **di-**, **tri-**, and **tetra-** are used before the **-ol** to indicate the number of hydroxyl groups present.



# Naming Alcohols



**1,2,3-Propanetriol (glycerol)**



**Cyclohexanol**

# Practice

**Draw the structure for each molecule.**

A. 1-propanol

B. 1,3-cyclopentanediol

# Practice

**Draw the structure for each molecule.**

A. 1-propanol

B. 1,3-cyclopentanediol

1. **An alcohol** is an organic compound in which a(n) \_\_\_\_\_ replaces a hydrogen atom of a hydrocarbon.

- A** halogen
- B** hydroxyl group
- C** amino group
- D** oxygen atom

1. **An alcohol** is an organic compound in which a(n) \_\_\_\_\_ replaces a hydrogen atom of a hydrocarbon.

 halogen

CORRECT

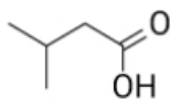
**B** hydroxyl group

 amino group

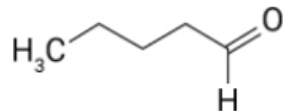
 oxygen atom

*Select the correct answer.*

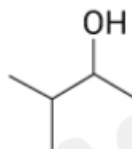
Which of the following line structures represents an alcohol molecule?



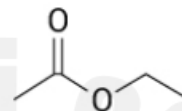
compound A



compound B



compound C



compound D



compound D



compound A



compound B

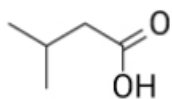


compound C

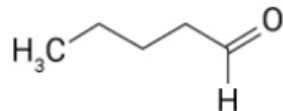


*Select the correct answer.*

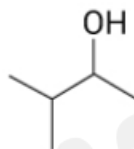
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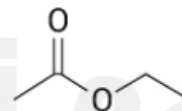
compound A



compound B



compound C



compound D

☐

compound D

☐

compound A

☐

compound B

☐

compound C

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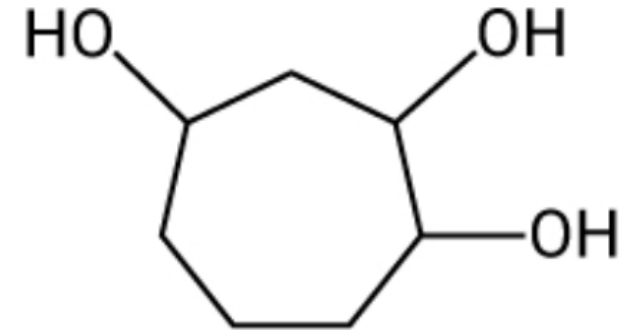
*Select the correct answers from the drop-down menus.*

Study the line structure of a cyclic alcohol.

The lowest position numbers for the hydroxyl groups are:

The prefix that indicates the number of hydroxyl groups is:

The IUPAC name of this compound is:



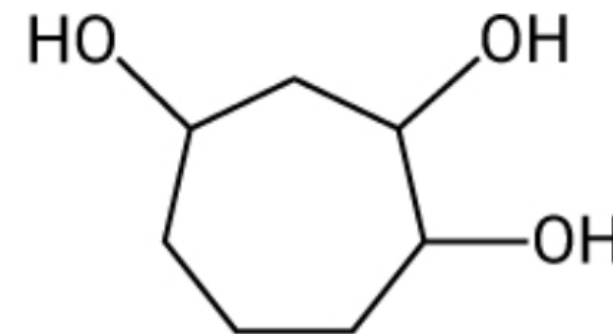
*Select the correct answers from the drop-down menus.*

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The lowest position numbers for the hydroxyl groups are:

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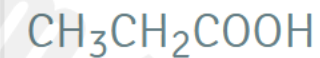
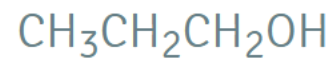
The IUPAC name of this compound is:



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*Select the correct answer.*

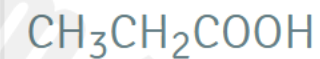
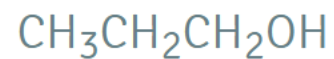
Which condensed structural formula represents an alcohol molecule?



## معاد عز Mouad Azz

*Select the correct answer.*

Which condensed structural formula represents an alcohol molecule?



*Select the correct answer to complete the sentence.*

Alcohols are polar compounds. They interact with other molecules through hydrogen bonding except with \_\_\_\_\_.

☐

polar molecules

☐

water molecules

☐

alcohol molecules

☐

non-polar molecules

*Select the correct answer to complete the sentence.*

Alcohols are polar compounds. They interact with other molecules through hydrogen bonding except with \_\_\_\_\_.

☐

polar molecules

☐

water molecules

☐

alcohol molecules

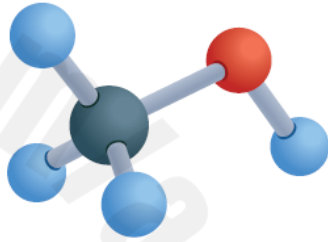
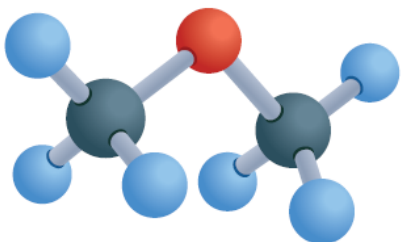
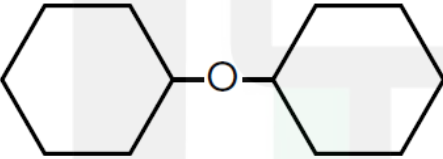
☐

non-polar molecules




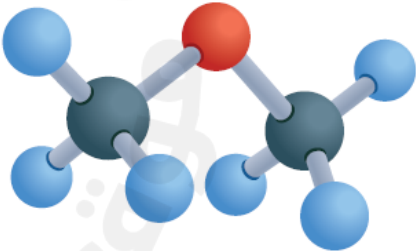
An **ether** is an organic compound containing an oxygen bonded to two carbon atoms.

Table 4 Ethers

General Formula	Methanol and Methyl ether	
$ROR'$ where R and R' represent carbon chains or rings bonded to functional groups	 Methanol bp = 65°C	 Methyl ether bp = -25°C
Examples of Ethers		
 Cyclohexyl ether	$CH_3CH_2CH_2-O-CH_2CH_2CH_3$ Propyl ether	
$CH_3CH_2-O-CH_2CH_2CH_2CH_3$ Butyl ethyl ether	$CH_3CH_2-O-CH_3$ Ethyl methyl ether	

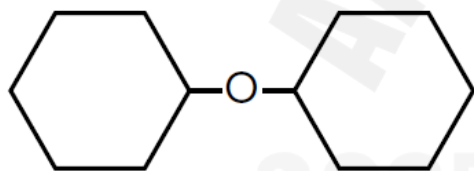
- **Ethers have no hydrogen atoms bonded to their oxygen atoms, so they cannot form hydrogen bonds with each other.**
- Because of that, Ethers are volatile and have low boiling points compared to alcohols.

Table 4 Ethers

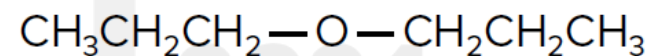
General Formula	Methanol and Methyl ether	
$ROR'$  where R and R' represent carbon chains or rings bonded to functional groups	 Methanol bp = 65°C	 Methyl ether bp = -25°C

- Ethers with identical chains are named by the chain followed by the word *ether*.
- Ethers with different chains are named in alphabetical order followed by *ether*.

