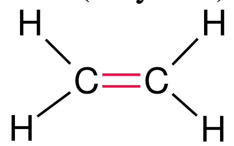
Section 3

ALKENES AND ALKYNES

Hydrocarbons

Saturated	unsaturated
Hydrocarbons containing a single covalent bond between carbon atoms	Hydrocarbons containing at least a double or a triple covalent bond between carbon atoms

Alkanes	Alkenes	Alkynes
C – C	C = C	C ≡ C

	Alkenes	Alkynes
defination	Hydrocarbons have **at least one double covalent bond** between the carbon atoms.	Hydrocarbons have **at least one triple covalent bond** between the carbon atoms.
General formula	C_nH_{2n}	C_nH_{2n-2}
Smallest molecular formula	C_2H_4 Ethene (ethylene) (smaller alkene)  $CH_2 = CH_2$ Two C atoms are bonded by a covalent bond and the remaining four e-, two of each atom shared with four H atoms.	C_2H_2 Ethyne (acetylene) (smaller alkyne) $CH \equiv CH$  Two C atoms are bonded with a triple covalent bond and the remaining two e-, everyone for each H atom.

Explain: **There is no Alkene contain one carbon atom (methene, for example):** because alkene must contain a double covalent bond between two carbon atoms.

Explain: **There is no Alkyne contain one carbon atom (methyne, for example):** Because alkyne must contain a triple covalent bond between two carbon atoms.

Notes

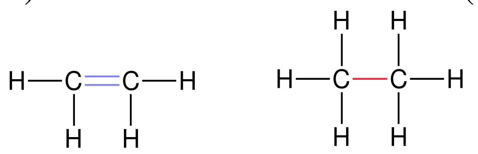
1- Alkene containing a single double covalent bond forms homogeneous chain.

2 - Alkene is less than the corresponding alkanes with two H atoms. **explain** due to the removal of two hydrogen atoms (each with its electron) from the alkans to turn into an alkene.

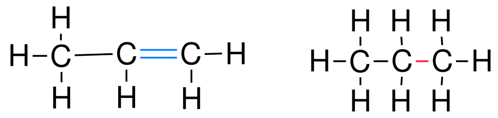
nomenclature

Straight alkenes:

1 - The suffix (ane) in the alkane is converted to (ene) in the alkene.



ethane **ethene**) **old name:ethelene(**



propane propene) **old name:proplene(**

2 – we choose the longest carbon chain contain the doube bond.

3 – we begin numbering from the carbon near to double bond.

$CH_3-CH=CH-CH_2-CH=CH_2$ (×)
1 2 3 4 5 6

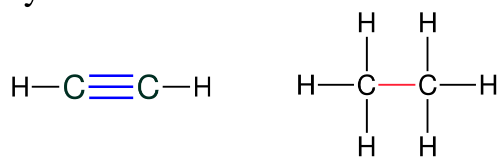
$CH_3-CH=CH-CH_2-CH=CH_2$ (√)
6 5 4 3 2 1

If the position of the two bonds (=) is equal to the two sides, the priority is to the branched group according to the above.

$CH_2=CH-CH_2-CH_2-CH=CH_2$
1 2 3 4 5 6
6 5 4 3 2 1 (√)

Straight alkynes:

1 - The suffix (ane) in the alkane is converted to (yne) in the alkyne.



ethyne **ethane**

2 – we choose the longest carbon chain contain the tripple bond.

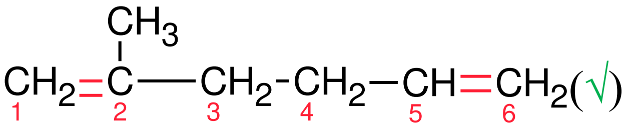
3 – we begin numbering from the carbon near to tripple bond.

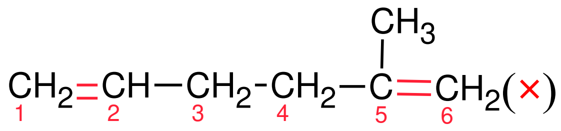
(×) $CH_3-CH_2-CH_2-CH_2-C\equiv CH$
1 2 3 4 5 6

(√) $CH_3-CH_2-CH_2-CH_2-C\equiv CH$
6 5 4 3 2 1

If the position of the two bonds (≡) is equal to the two sides, the priority is to the branched group according to the above.

