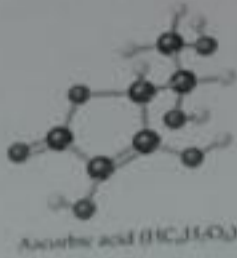
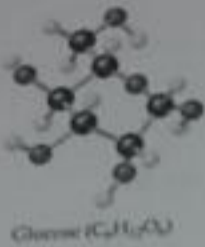


Introduction To Organic Chemistry

> The existence of a great number of different organic compounds has raised up the need to classify them into "families".
 تم تصنيف المركبات العضوية إلى عائلات



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الهيدروكربونات

3

Hydrocarbons

- The family of "Hydrocarbons" is the simplest family of organic compounds, containing only hydrogen and carbon atoms.
 التي تتوي على كربون وهيدروجين فقط
- Hydrocarbons are non-polar molecules, insoluble in water and soluble in non-polar solvents.
 غير قطبية ولا تذوب في الماء
- Hydrocarbons have low melting and boiling points.
- There are four basic types of hydrocarbons:
 - Alkanes (C-C) الألكانات
 - Alkenes (C=C) الألكينات
 - Alkynes (C≡C) الألكاينات
 - Aromatic hydrocarbons (C₆H₆) المركبات الأروماتية

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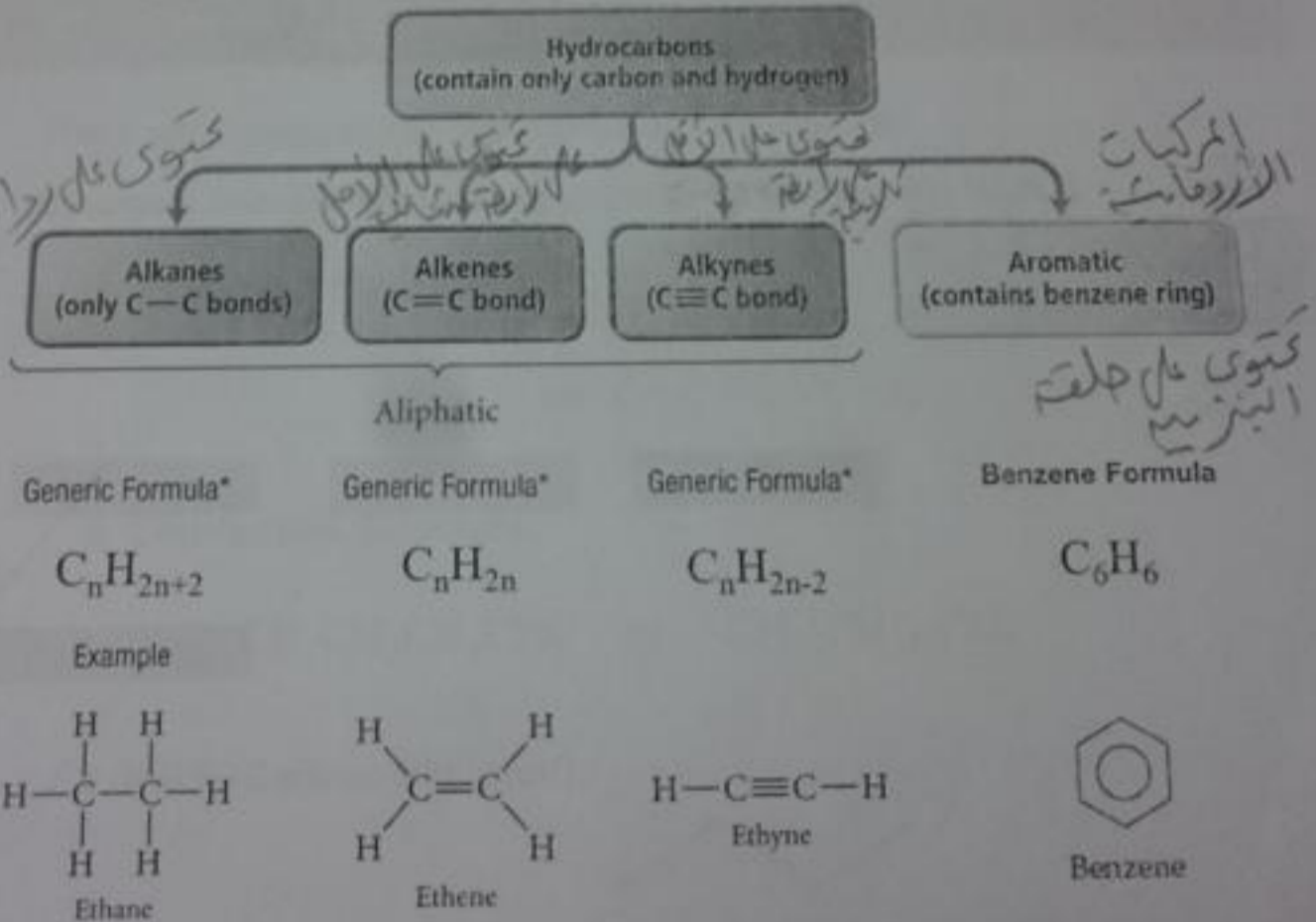
Types of Hydrocarbons