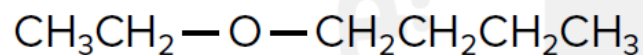
## Examples of Ethers



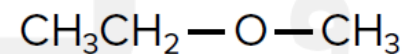
Cyclohexyl ether



Propyl ether

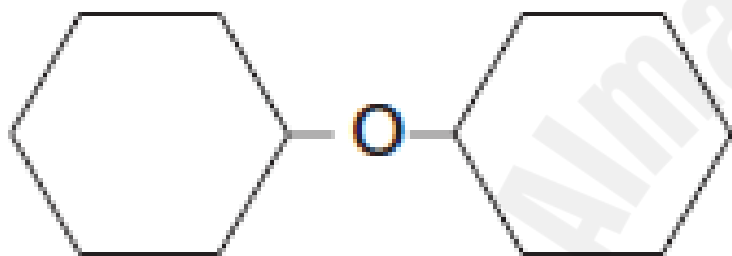


Butyl ethyl ether

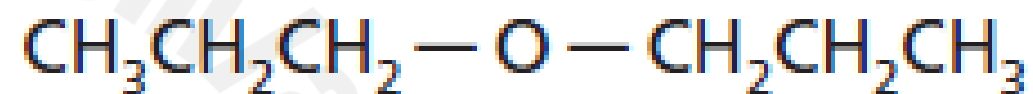


Ethyl methyl ether

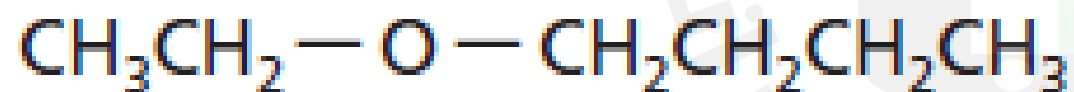
# Examples of Ethers



Cyclohexyl ether



Propyl ether



Butylethyl ether

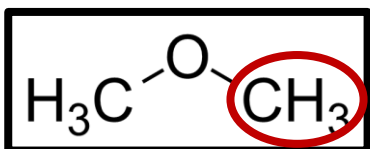


Ethylmethyl ether

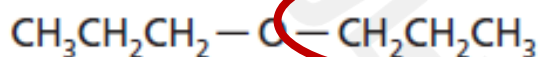
# Naming Ethers

**Symmetrical  
identical alkyl chains**

- first name the alkyl group
- then add the word *ether*



Methyl ether



Propyl ether

**Asymmetrical  
different alkyl chains**

- the groups are listed in alphabetical order
- then followed by the word *ether*



Butylethyl ether

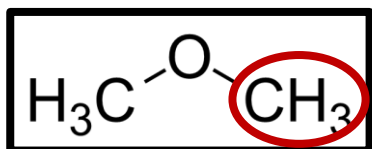


Ethylmethyl ether

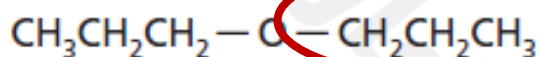
# Naming Ethers

**Symmetrical  
identical alkyl chains**

- first name the alkyl group
- then add the word *ether*



Methyl ether



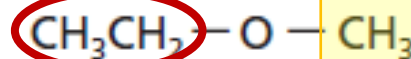
Propyl ether

**Asymmetrical  
different alkyl chains**

- the groups are listed in alphabetical order
- then followed by the word *ether*



Butylethyl ether

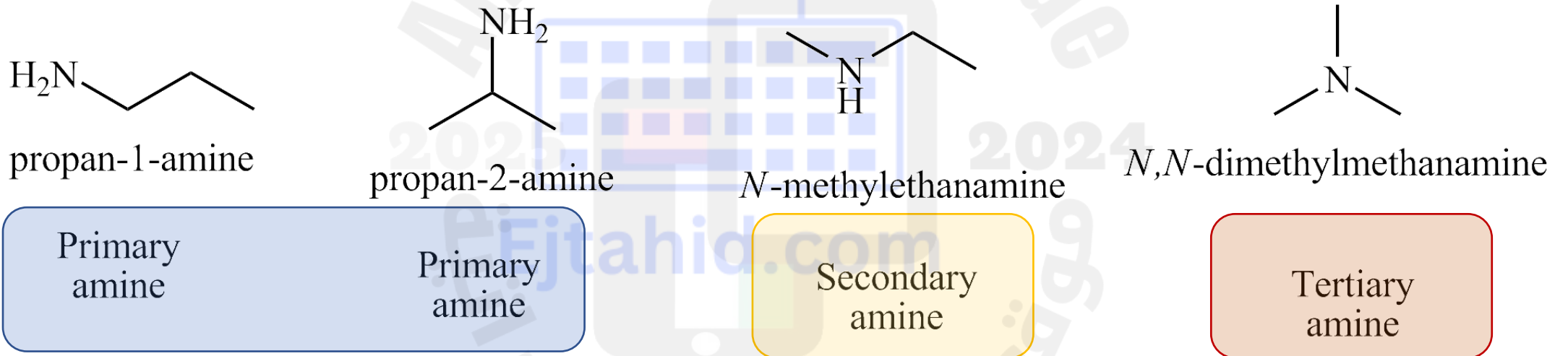


Ethylmethyl ether

# Amines

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- **Amines** contain **nitrogen atoms bonded to carbon atoms** in aliphatic chains or aromatic rings and have the general formula  $RNH_2$ .
- Chemists consider **amines derivatives of ammonia** ( $NH_3$ ).
- Amines are considered **primary, secondary, or tertiary amines** depending on whether one, two, or three of the hydrogens in ammonia ( $NH_3$ ) have been replaced by organic groups.



$NH_3$  becomes  $NH_2$

**1 H are lost**

$NH_3$  becomes  $NH$

**2 H are lost**

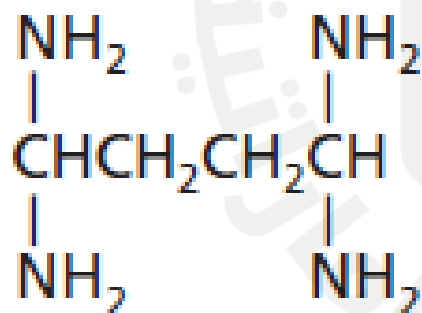
$NH_3$  becomes  $N$

**3 H are lost**

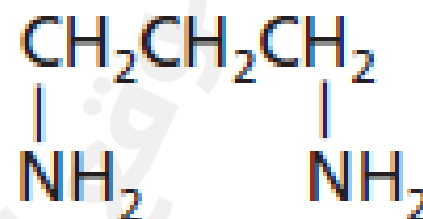


# Naming Amines

- the  $\text{-NH}_2$  (amino) group is indicated by the suffix  $\text{-amine}$  (the last part of the name is **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.



1,1,4,4-Butanetetraamine



1,3-Propanediamine

3. What kind of organic compound would most likely be derived from ammonia,  $\text{NH}_3$ ?

 alcohol

 ether

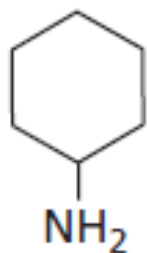
 c amine

 alkyl halide

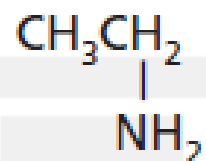
CORRECT

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# Examples of amines



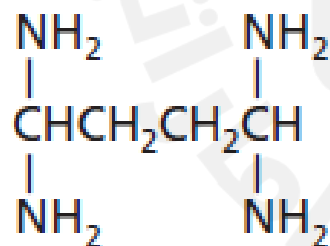
Cyclohexylamine



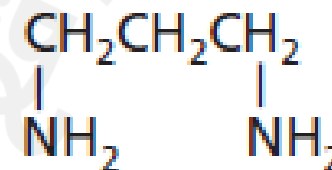
Ethylamine



Aniline



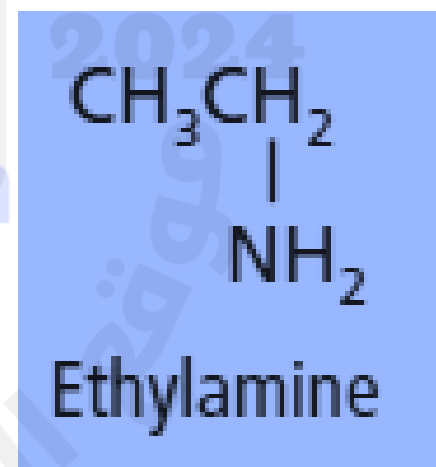
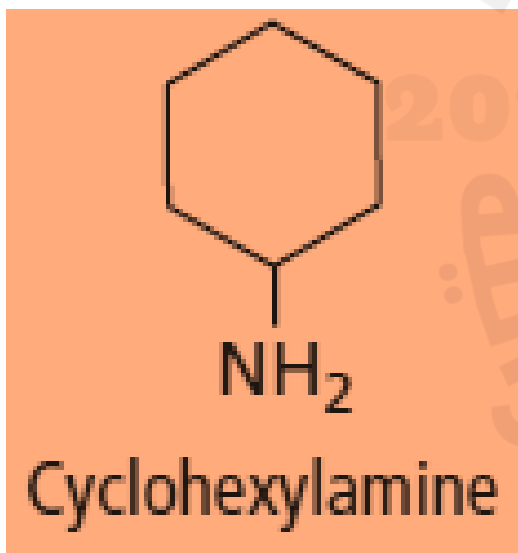
1,1,4,4-Butanetetraamine