$CH\equiv C-CH_2-CH_2-C\equiv CH$
1 2 3 4 5 6
(√) 6 5 4 3 2 1

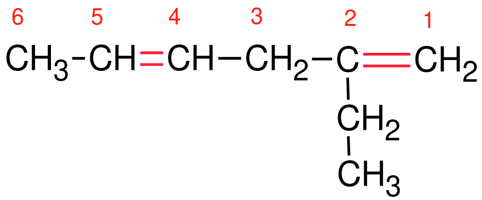


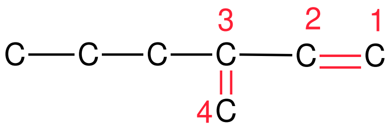


Branched alkenes:

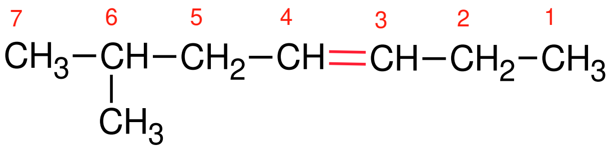
1 - Follow the rules of IUPAC system in naming branched alkanes, **bearing in mind two things:**

A - the main chain in alkenes is always the longest chain **containing the double covalent bonds**, whether or not the longest carbon chain.



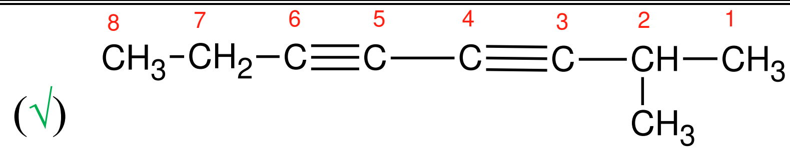


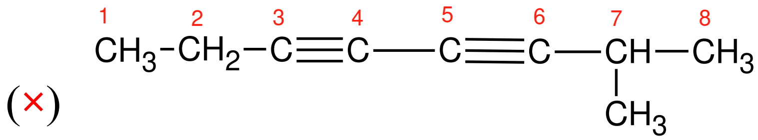
B - The location of the double covalent bond is determined, not the branches.



2 - In the event that there is more than one bouble covalent bond, the prefix "Di / Tri / Tetra ......" shall be used before the phrase "ene"

►bonds are numbered to produce the smallest set of numbers.

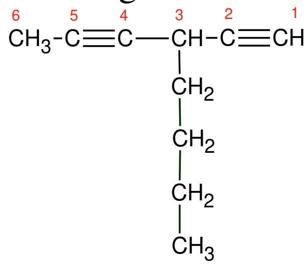




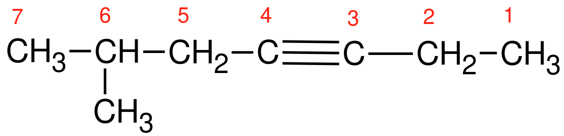
Branched alkynes:

1 - Follow the rules of IUPAC system in naming branched alkanes, **bearing in mind two things:**

A - the main chain in alkynes is always the longest chain **containing the tripple covalent bonds**, whether or not the longest carbon chain.



B - The location of the tripple covalent bond is determined, not the branches.

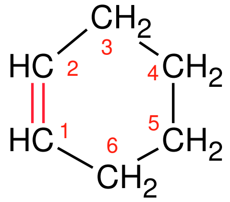


2 - In the event that there is more than one tripple covalent bond, the prefix "Di / Tri / Tetra ......" shall be used before the phrase "yne"

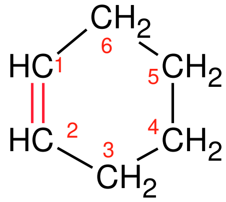
►bonds are numbered to produce the smallest set of numbers.

