**Alkynes**

Alkynes are organic molecules made of the functional group carbon-carbon triple bonds and are written in the empirical formula of CnH2n−2. They are unsaturated hydrocarbons. Alkynes can be a useful functional group to synthesize due to some of their antibacterial, antiphrastic, and antifungal properties. IUPAC nomenclature of Ethan is Ethyne. Like other hydrocarbons, alkynes are generally hydrophobic but tend to be more reactive. Like alkenes have the suffix –ene, alkynes use the ending –yne; this suffix is used when there is only one alkyne in the molecule. If a molecule contains both a double and a triple bond, the carbon chain is numbered so that the first multiple bond gets a lower number.

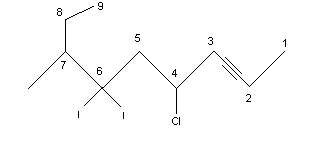
|  |  |
| --- | --- |
| Name | Molecular Formula |
| [Ethyne](http://www.chemicalize.org/?mol=Ethyne) | C2H2 |
| Propyne | C3H4 |
| 1-Butyne | C4H6 |
| 1-Pentyne | C5H8 |
| 1-Hexyne | C6H10 |
| 1-Heptyne | C7H12 |
| 1-Octyne | C8H14 |
| 1-Nonyne | C9H16 |
| 1-Decyne | C10H18 |

**The IUPAC rules for alkynes**

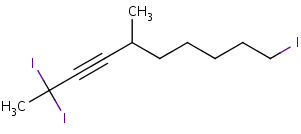
1-Find the longest carbon chain that includes both carbons of the triple bond.

2-Number the longest chain starting at the end closest to the triple bond. A 1-alkyne is referred to as a terminal alkyne and alkynes at any other position are called internal alkynes. For example:

[**4-chloro-6-diiodo-7-methyl-2-nonyne**](http://www.chemicalize.org/?mol=4-chloro-6-diiodo-7-methyl-2-nonyne)

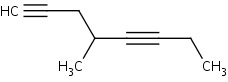


3-After numbering the longest chain with the lowest number assigned to the alkyne, label each of the substituents at its corresponding carbon. While writing out the name of the molecule, arrange the substituents in alphabetical order. If there are more than one of the same substituent use the prefixes di, tri, and tetra for two, three, and four substituents respectively. These prefixes are not taken into account in the alphabetical order. For example:



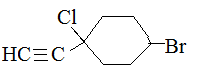
2,2,10-triiodo-5-methyl-3-decyne

When there are two triple bonds in the molecule, find the longest carbon chain including both the triple bonds. Number the longest chain starting at the end closest to the triple bond that appears first. The suffix that would be used to name this molecule would be –diyne. For example:



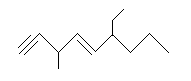
4-methyl-1,5-octadiyne

4-Substituents containing a triple bond are called alkynyl. For example:

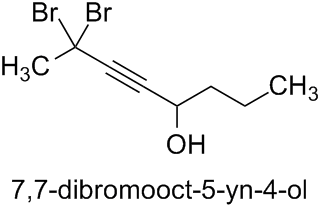
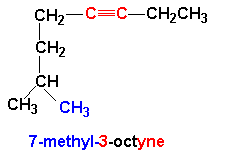


1-chloro-1-ethynyl-4-bromocyclohexane

5-A molecule that contains both double and triple bonds is called an alkenyne. The chain can be numbered starting with the end closest to the functional group that appears first. For example:

[](https://chem.libretexts.org/@api/deki/files/2174/7_(1).bmp?revision=1)

6-ethyl-3-methyl-1,4-nonenyne



**Properties of Alkynes**

Hybridization due to triple bonds allows the uniqueness of alkyne structure. This triple bond contributes to the nonpolar bonding strength, linear, and the acidity of alkynes. Physical Properties include nonpolar due to slight solubility in polar solvents and insoluble in water. This solubility in water and polar solvents is a characteristic feature to alkenes as well.  Alkynes dissolve in organic solvents.

**Synthesis of Alkynes**

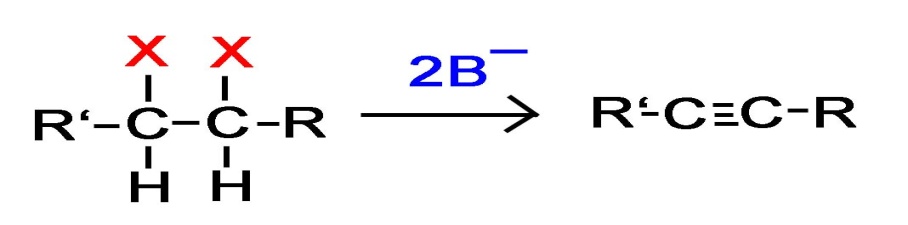
**Commercially**, the dominant alkyne is acetylene itself, which is used as a fuel and a precursor to other compounds, e.g., acrylates. Hundreds of millions of kilograms are produced annually by partial oxidation of natural gas:

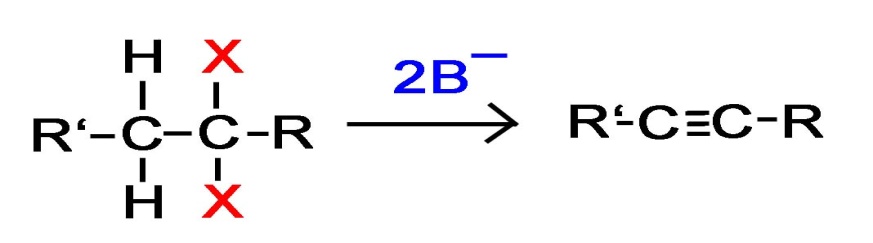
2 CH4 + 3/2 O2 → HC≡CH + 3 H2O

Propyne, also industrially useful, is also prepared by thermal cracking of hydrocarbons. Most other industrially useful alkyne derivatives are prepared from acetylene, e.g. via condensation with formaldehyde.