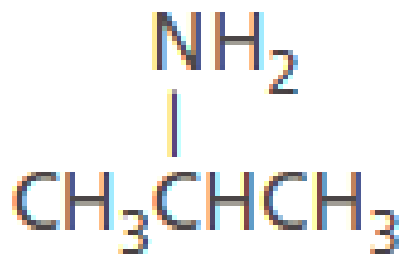
1,3-Propanediamine

# Uses of Amines

- **Cyclohexylamine** and **ethylamine** are important in the manufacture of pesticides, plastics, pharmaceuticals, and rubber that is used to make tires.

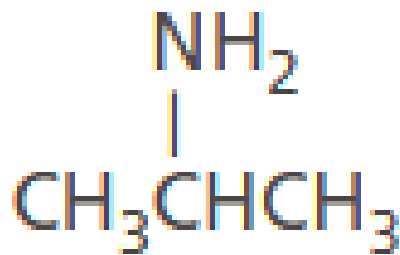


1. Name the following amine structure.



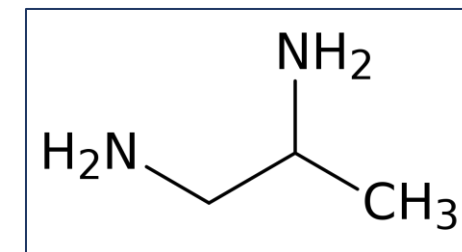
2. Draw the structure for the molecule: 1,2-propanediamine

1. Name the following amine structure.



isopropylamine

2. Draw the structure for the molecule: 1,2-propanediamine



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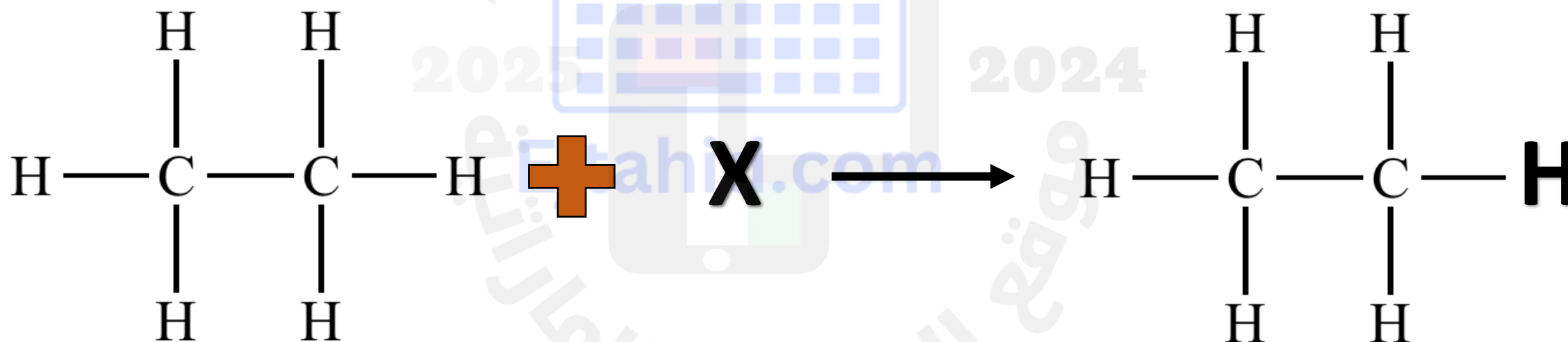




**(17)** Define substitution reaction while writing the equation for the substitution reaction including halogenation of alkanes, alkyl halide-alcohol reaction and alkyl halide-ammonia reaction

# Substitution Reactions

- 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.
- Replacing hydrogen atom with a halogen, typically chlorine or bromine, is a process called **halogenation**.



# Substitution Reactions

Table 1.3

## Substitution Reactions

### Generic Substitution Reaction



where X is fluorine, chlorine, or bromine

### Example of General Substitution Reaction (Halogenation)



Ethane

Chloroethane

### General Alkyl Halide-Alcohol Reaction



Alkyl halide

Alcohol

### Example of an Alkyl Halide-Alcohol Reaction



Chloroethane

Ethanol

### General Alkyl Halide-Ammonia Reaction



Alkyl halide

Amine

### Example of an Alkyl Halide-Ammonia Reaction



1-Bromooctane

Octaneamine

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## Further substitution

- Once an alkane has been halogenated, the resulting alkyl halide can undergo other types of substitution reactions in which the halogen atom is replaced by another atom or group of atoms.
- For example, reacting an alkyl halide with a basic solution results in the **replacement** of the halogen atom by an **-OH** group, forming an **alcohol**.

### General Alkyl Halide-Alcohol Reaction



Alkyl halide

Alcohol

### Example of an Alkyl Halide-Alcohol Reaction



Chloroethane

Ethanol

## Further substitution

- Reacting an alkyl halide with ammonia ( $\text{NH}_3$ ) replaces the halogen atom with an amino group ( $-\text{NH}_2$ ), forming an alkyl amine.
- The alkyl amine is one of the products produced in this reaction. Some of the newly formed amines continue to react, resulting in a mixture of amines.

### General Alkyl Halide-Ammonia Reaction



Alkyl halide

Amine

### Example of an Alkyl Halide-Ammonia Reaction



1-Bromooctane

Octaneamine

- (22)** Compare and contrast aldehydes and ketones
- (23)** Use the IUPAC system to name aldehydes and ketones
- (24)** Use the IUPAC system to name esters
- (25)** Write an equation for the reaction of alcohols with carboxylic acids to form esters(condensation reaction)