Cycloalkene:

They are named in the same way of cycloalkanes, the number 1 is to carbon bonded to double covalent bond**.**

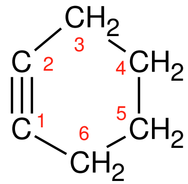


أو

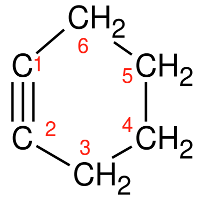


Cycloalkyne:

They are named in the same way of cycloalkanes, the number 1 is to carbon bonded to tripple covalent bond**.**

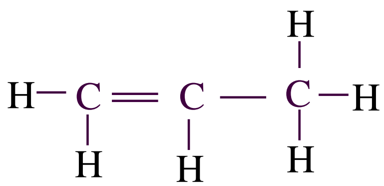


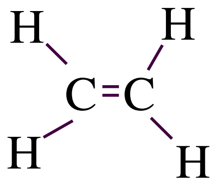
أو



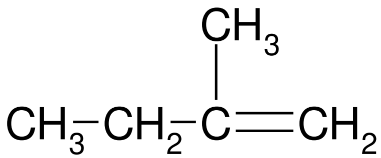
Q: Use IUPAC rules to name the following structural formulas

examples



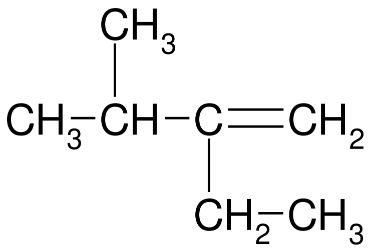


$CH \equiv CH$

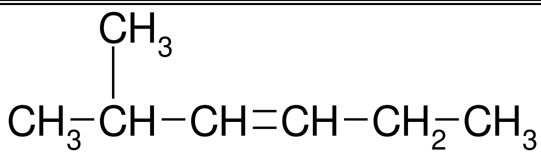


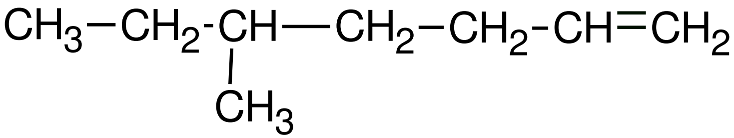
$H_2C{=}CH - CH_3$

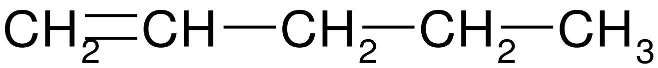
$CH_3 - CH_2 - CH_2 - C \equiv CH$

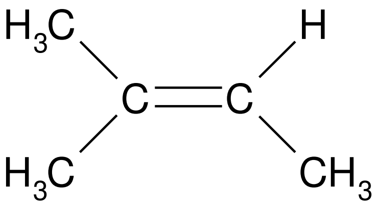


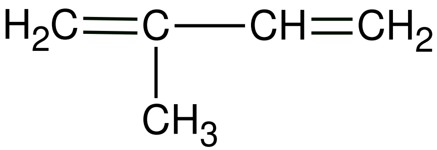
$CH_3 - CH_2 - CH_2 - CH{=}CH - CH_3$

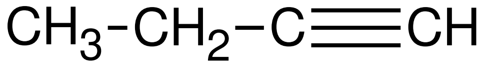


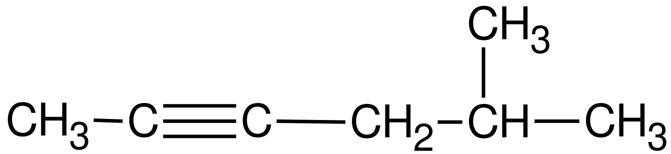


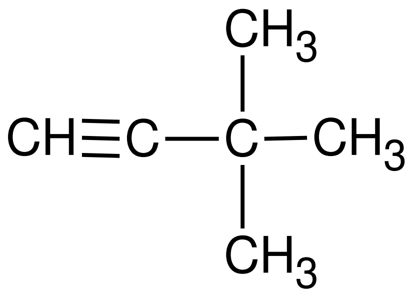


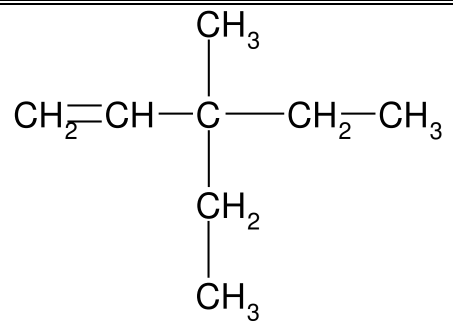


