

Alkynes



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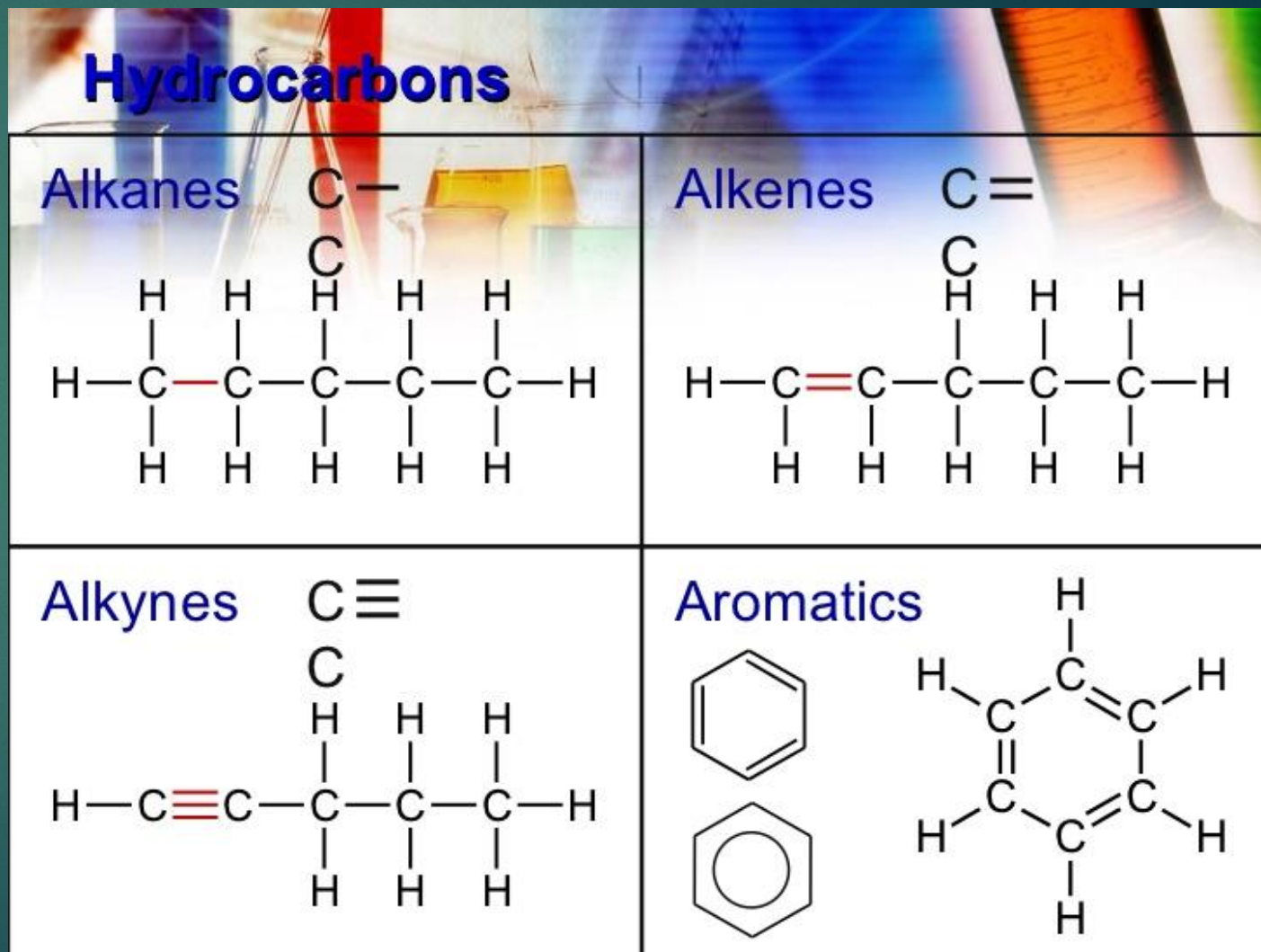
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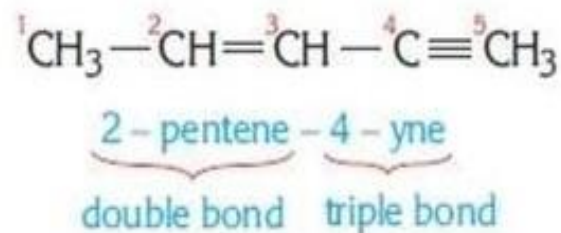
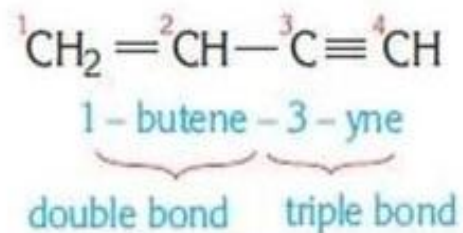
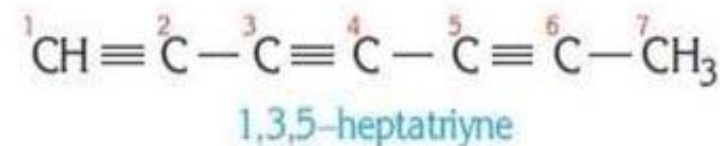
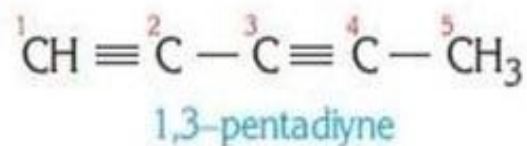
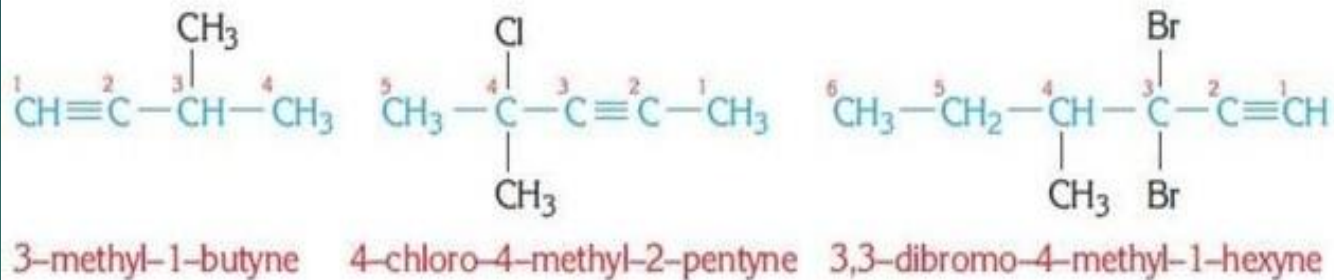
Alkynes (or acetylenes)