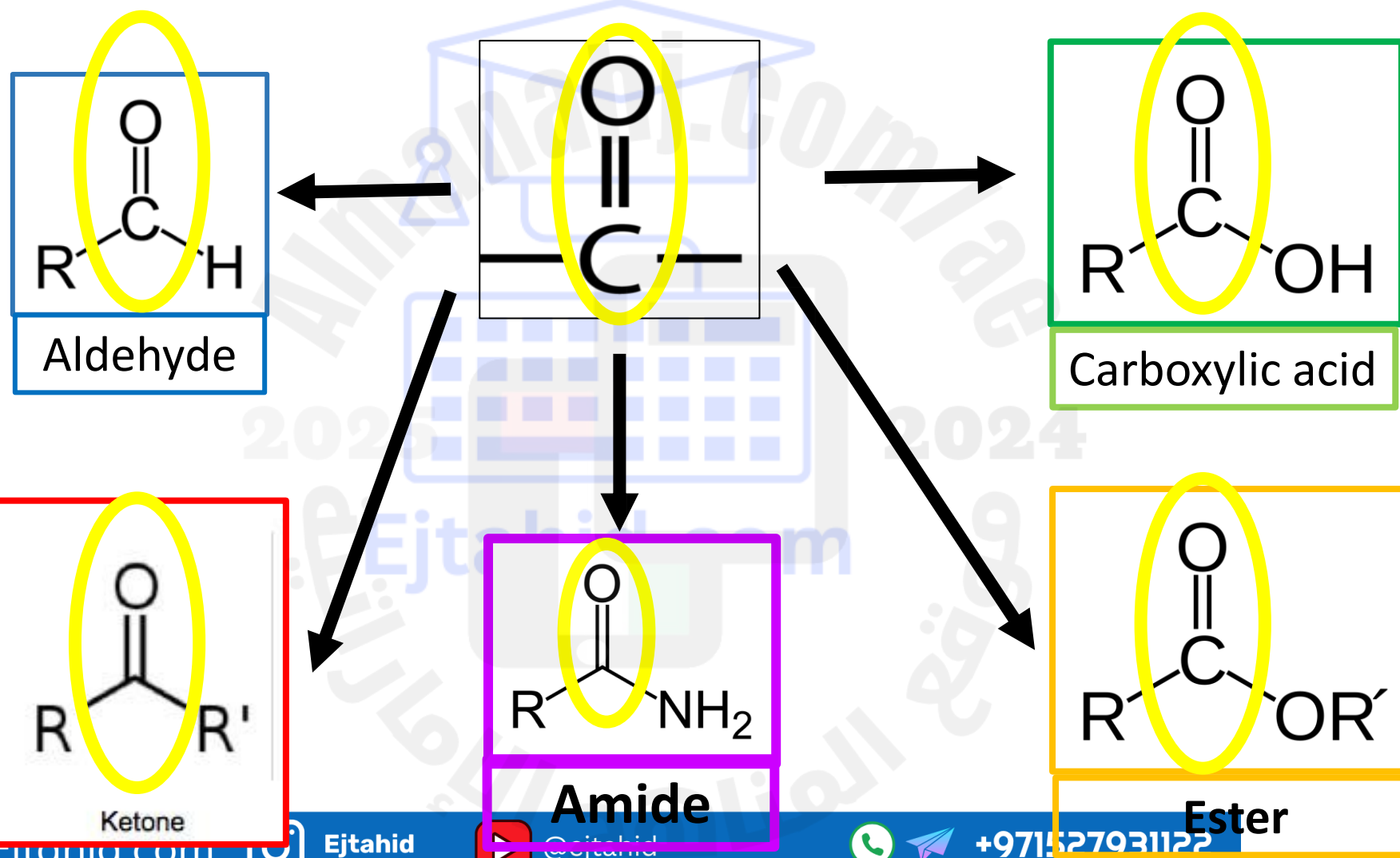


# Carbonyl Compounds

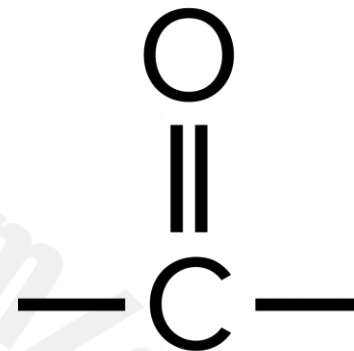
- Carbonyl compounds contain a **double-bonded oxygen** in the functional group.



# Organic Compounds Containing the Carbonyl Group



1. What is the functional group shown at right?



☒ A a carbonyl group **CORRECT**

☐ an aldehyde

☐ a ketone

☐ a carboxyl group

# Aldehydes

- 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.
- Aldehydes have the general formula  $*CHO$ , where  $*$  represents an alkyl group or a hydrogen atom, as shown in **table**.

## General Formula



$*$  represents an alkyl group  
or a hydrogen atom



Carbonyl group

# Naming Aldehydes

- 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.
- Because the carbonyl group in an aldehyde always occurs at the end of a carbon chain, no numbers are used in the name unless branches or additional functional groups are present.
- Methanal is also commonly called formaldehyde.
- Ethanal has the common name *acetaldehyde*.

# Examples of Aldehydes

## Aldehydes

### Examples of Aldehydes

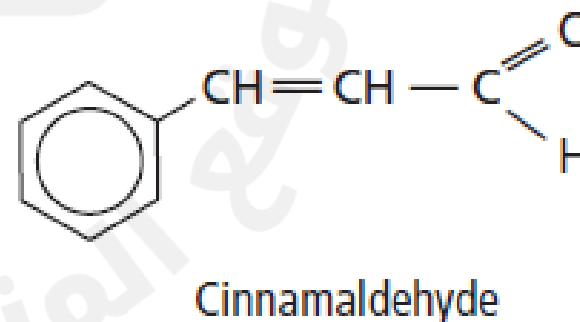
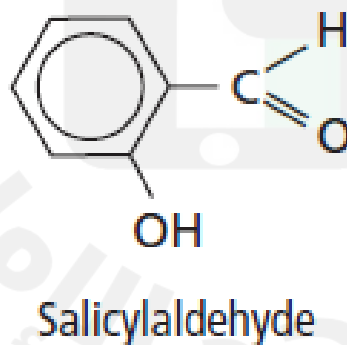
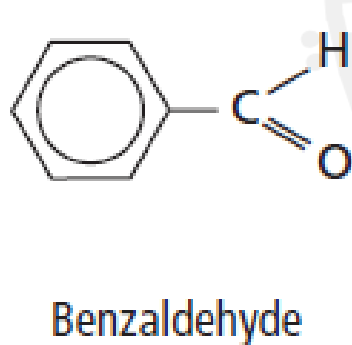
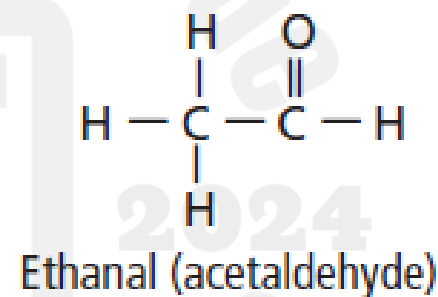
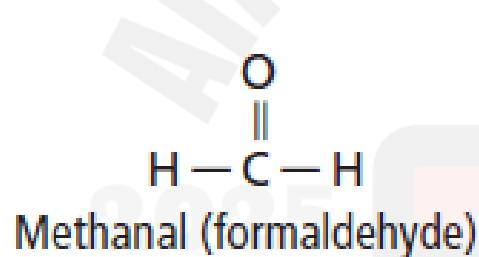
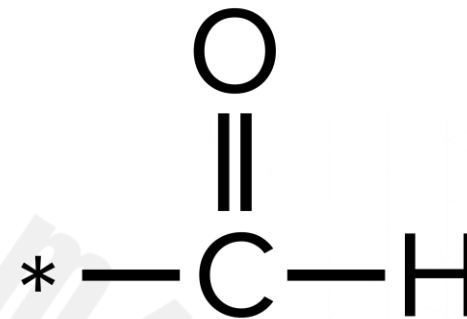


Table 7 Aldehydes

General Formula	Examples of Aldehydes		
*CHO  *represents an alkyl group or a hydrogen atom	$\begin{array}{c} \text{O} \\ \parallel \\ \text{H}-\text{C}-\text{H} \end{array}$ Methanal (formaldehyde)	$\begin{array}{c} \text{H} \quad \text{O} \\   \quad \parallel \\ \text{H}-\text{C}-\text{C}-\text{H} \\   \\ \text{H} \end{array}$ Ethanal (acetaldehyde)	
$\begin{array}{c} \text{O} \\ \parallel \\ -\text{C}- \end{array}$ Carbonyl group	$\begin{array}{c} \text{H} \\   \\ \text{C}_6\text{H}_5-\text{C}=\text{O} \end{array}$ Benzaldehyde	$\begin{array}{c} \text{H} \\   \\ \text{C}_6\text{H}_4-\text{C}=\text{O} \\   \\ \text{OH} \end{array}$ Salicylaldehyde	$\begin{array}{c} \text{H} \quad \text{H} \quad \text{O} \\   \quad   \quad \parallel \\ \text{C}=\text{C}-\text{C}-\text{H} \\   \\ \text{C}_6\text{H}_5 \end{array}$ Cinnamaldehyde


2. What has the general formula shown at right?



 a carbonyl group

 B an aldehyde **CORRECT**

 a ketone

 an ester



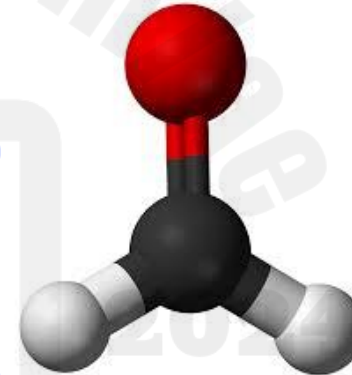
# Properties of Aldehydes

- An aldehyde molecule contains a **polar, reactive structure**.
- However, like ethers, aldehyde molecules cannot form hydrogen bonds among themselves **because the molecules have no hydrogen atoms bonded to an oxygen atom**.
- Therefore, **aldehydes** have lower boiling points than alcohols with the **same number of carbon atoms**.
- Water molecules can form hydrogen bonds with the oxygen atom of aldehydes, so **aldehydes are more soluble in water than alkanes but not as soluble as alcohols or amines**.