TABLE 2.1 The Four Hydrocarbon Types

Type	Example	Chemical Formula	Ball-and-Stick Model	Structural Formula
Alkane	Ethane	CH_3CH_3		
Alkene	Ethylene (Ethene)	$\text{CH}_2=\text{CH}_2$		
Alkyne	Acetylene (Ethyne)	$\text{CH}\equiv\text{CH}$		
Aromatic	Benzene	C_6H_6		

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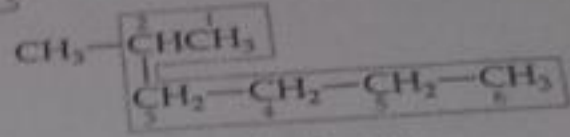


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Nomenclature of Alkanes

1. Find the longest continuous chain of carbon atoms in the molecule and use this chain as the base name (see the table of base names).



2-Methylhexane

2. Number the carbon atoms in the longest chain, beginning with the end nearest to a substituent.

3. Name each substituent (prefixes)

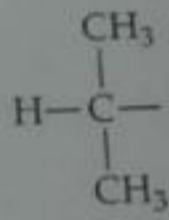
4. Begin the name with the number or numbers of carbon atoms to which each substituent is bonded.

5. When two or more substituents are present, list them alphabetically

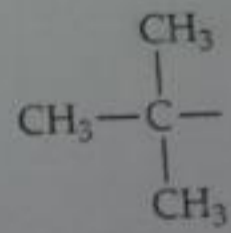
Names of Substituent Groups (Branches)

➤ Carbon Groups (alkyl groups, R):

- Methyl CH_3-
- Ethyl CH_3CH_2-
- Propyl $\text{CH}_3\text{CH}_2\text{CH}_2-$
- Butyl $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2-$



Isopropyl



tert-Butyl

➤ Halogens:

- Fluoro $\text{F}-$
- Chloro $\text{Cl}-$
- Bromo $\text{Br}-$
- Iodo $\text{I}-$

Properties of Alkanes

Boiling points of Alkanes increase as chain length increases.

TABLE 24.2 - First Ten Members of the Straight-Chain Alkane Series

Molecular Formula	Condensed Structural Formula	Name	Boiling Point (°C)
CH ₄	CH ₄	Methane	-161
C ₂ H ₆	CH ₃ CH ₃	Ethane	-89
C ₃ H ₈	CH ₃ CH ₂ CH ₃	Propane	-44
C ₄ H ₁₀	CH ₃ CH ₂ CH ₂ CH ₃	Butane	-0.5
C ₅ H ₁₂	CH ₃ CH ₂ CH ₂ CH ₂ CH ₃	Pentane	36
C ₆ H ₁₄	CH ₃ CH ₂ CH ₂ CH ₂ CH ₂ CH ₃	Hexane	68
C ₇ H ₁₆	CH ₃ CH ₂ CH ₂ CH ₂ CH ₂ CH ₂ CH ₃	Heptane	98
C ₈ H ₁₈	CH ₃ CH ₂ CH ₂ CH ₂ CH ₂ CH ₂ CH ₂ CH ₃	Octane	125
C ₉ H ₂₀	CH ₃ CH ₂ CH ₂ CH ₂ CH ₂ CH ₂ CH ₂ CH ₂ CH ₃	Nonane	151
C ₁₀ H ₂₂	CH ₃ CH ₂ CH ₂ CH ₂ CH ₂ CH ₂ CH ₂ CH ₂ CH ₂ CH ₃	Decane	174