- ▶ **Hydrocarbons that contain the carbon-carbon triple bond —C (triple)C— are called alkynes**
- ▶ General formula: $\text{C}_n\text{H}_{2n-2}$ ($n > 1$)
- ▶ Alkynes are named by using the —yne suffix in place of the —ane suffix of alkanes.
- ▶ **Each triple bond contains one sigma (σ) and two pi (π) bonds.**
- ▶ **Because of the π bonds in their structure alkynes are unsaturated hydrocarbons.**



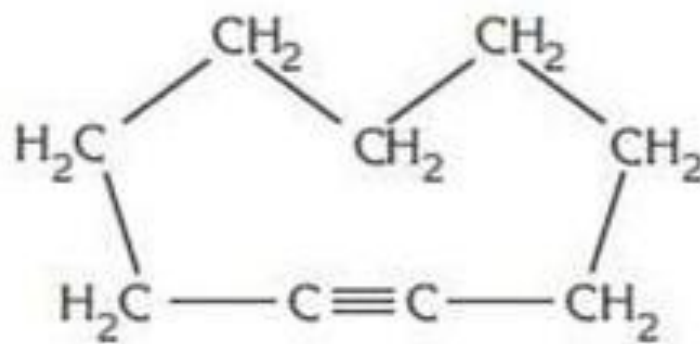
NOMENCLATURE

- ▶ The naming of alkynes is similar to that of other hydrocarbons.
- ▶ Alkynes may contain more than one triple bond.
- ▶ Alkenynes



CYCLOALKYNES

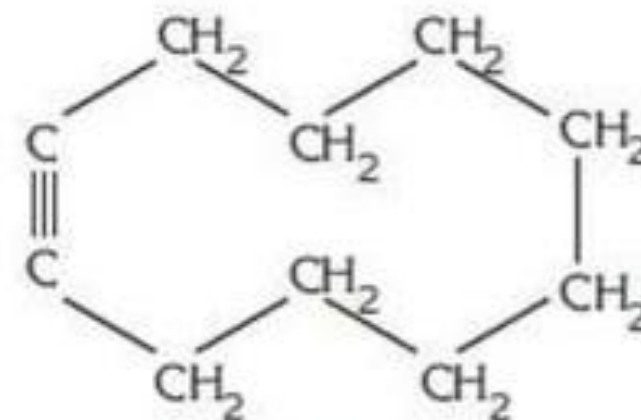
- ▶ Alkynes may be cyclo compounds (cycloalkynes).
- ▶ The simplest stable cycloalkyne at room temperature is cyclononyne.



cyclononyne



cyclononyne



cyclodecyne



cyclodecyne

ISOMERISM

- ▶ The triple bond may be in different locations in an alkyne, so alkynes can exhibit structural isomerism.
- ▶ For the first two members of alkynes there is only one possible position for the triple bond, so for these cases there is no isomerism.
- ▶ Alkynes, alkadienes and cycloalkenes containing the same number of carbon atoms are isomers of each other.