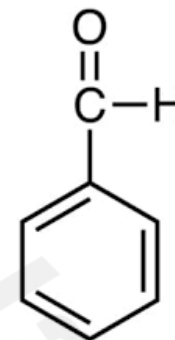
An aldehyde molecule contains a **polar, reactive structure**.  
But aldehyde molecules cannot form hydrogen bonds

- **Formaldehyde** has been used for preservation (حفظ العينات) for many years.
- Industrially, large quantities of **formaldehyde** are reacted with urea to manufacture a type of **grease-resistant, hard plastic** used to **make buttons, appliance and automotive parts, and electrical outlets**, as well as the **glue that holds the layers of plywood together**.

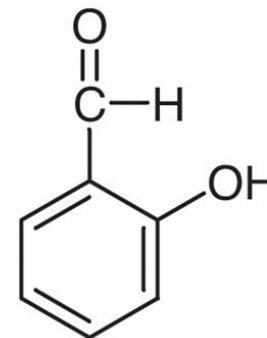


# Uses of Aldehydes

- Benzaldehyde and salicylaldehyde, are two components that give **almonds(اللوز)** their natural flavor.

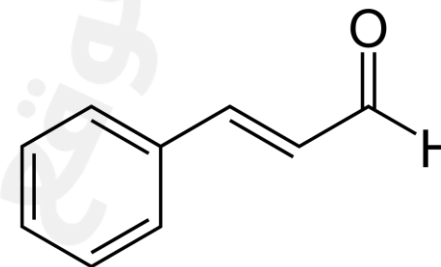


Benzaldehyde



salicylaldehyde

- The **aroma and flavor of cinnamon**, a spice that comes from the bark of a tropical tree, are produced largely by cinnamaldehyde.

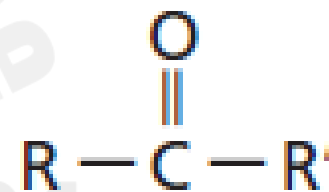


cinnamaldehyde

# Ketones

- A carbonyl group can also be located within a carbon chain rather than at the end.
- **A ketone** is an organic compound in which the **carbon of the carbonyl group** is bonded to **two other carbon atoms**. Ketones have the general formula shown in the picture.

## General Formula

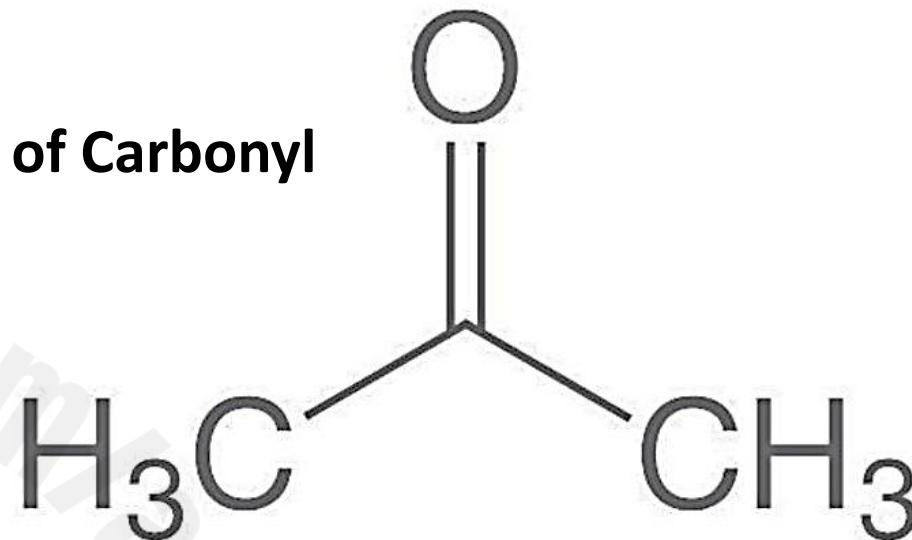


where R and R' represent carbon chains or rings bonded to functional groups

# Ketones

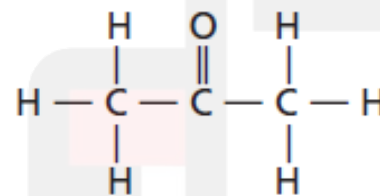
The carbon of Carbonyl

- The carbon atoms on either side of the carbonyl group are bonded to other atoms.
- The **simplest** ketone, commonly known as **acetone**, has only hydrogen atoms bonded to the side carbons.



# Naming Ketones

- Ketones are formally named by changing the **-e** at the end of the **alkane** name to **-one**.
- and including a **number** before the name to **indicate the position of the ketone group**.



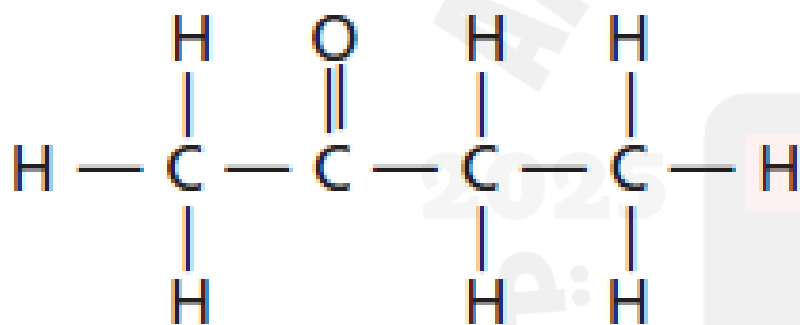
2-Propanone  
(acetone)

- In the previous example, the alkane name **propane** is changed to **propanone**. The carbonyl group can be located **only in the center**, but the **prefix 2-** is usually added to the name for clarity.

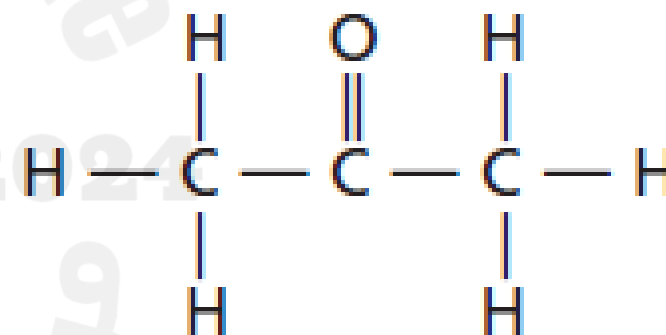


# Naming Ketones

- Examples



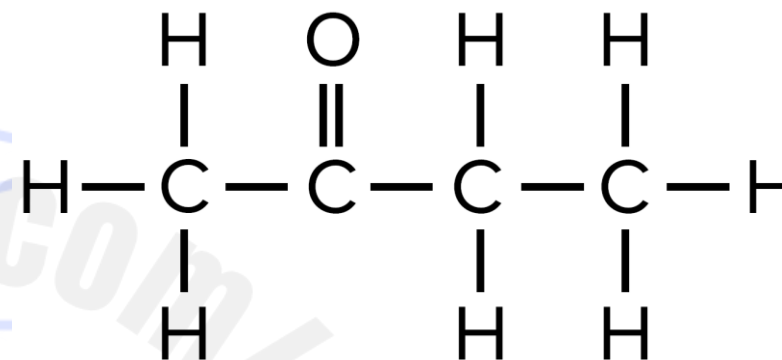
2-Butanone  
(methyl ethyl ketone)




2-Propanone  
(acetone)



3. What is the name of the compound with the formula shown at right?



 2-butanal

 B 2-butanone

CORRECT

 ethyl methyl ether

 methyl ethanoate

# Properties and Uses of Ketones

- Ketones and aldehydes share many chemical and physical properties because their structures are similar.
- **Ketones are polar molecules** and are **less reactive than aldehydes**. For this reason, ketones are **popular solvents** for other moderately polar substances, including waxes, plastics, paints, lacquers, varnishes, and glues.
- Like aldehydes, **ketone molecules cannot form hydrogen bonds with each other but can form hydrogen bonds with water molecules**. Therefore, ketones are somewhat **soluble in water**.
- Acetone is completely miscible with water.