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Isomers of Alkanes

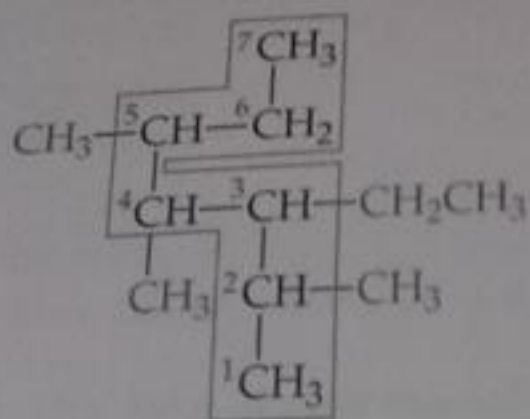
Isomers: compounds that have the same molecular formula but different chemical structures (i.e. different order of bonding).

Systematic Name (Common Name)	Structural Formula	Condensed Structural Formula	Space-Filling Model	Melting Point (°C)	Boiling Point (°C)
Butane (n-butane)		CH ₃ CH ₂ CH ₂ CH ₃		-138°C	-0.5°C
2-Methylpropane (isobutane)		CH ₃ -CH(CH ₃)-CH ₃		-138°C	-11.7°C
Pentane (n-pentane)		CH ₃ CH ₂ CH ₂ CH ₂ CH ₃		-129°C	-31°C
2-Methylbutane (isopentane)		CH ₃ -CH(CH ₃)-CH ₂ -CH ₃		-108°C	+2°C
2,2-Dimethylpropane (neopentane)		CH ₃ -C(CH ₃) ₄		-18°C	+9°C

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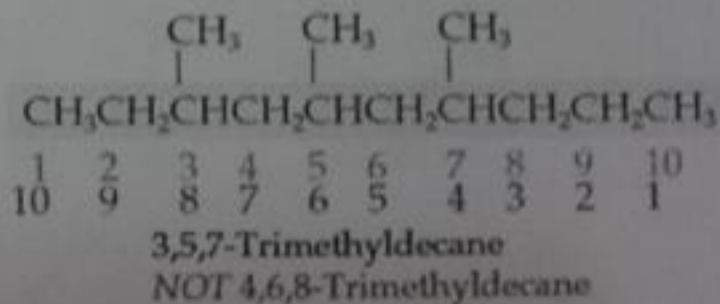
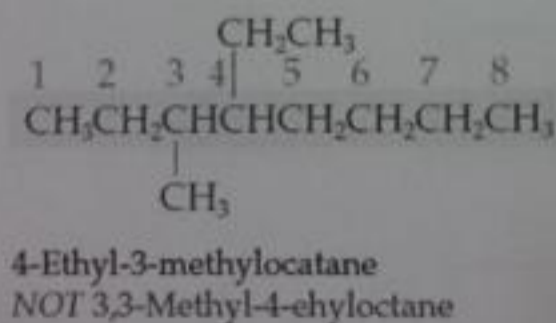
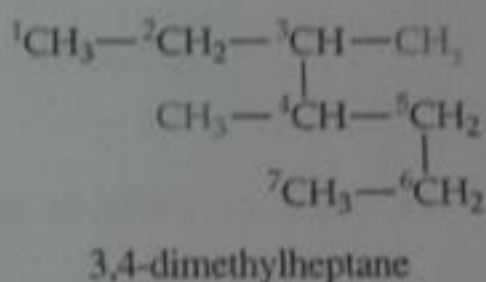
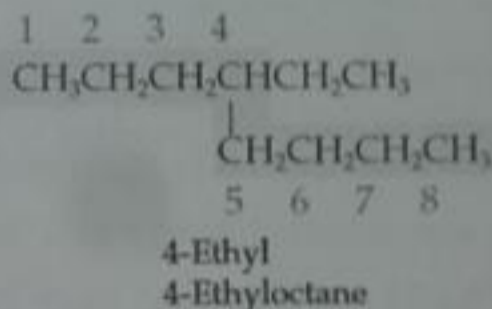
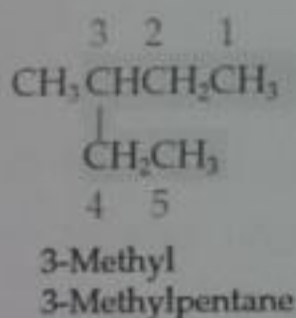
Names of Substituent Groups (Branches)