Structural formula	Formula	Type of hydrocarbon	Name
$\begin{array}{c} \text{H}_2\text{C} - \text{CH} \\ \quad \quad \parallel \\ \text{H}_2\text{C} - \text{CH} \end{array}$	C_4H_6	cycloalkene	cyclobutene
$\text{CH}_2 = \text{C} = \text{CH} - \text{CH}_3$	C_4H_6	alkadiene	1,2-butadiene
$\text{CH}_2 = \text{CH} - \text{CH} = \text{CH}_2$	C_4H_6	alkadiene	1,3-butadiene
$\text{CH} \equiv \text{C} - \text{CH}_2 - \text{CH}_3$	C_4H_6	alkyne	1-butyne
$\text{CH}_3 - \text{C} \equiv \text{C} - \text{CH}_3$	C_4H_6	alkyne	2-butyne

PHYSICAL PROPERTIES

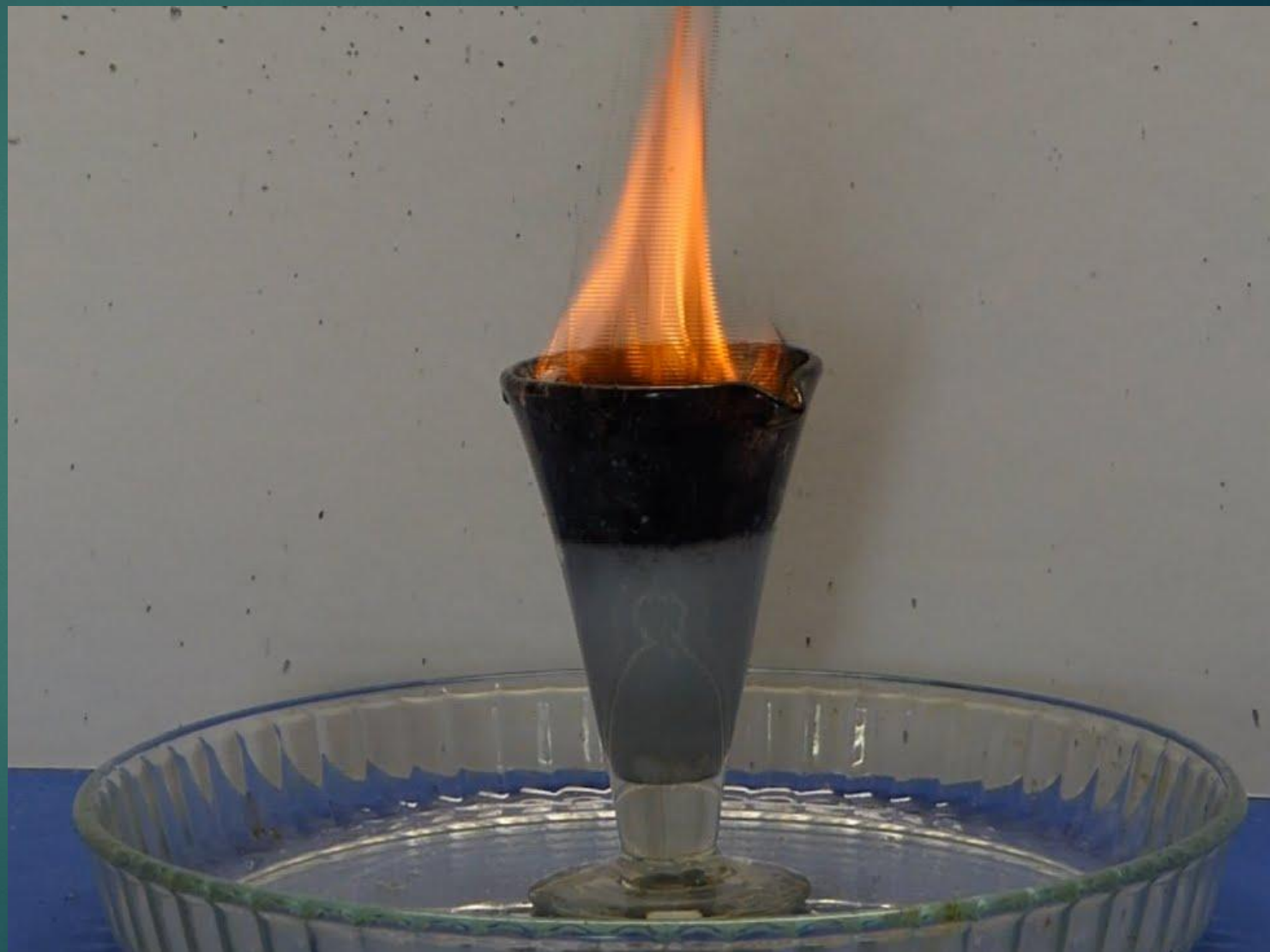
Similar to alkanes,
alkenes :