# Properties of Ketones

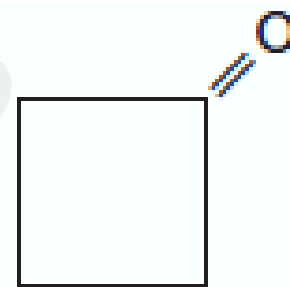
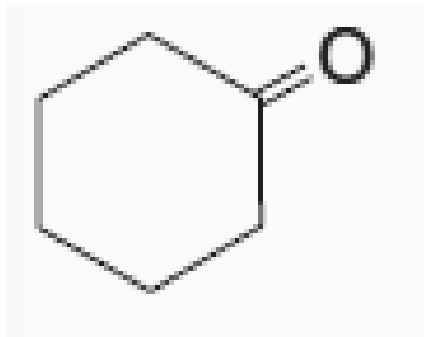
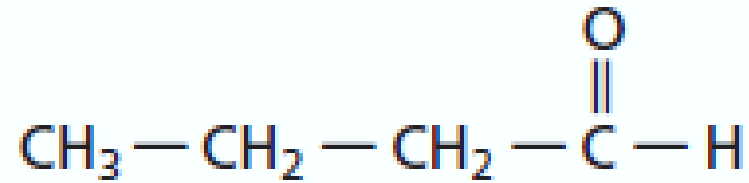


A Ketone molecule contains a **polar**, less reactive than aldehydes.  
**But ketone molecules cannot form hydrogen bonds**

# Plenary

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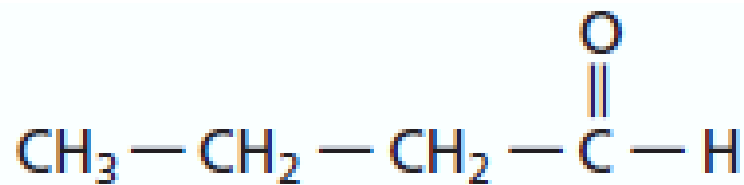
- Name the following compound



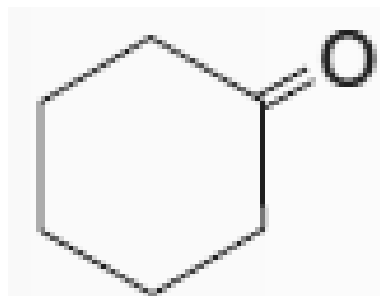
# Plenary

معاد عز Mouad Azz

- Name the following compound

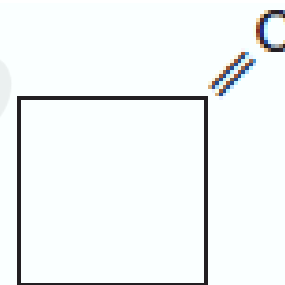


Butanal



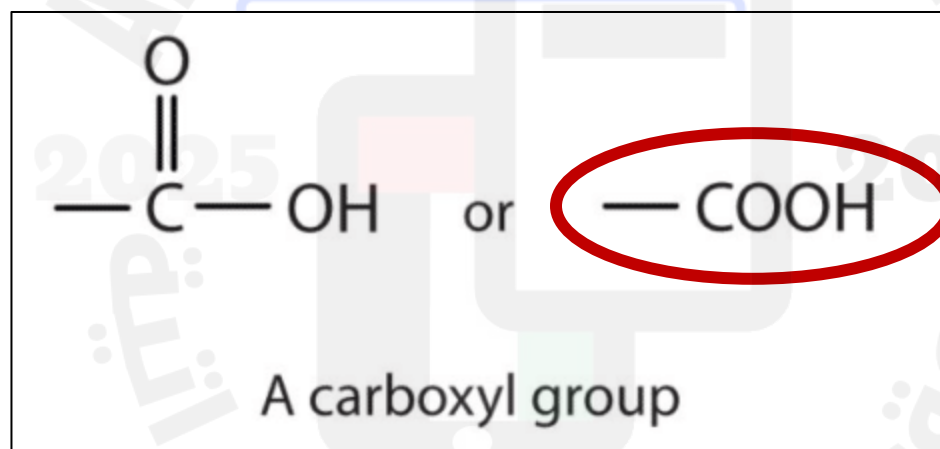
Cyclohexanone

Cyclobutanone



# Carboxylic Acids

- A **carboxylic acid** is an organic compound that has a carboxyl group.
- **Carboxyl group** consists of a **carbonyl group** bonded to a **hydroxyl group**.



A carboxyl group is usually represented in condensed form by writing  $\text{—COOH}$ . For example, acetic acid, the acid found in vinegar, can be written as  $\text{CH}_3\text{COOH}$

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# Carboxylic Acids (General Formula)

## General Formula

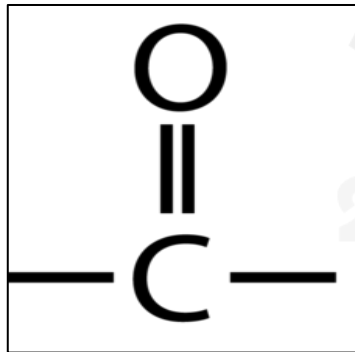


where R represents carbon chains or rings bonded to functional groups

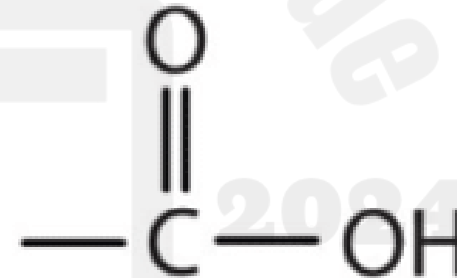
# Activity

- What is the difference between carbonyl and carboxyl group?

(Hint: draw them both and compare)



carbonyl



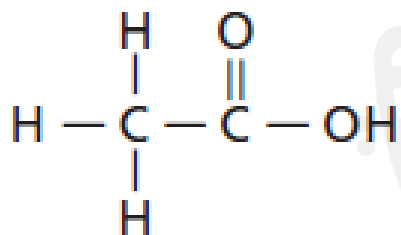
carboxyl



# Naming Carboxylic Acids

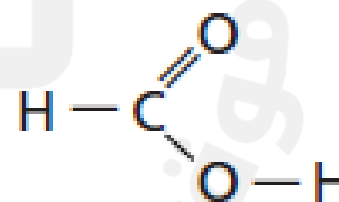
- The formal name is formed by **changing the -ane** of the parent alkane **to -anoic acid**. Thus, the formal name of acetic acid is ethanoic acid.

## Examples



Ethanoic acid (acetic acid)

Eth**ane** → Eth**anoic Acid**

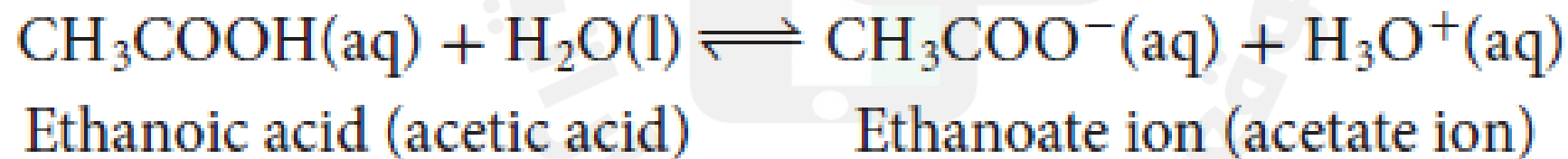


Methanoic acid (formic acid)

Meth**ane** → Meth**anoic Acid**

# Properties of Carboxylic acid

- Carboxylic acids are polar and reactive.
- Those that dissolve in water ionize weakly to produce hydronium ions, the anion of the acid in equilibrium with water, and the unionized acid.
- Recall: The ionization of ethanoic acid.