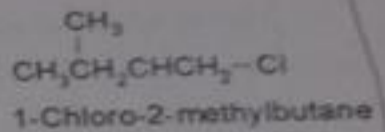
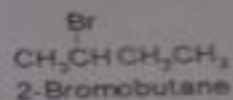
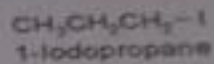
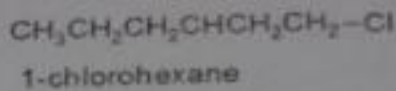
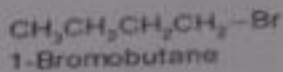
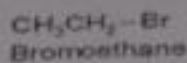
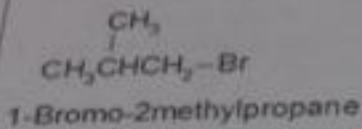
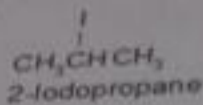
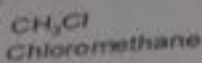
3-Ethyl-2,4,5-trimethylheptane

If there is more than one type of substituent in the molecule, list them "alphabetically".

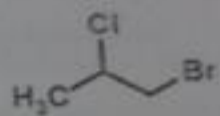
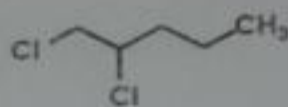
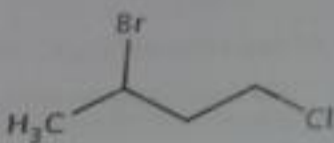
Nomenclature of Alkanes: Exercises



Nomenclature of Alkanes: Exercises



➤ Practice: Name the following compounds:

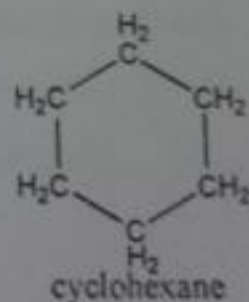
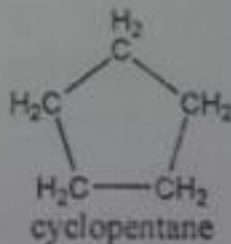
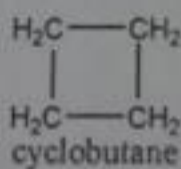
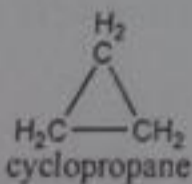


Cycloalkanes

- Carbon can also form cyclic (ringed) structures.

The general formula of cycloalkanes is C_nH_{2n}

- Five- and six-carbon rings are most stable.
- Smaller rings than five carbon atoms are quite strained because the angle of C-C bond must be less than 109.5° .



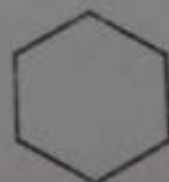
cyclopropane



cyclobutane

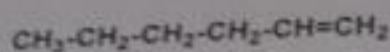


cyclopentane

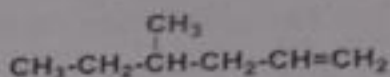


cyclohexane

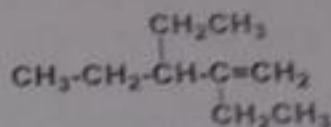
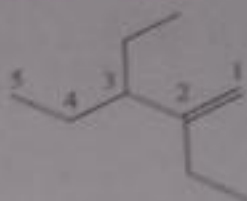
Nomenclature of Alkenes



1-Hexene



4-methyl-1-hexene



2,3-diethyl-1-pentene

Note: If an alkene contains two or more double bonds, the location of each is indicated by numerical prefix, and the ending of the name is altered to identify the number of double bonds: diene(two), triene (three);

Example: $\text{CH}_2=\text{CH}-\text{CH}_2-\text{CH}=\text{CH}_2$ is named: 1,4-pentadiene.

تفاعلات الألكينات

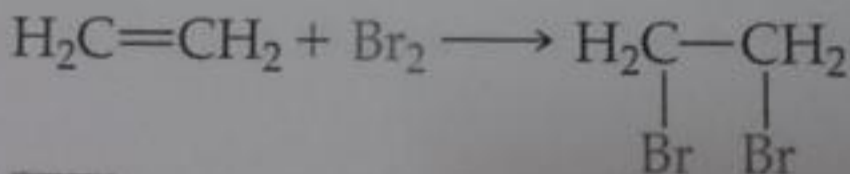
Addition Reactions of Alkenes

تفاعل الإضافة

➤ One important reaction of alkenes is the **Addition Reaction**:

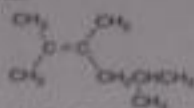
- In which, two atoms (e.g., bromine) add across the double bond.