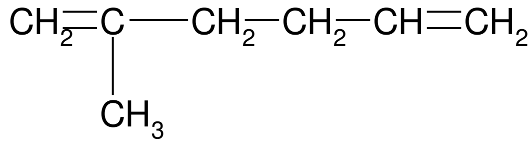


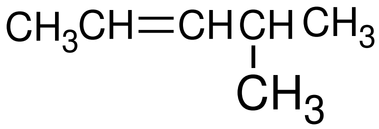


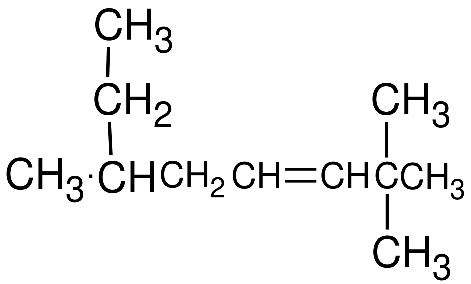


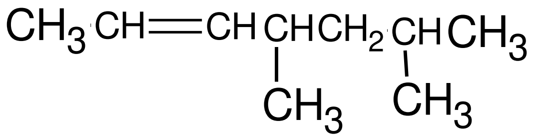






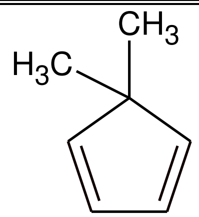


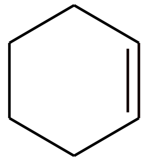


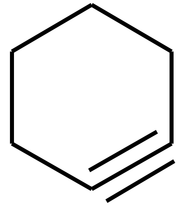


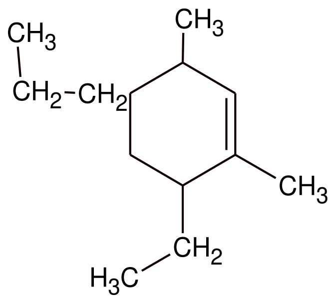
Q: Draw three different structural formulas of alkyne containing **five carbon atoms** and a triple bond. Name the molecule that you drew.

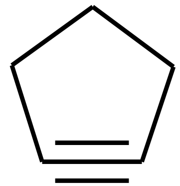
Q - Write the molecular formula of each type of hydrocarbon if it contains **seven carbon** atoms.

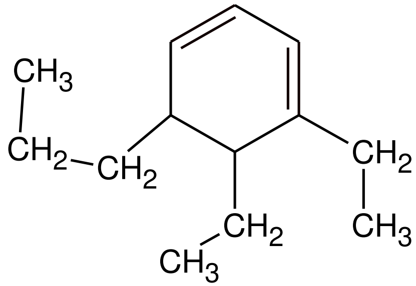












Draw the short condensed formulas for:

2,4-heptadiene

2- methyl - 3-heptene

1,3- butdiene

1 – butene Ethene

4- methyl-1, 3- pentadiene

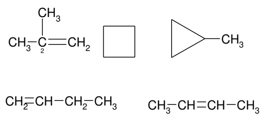
2- butene 2- ethyl-3-methyl-1- butene

Propene 2-methyl-2-hexene

2-methyl butene

3 - ethyl - 2,2 - dimethyl - 3 – heptane
1,3-pentadiene

Q: Draw three condensed formulas that can represent C_4H_8 .