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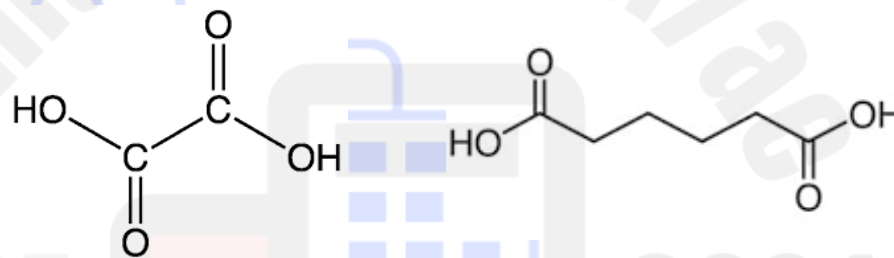
# Properties of Carboxylic acid

- Carboxylic acids can ionize in water solution because the **two oxygen atoms** are highly electronegative and attract electrons away from the hydrogen atom in the  $\text{-OH}$  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. Because they ionize in water, soluble carboxylic acids turn **blue litmus paper red** and have a **sour taste**.

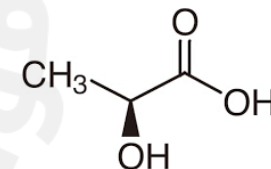


# Dicarboxylic Acid

- An acid with two carboxyl groups is called a **dicarboxylic acid**.
- Some important carboxylic acids, such as **oxalic acid** and **adipic acid**, have two or more carboxyl groups.



- Others have additional functional groups such as hydroxyl groups, as in the **lactic acid** found in yogurt.



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

## Carboxylic Acids

- **Carboxyl groups** are carbonyls bonded to a hydroxyl group. They are represented as  $\text{—COOH}$ .
- **Carboxylic acids** are organic compounds that have a carboxyl group.
- Carboxylic acids are named by changing the *—ane* to *—anoic acid*.

# Carboxylic Acids

Table 9 Carboxylic Acids

General Formula	Examples of Carboxylic Acids
$\begin{array}{c} \text{O} \\ \parallel \\ * - \text{C} - \text{OH} \end{array}$ <p>where * represents a hydrogen atom, carbon chain, or ring bonded to the functional group</p>	<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;"> <math display="block">\begin{array}{c} \text{H} \quad \text{O} \\   \quad \parallel \\ \text{H} - \text{C} - \text{C} - \text{OH} \\   \\ \text{H} \end{array}</math> <p>Ethanoic acid (acetic acid)</p> </div> <div style="text-align: center;"> <math display="block">\begin{array}{c} \text{O} \\ \parallel \\ \text{H} - \text{C} - \text{O} - \text{H} \end{array}</math> <p>Methanoic acid (formic acid)</p> </div> </div>



## Carboxylic Acids

- Carboxylic acids are polar and reactive, and ionize partially in water to form hydronium ions, so they are considered weak acids.
- They have properties of other acids. For example, they turn blue litmus paper red, and they have a sour taste.
- Methanoic acid, also called formic acid, is used by ants as a defense.
- Ethanoic acid, also called acetic acid, is the acid found in vinegar.
- Lactic acid, found in yogurt, is a carboxylic acid with additional hydroxyl groups.

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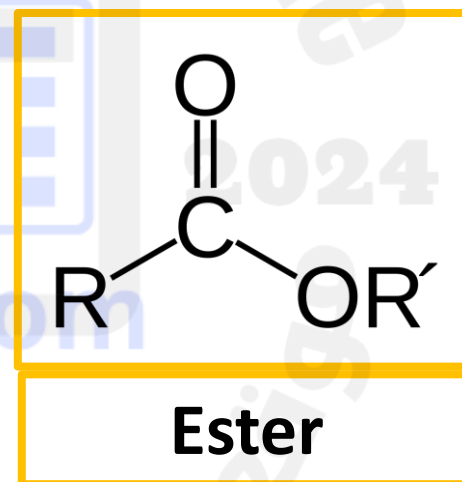
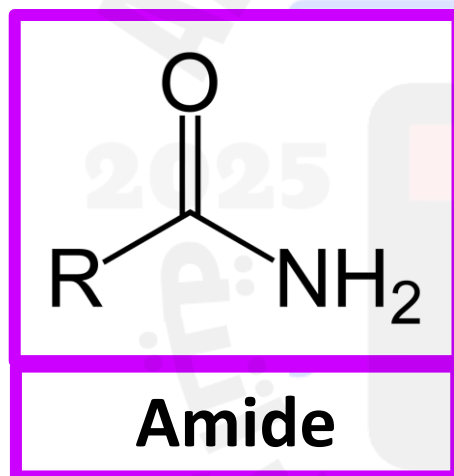


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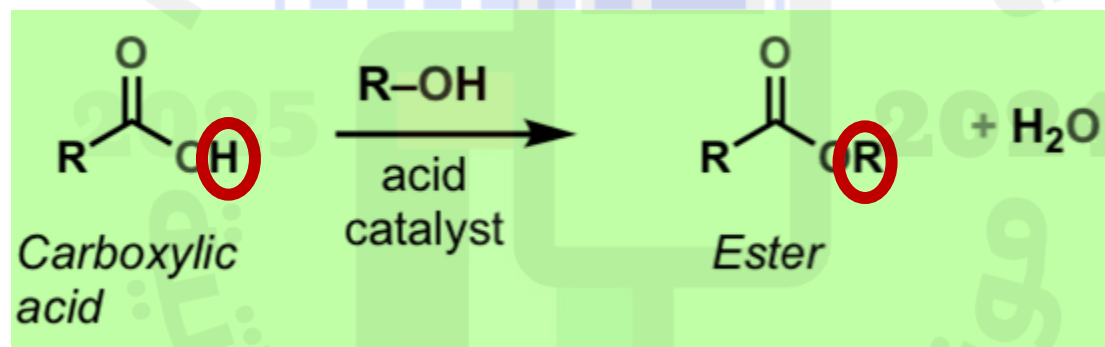
# Organic Compounds Derived from Carboxylic Acids

- 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** and **amides**.