- One π -bond (from $\text{C}=\text{C}$) and one σ -bond (from $\text{Br}-\text{Br}$) are replaced by two σ -bonds (2 $\text{C}-\text{Br}$); therefore, ΔH is negative.



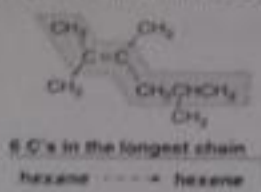
Nomenclature of Alkenes

Example Give the IUPAC name of the following alkene:



الاسم الصحيح
هو
الاسم الصحيح
للربطة المزدوجة

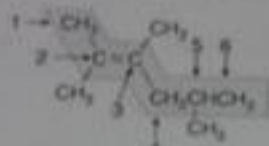
Step [1] Find the longest chain that contains both carbon atoms of the double bond.



• Change the -ane ending of the parent alkane to -ene

Step [2] Number the carbon chain to give the double bond the lower number, and apply all other rules of nomenclature.

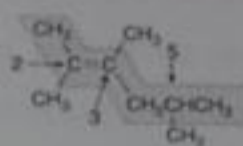
(a) Number the chain, and name using the first number assigned to the C=C



• Number the chain to put the C=C at C2, not C4

2-hexene

(b) Name and number the substituents.

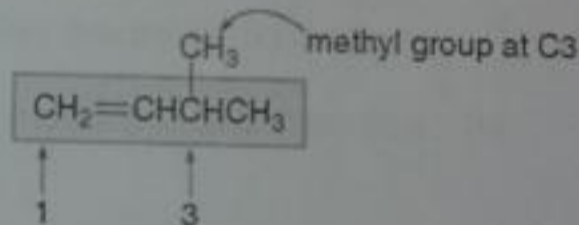
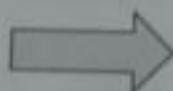
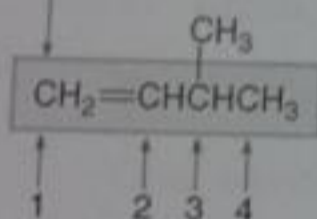


three methyl groups at C2, C3, and C5

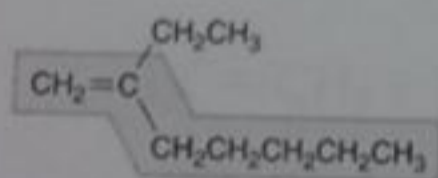
Answer: 2,3,5-trimethyl-2-hexene

Nomenclature of Alkenes

Start numbering here.



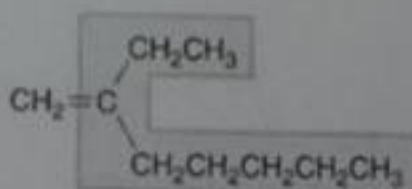
Answer: 3-methyl-1-butene



7 C's ----> heptene

Both C's of the C=C are contained in this long chain.

Correct: 2-ethyl-1-heptene



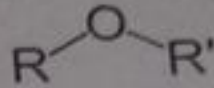
8 C's

Both C's of the C=C are NOT contained in this long chain.

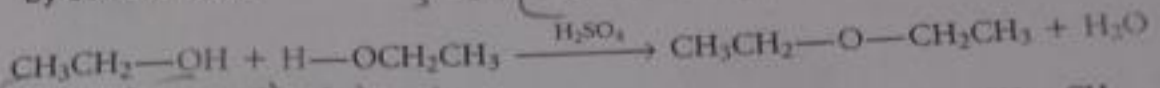
Incorrect

Ethers (R-O-R)

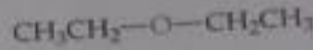
Ethers: compounds in which two hydrocarbon groups (R) are bonded to one oxygen atom.



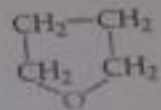
- Ethers can be formed from two molecules of alcohol by splitting out a molecule of water (**Condensation Reaction**). This reaction is catalyzed by sulfuric acid.



Ethers tend to be quite **unreactive**. Therefore, they are common solvents for organic reactions.