**Preparation of Alkynes - Elimination Reactions of Dihalides**

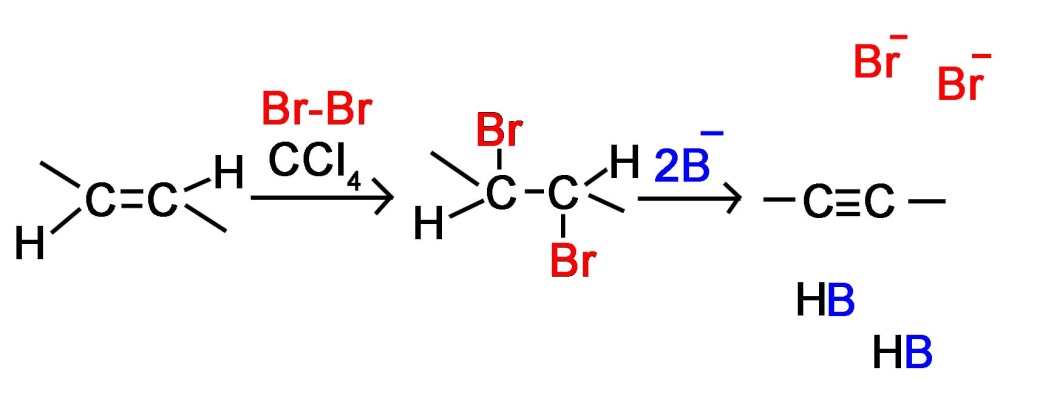
To synthesize alkynes from dihaloalkanes we use dehydrohalogenation. The majority of these reactions take place using alkoxide bases (other strong bases can also be used) with high temperatures.





**Preparation of Alkynes from Alkenes**

**Example**



## Reactions

\***Addition:**

**\*Hydrogenation**

Alkynes undergo catalytic hydrogenation with the same catalysts used in alkene hydrogenation: platinum, palladium, nickel, and rhodium. Hydrogenation proceeds in a stepwise fashion, forming an alkene first, which undergoes further hydrogenation to an alkane.

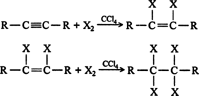
https://www.cliffsnotes.com/%7E/media/b0f90f12e1e947fc98f46e922ec42831.ashx?la=en

Alkynes can also be hydrogenated with sodium in liquid ammonia at low temperatures.

https://www.cliffsnotes.com/%7E/media/06eec737163e41259abcb5692fdc9483.ashx?la=en

**\*Halogenations.**

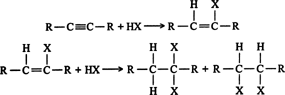
The addition of halogens to an alkyne proceeds in the same manner as halogen addition to alkenes. The halogen atoms add to an alkyne molecule in a stepwise fashion, leading to the formation of the corresponding alkene, which undergoes further reaction to a tetrahaloalkane.



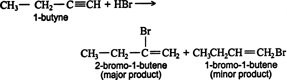
Unlike most hydrogenation reactions, it is possible to stop this reaction at the alkene stage by running it at temperatures slightly below 0°C.

**\*Hydrohalogenation**

Hydrogen halides react with alkynes in the same manner as they do with alkenes.

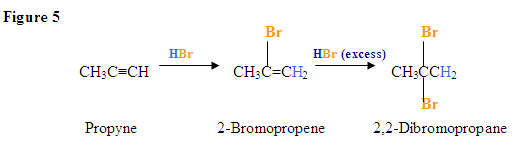


Both steps in the above addition follow the Markovnikov rule. Thus, the addition of hydrogen bromide to 1‐butyne gives 2‐bromo‐1‐butene as the major product of the first step.



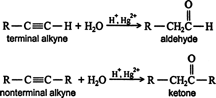
The reaction of 2‐bromo‐1‐butene in the second step gives 2,2‐dibromobutane as the major product.

https://www.cliffsnotes.com/%7E/media/609ac37f351a449c9f6a0489d0dda1f7.ashx?la=en



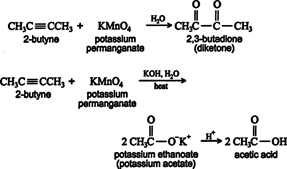
**\*Hydration**

The addition of the elements of water across the triple bond of an alkyne leads to the formation of aldehydes and ketones. Water addition to terminal alkynes leads to the generation of **aldehydes**, while nonterminal alkynes and water generate **ketones.**



**\*Oxidation**

Alkynes are oxidized by the same reagents that oxidize alkenes. Disubstituted alkynes react with potassium permanganate to Vic‐diketones or 1,2‐diketones or, carboxylic acids.



Ozonolysis of an alkyne also leads to carboxylic acid formation.