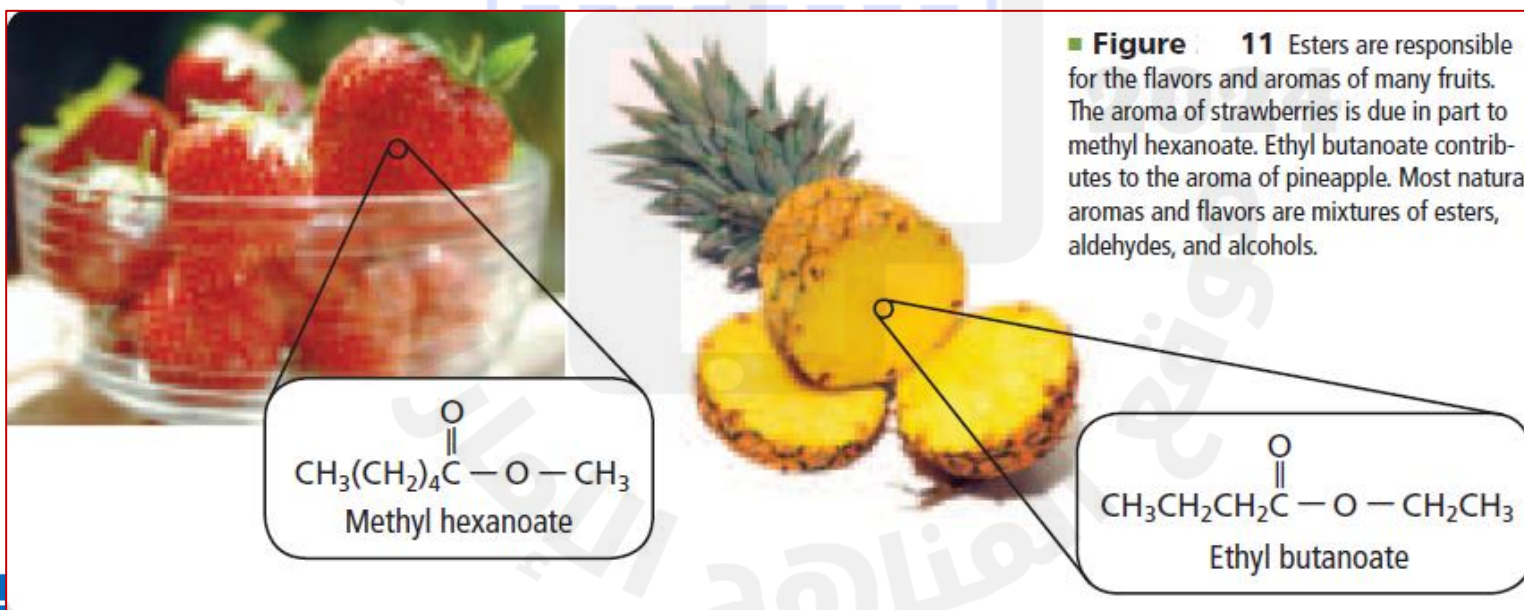
# Esters

- 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**.



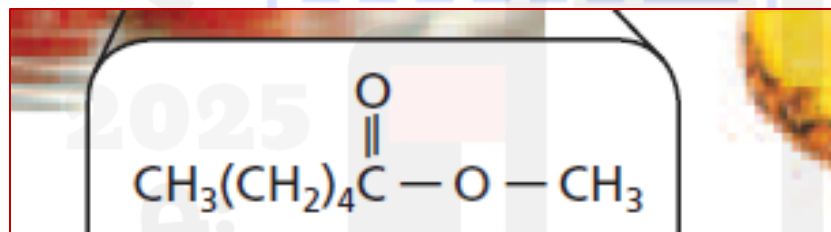
# Naming esters

- Write the **name** of the **alkyl group** followed by the **name of the acid** with the *-ic acid* ending replaced by *-ate*.
- Note how the name *propyl* results from the structural formula.
- The name shown in parentheses is based on the name *acetic acid*, the common name for ethanoic acid.



# Naming esters

- Write the **name** of the **alkyl group** followed by the **name of the acid** with the *-ic acid* ending replaced by *-ate*.
- Note how the name *propyl* results from the structural formula.
- The name shown in parentheses is based on the name *acetic acid*, the common name for ethanoic acid.



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# Properties of Esters

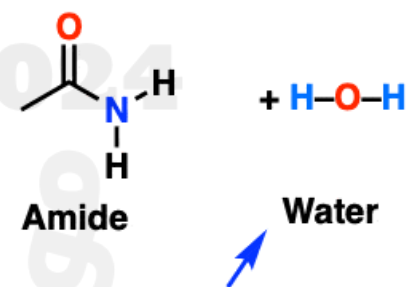
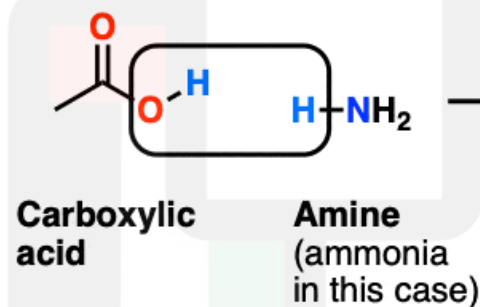
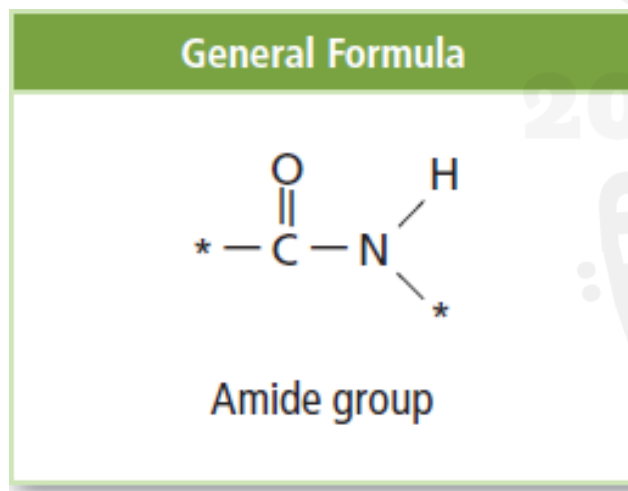
- polar molecules and many are volatile and sweet-smelling.
- Therefore, esters are manufactured for use as flavors in many foods and beverages and as fragrances in candles, perfumes, and other scented items.





# Amides

- 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.



A "condensation" reaction because water is a byproduct

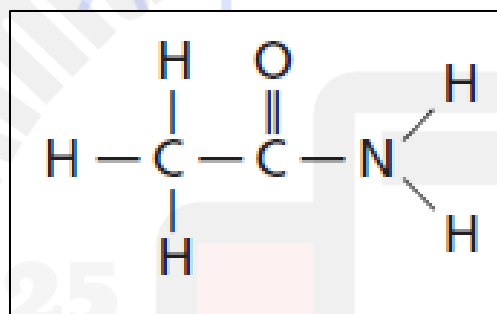
Bonds Formed	Bonds Broken
C-N	C-O
O-H	N-H



# Amides

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- The general structure of an amide is shown in **table**.
- 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**.

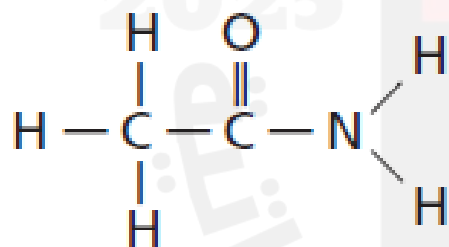


# Amides

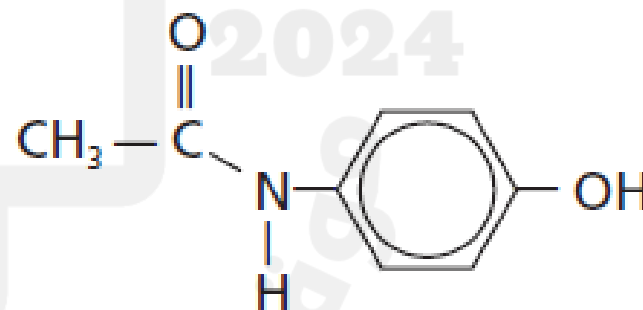
معاد عز Mouad Azz

- The general structure of an amide is shown in **table**.
- 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**.
- Thus, the amide shown in **table** is called ethanamide, but it can also be named **acetamide** from its common name, **acetic acid**.

## Examples of Amides



Ethanamide (acetamide)



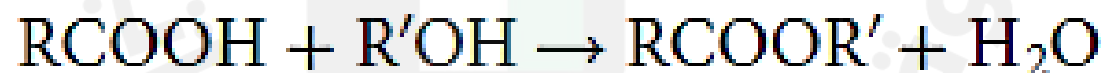
Acetaminophen

# Condensation Reactions

- In a **condensation reaction**, two smaller organic molecules combine to form a more complex molecule, accompanied by the loss of a small molecule such as water.
- In essence, a **condensation reaction** is an **elimination reaction** in which a bond is formed between two atoms not previously bonded to each other.

# Condensation Reactions

- The most common condensation reactions involve the **combining of carboxylic acids with other organic molecules**.
- A common way to **synthesize an ester** is by a **condensation reaction** between a carboxylic acid and an alcohol.
- Such a reaction can be represented by the following general equation.



## Condensation Reactions

- In a **condensation reaction**, two smaller organic molecules combine to form a more complex molecule, accompanied by the loss of a small molecule, such as water.