Diethyl ether



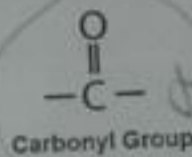
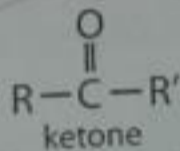
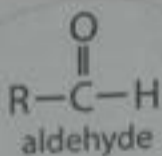
Tetrahydrofuran (THF)

Some Ethers are used as medical "anesthetics" that inhibit pain signals to the brain during surgeries.

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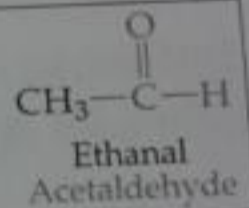
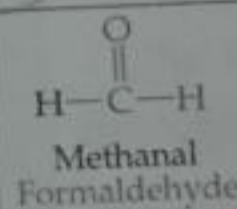
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Aldehydes (R-CO-H) and Ketones (R-CO-R')

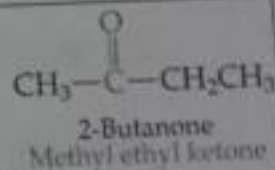
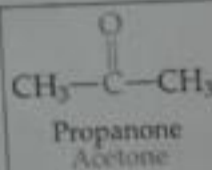


Alkyl Group (e.g. CH₃-)

In Aldehydes, at least one "H" is attached to the carbonyl (C=O) carbon atom.



In Ketones, there are two "C" bonded to the carbonyl (C=O) carbon atom.



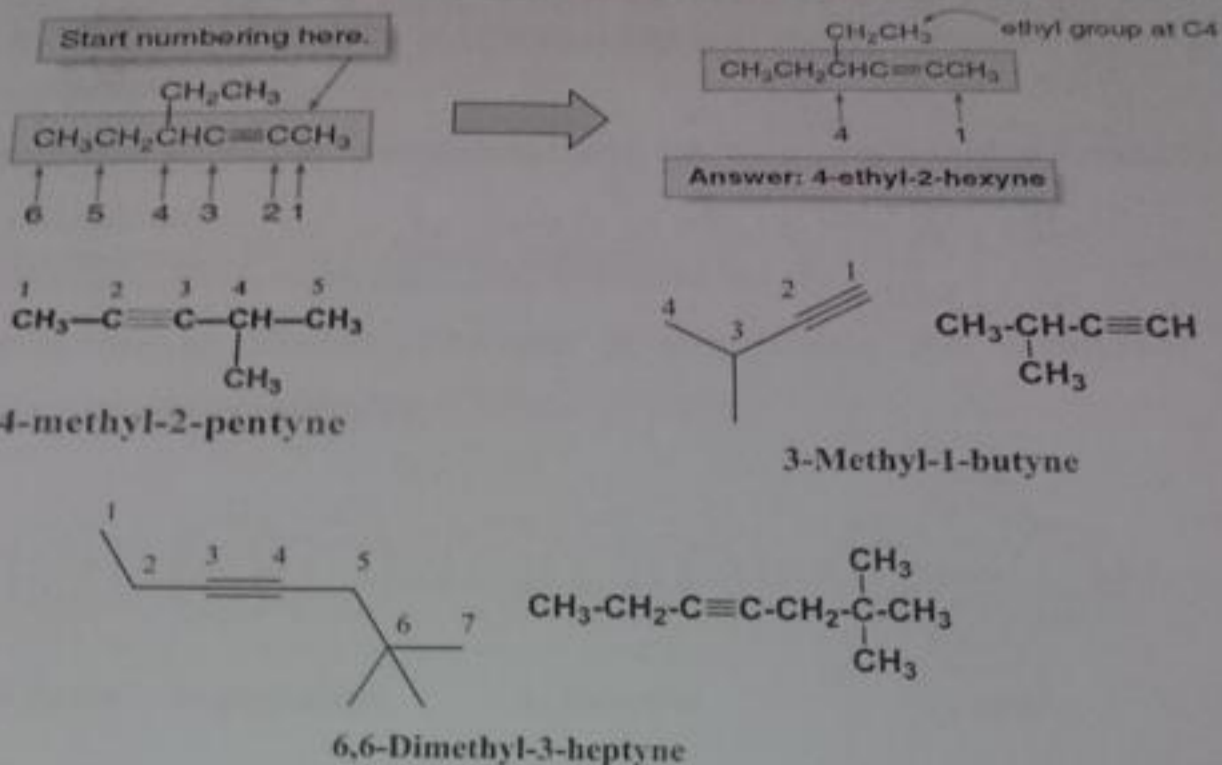
The systematic names of **aldehydes** are ended by the suffix **-al** and that of **ketones** are ended by the suffix **-one**.