- ▶ Insoluble in water.
BUT
- ▶ Soluble in organic solvents
- ▶ Density less than water

Name	Number of Carbon	Molecular Formula	Structural Formula
Ethyne	2	C_2H_2	$CH \equiv CH$
Propyne	3	C_3H_4	$CH \equiv CCH_3$
Butyne	4	C_4H_6	$CH \equiv CCH_2CH_3$
Pentyne	5	C_5H_8	$CH \equiv C(CH_2)_2CH_3$
Hexyne	6	C_6H_{10}	$CH \equiv C(CH_2)_3CH_3$
Heptyne	7	C_7H_{12}	$CH \equiv C(CH_2)_4CH_3$
Octyne	8	C_8H_{14}	$CH \equiv C(CH_2)_5CH_3$
Nonyne	9	C_9H_{16}	$CH \equiv C(CH_2)_6CH_3$
Decyne	10	$C_{10}H_{18}$	$CH \equiv C(CH_2)_7CH_3$

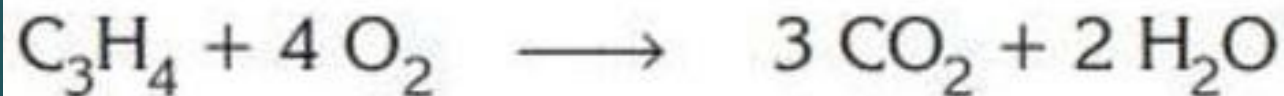
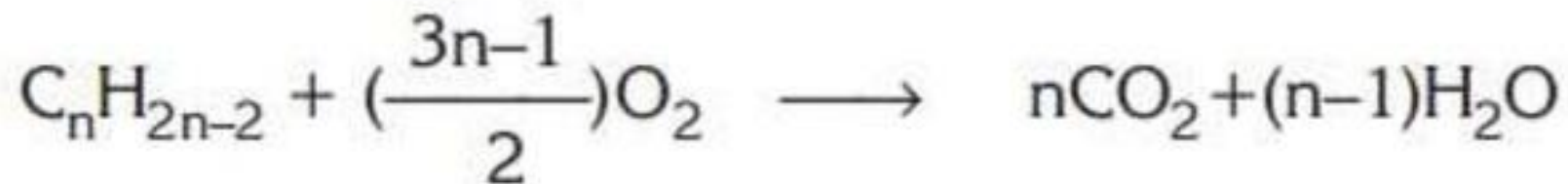
CHEMICAL PROPERTIES

- ▶ Alkynes are unsaturated compounds and their chemical properties are similar to alkenes.
- ▶ Alkynes undergo combustion reactions and addition reactions, as alkenes do.
- ▶ In addition, alkynes undergo substitution reactions with metals.