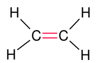
►Draw condensed formulas for:

2-Butyne

3-methyl-1-pentyne

3-methyl-1-butyne

2-ethyl-3-methyl-1-butene

properties	1- Non-polar molecules 2 - Its solubility in water is low 3 - Its melting and boiling point is low 4 - **More active than alkanes**: due to The presence of the easily weak broken **(π) bond**, π bond **increases the electronic density** between the two carbon atoms, causing a good location for chemical activity, and thus the reactants attract (withdraw) π bond away from Double bond. **Explain**: **Although 1- butene and 2- butene have the same structural formula (C_4H_8),** they are different characteristics.	1- Non-polar molecules 2 - Its solubility in water is low 3 - Its melting and boiling point is low 4 - **More active than alkenes**: due to The presence of **two** easily weak broken **(π) bond**, π bond **increases the electronic density** between the two carbon atoms, causing a good location for chemical activity, and thus the reactants attract (withdraw) π bond away from Double bond.
Uses	**Ethene** (**ethylene**) () ($CH_2 = CH_2$) C_2H_4 1 - A **naturally produced hormone** produced by plants, which is responsible for the **ripening process** in fruits, and **added to fruits before ripening** until **they are ripe.** 	**ethyne** (**acetylene**)**:**($H-C\equiv C-H$) ($CH\equiv CH$) (C_2H_2) 1 - In **metal cutting** and **welding** (**explain**): because of the **presence of the triple covalent bond** in which **increases the activity** and reactivity of **ethyne** (**acetylene**) and therefore **burns strongly with oxygen** and give **oxy-acetylene flame** whose temperature may reach 3000^0C $2C_2H_2 + 5O_2 \rightarrow 4CO_2 + 2H_2O$ 

	2 - It plays a role in **falling leaves from** trees in preparation for the winter**.** 3 - **Manufacture of polyethylene** plastic material used in the manufacture of (plastic bags - ropes - milk cans) **Note**: There are other alkenes responsible for the smells of yellow lemon, green lemon and **pine** trees**.**	2 - As **raw materials in the plastics industry** (**explain**): Because the triple covalent bond makes alkynes more active, and thus can be a raw material in the plastics industry. **Notes**: 1-Ethyne is a **by-product of oil refining** 2- It results from the reaction of **calcium carbide with water** $CaC_{2(s)} + 2H_2O_{(l)} \rightarrow H-C \equiv C-H_{(g)} + Ca(OH)_{2(aq)}$

Section 21.3 Assessment

Section Summary

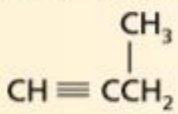
- Alkenes and alkynes are hydrocarbons that contain at least one double or triple bond, respectively.
- Alkenes and alkynes are nonpolar compounds with greater reactivity than alkanes but with other properties similar to those of alkanes.

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

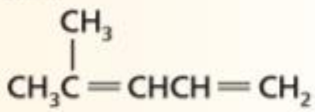
20. **Identify** how the chemical properties of alkenes and alkynes differ from those of alkanes.

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

a.



b.



22. **Draw** the molecular structure 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 research data to see it if supports your idea.

24. **Predict** What geometric arrangement 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.)*

Section 21.3

Mastering Concepts

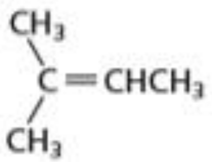
59. Explain how alkenes differ from alkanes. How do alkynes differ from both alkenes and alkanes?

60. The name of a hydrocarbon is based on the name of the parent chain. Explain how the determination of the parent chain when naming alkenes differs from the same determination when naming alkanes.

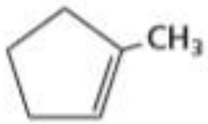
Mastering Problems

61. Name the compound represented by each of the following condensed structural formulas.

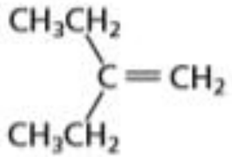
a.



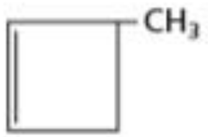
c.



b.



d.



62. Draw condensed structural formulas for the following compounds. Use line structures for rings.

a. 1,4-diethylcyclohexene
b. 2,4-dimethyl-1-octene
c. 2,2-dimethyl-3-hexyne

63. Name the compound represented by the following condensed structural formula.