They can be prepared by the controlled **oxidation** of alcohols.

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Nomenclature of Alkynes



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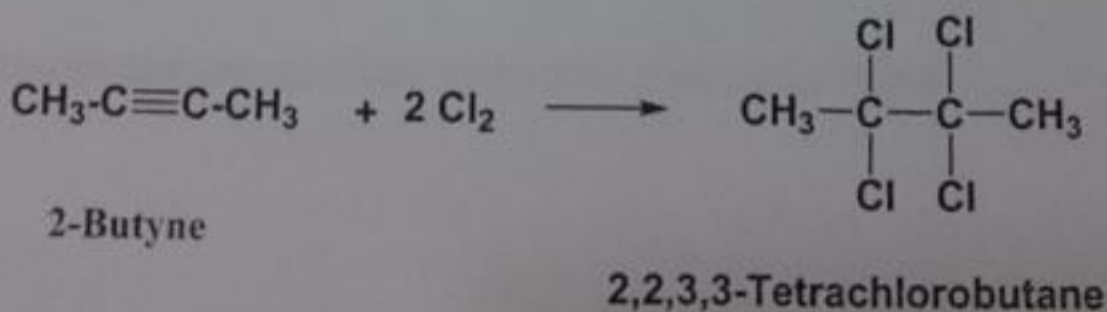
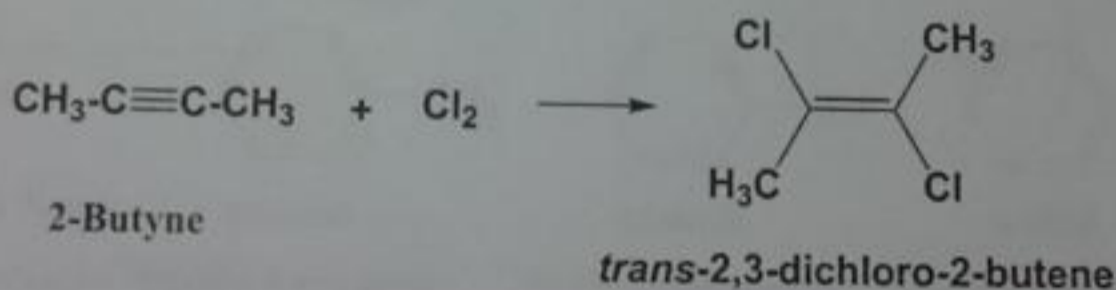
31

تفاعلات الألكاينات

Addition Reactions of Alkynes

تفاعل الإضافة

- Alkynes undergo many of the same reactions that alkenes do.
- As with alkenes, the drive for the addition reaction is the replacement of π -bonds by σ -bonds.

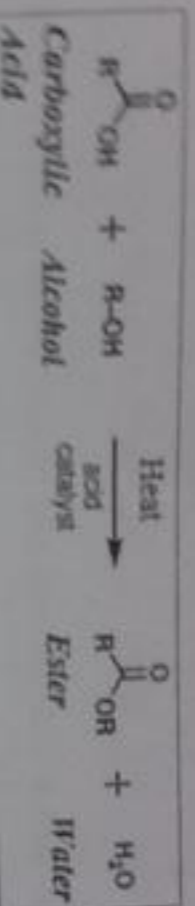


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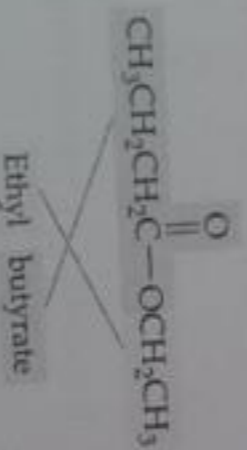
Esters

- Esters can be synthesized by **Condensation Reactions** of *carboxylic acids* with *alcohols*:



- The name of any ester consists of the name of the "R" group coming from the alcohol followed by the name of the group coming from the *carboxylic acid*, with the *-ic* replaced by *-ate*.

For example, the ester formed from ethyl alcohol, $\text{CH}_3\text{CH}_2\text{OH}$, and butyric acid, $\text{CH}_3(\text{CH}_2)_2\text{COOH}$, is:



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Common Fruit Esters