COMBUSTION REACTIONS

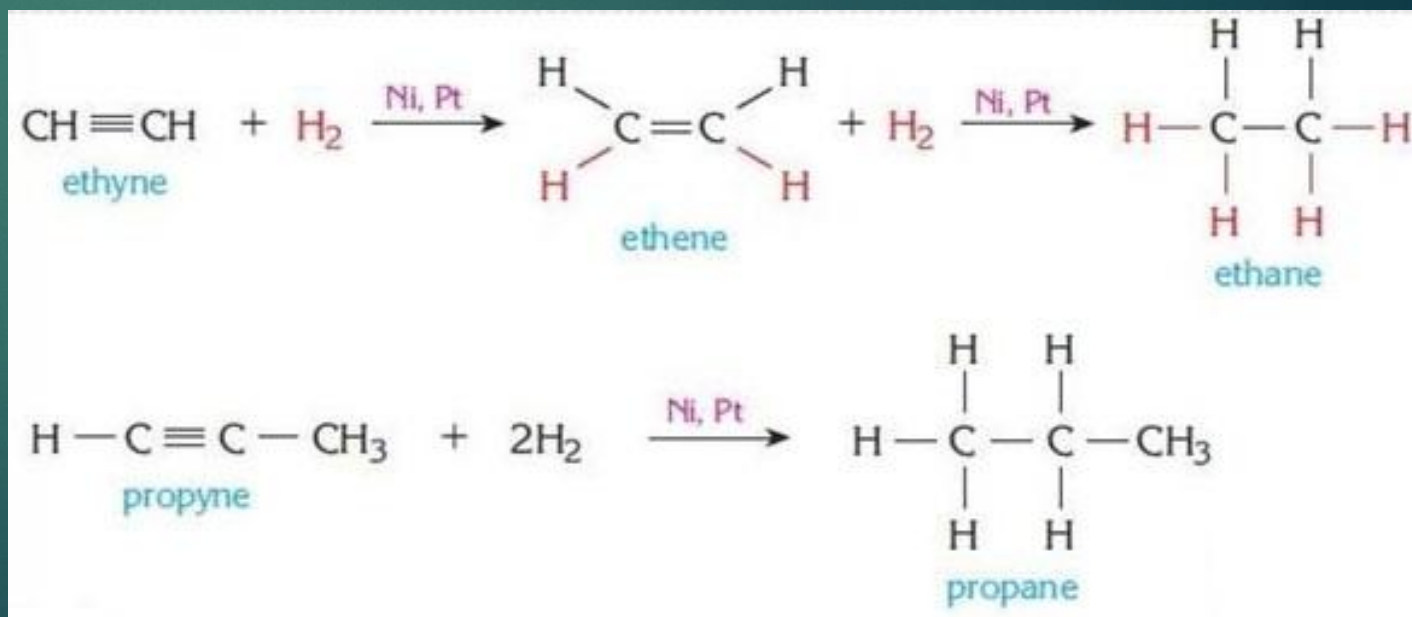
- ▶ Alkynes produce CO₂ and H₂O when they're burnt with a sufficient amount of oxygen. The general combustion reaction is:



ADDITION REACTIONS

- ▶ Addition reactions occur by breaking the π bonds of the triple bond. Hydrogen, halogens, hydrogen halides and water may give addition reactions with alkynes.
- ▶ ADDITION OF HYDROGEN :

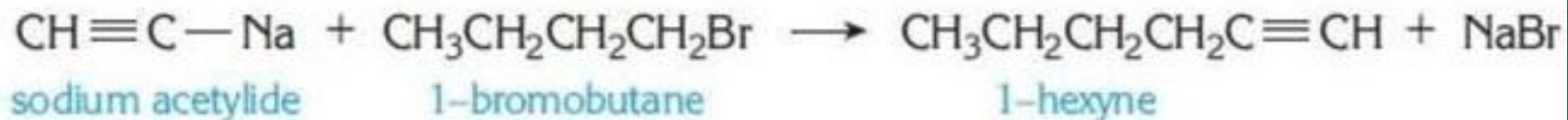
Two hydrogen molecules are added to one triple bond using a nickel, platinum or palladium catalyst. Alkenes are the intermediate products.



PREPERATION OF ALKYNES

- ▶ Alkynes can be synthesized from metallic acetylides and alkyl halides.

BY THE REACTION OF METAL ACETYLIDES AND ALKYL HALIDES



ACETYLENE

Acetylene, the first member of the alkyne series, is one of the major chemicals used in industry.

Physical properties:

- ▶ Very light odor
- ▶ Colorless
- ▶ Soluble in water
- ▶ Soluble in acetone
- ▶ Boiling point -83°C
- ▶ Can be liquified at 1°C

Chemical properties:

- ▶ It burns with a bright flame
- ▶ Explodes at about 15 atm pressure



ALKYNYL GROUP

- ▶ Alkynyl groups are formed from alkynes by removing one H atom. The most common alkynyl groups are ethynyl, 1-propynyl, and 1-butynyl

USES OF ALKYNES

- ▶ **Histrionicotoxin**
toxic alkyne present in South American frogs
used to make poison-tipped arrows
- ▶ **Ichthyothereol**
highly toxic alkyne found in the leaves of a Brazilian herb
used to kill fish
- ▶ **Calicheamicin and Esperamicin**
extremely toxic to cells
breaks double strand of DNA
researchers are trying to use it to develop a cancer fighting drug
- ▶ **Capillin**
natural plant fungicide