

Chapter 9

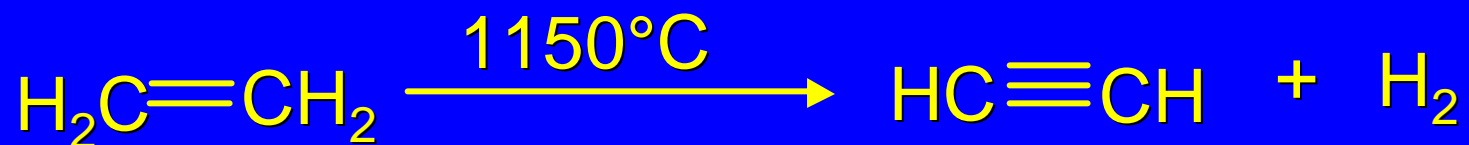
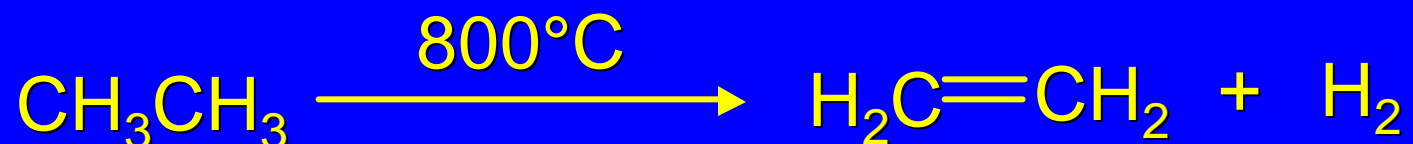
Alkynes

9.1

Sources of Alkynes

Acetylene

Industrial preparation of acetylene is by dehydrogenation of ethylene



cost of energy makes acetylene a more expensive industrial chemical than ethylene

9.2 Nomenclature

Nomenclature

Acetylene and ethyne are both acceptable IUPAC names for $\text{HC}\equiv\text{CH}$

Higher alkynes are named in much the same way as alkenes except using an *-yne* suffix instead of *-ene*.



Propyne

1-Butyne



4,4-Dimethyl-2-pentyne

9.3

Physical Properties of Alkynes

The physical properties of alkynes are similar to those of alkanes and alkenes.

9.4

Structure and Bonding in Alkynes: *sp* Hybridization

Structure

linear geometry for acetylene

120 pm



106 pm 106 pm

121 pm

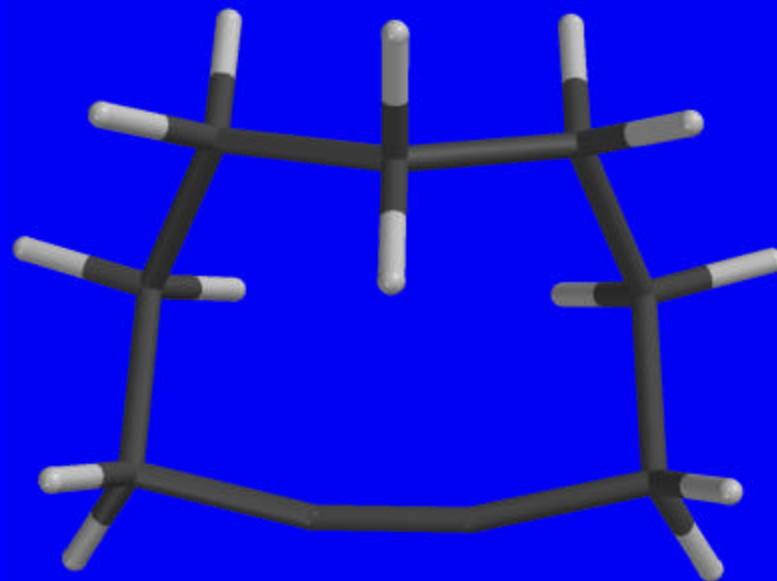


146 pm 106 pm

Cycloalkynes

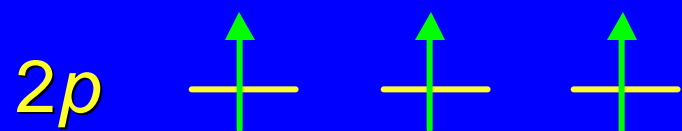
Cyclononyne is the smallest cycloalkyne stable enough to be stored at room temperature for a reasonable length of time.

Cyclooctyne polymerizes on standing.



sp Hybridization in Acetylene

Mix together (hybridize) the 2s orbital
and **one** of the three 2p orbitals



sp Hybridization in Acetylene

Mix together (hybridize) the 2s orbital and **one** of the three 2p orbitals



Each carbon has two half-filled *sp* orbitals available to form σ bonds.



s Bonds in Acetylene

Each carbon is connected to a hydrogen by a σ bond. The two carbons are connected to each other by a σ bond and two π bonds.



Figure 9.2 (a)

p Bonds in Acetylene

One of the two π bonds in acetylene is shown here. The second π bond is at right angles to the first.

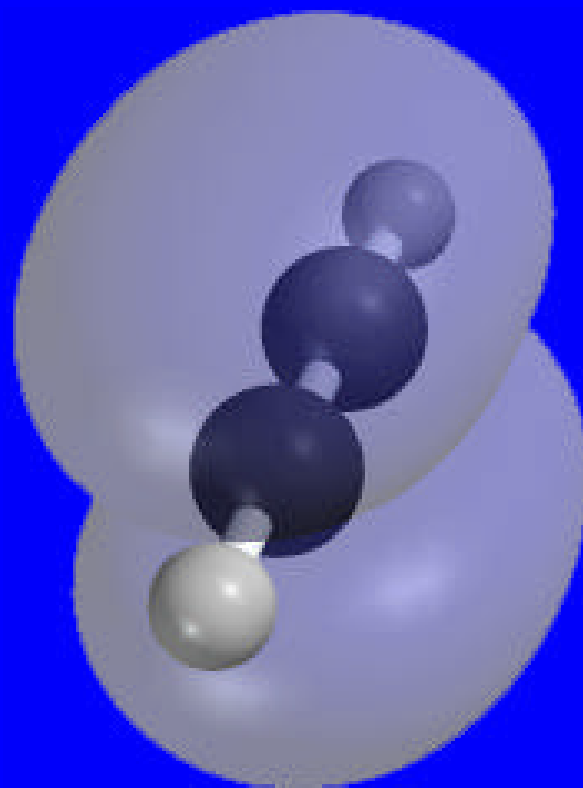


Figure 9.2 (b)

p Bonds in Acetylene

This is the second
of the two
 π bonds in
acetylene.

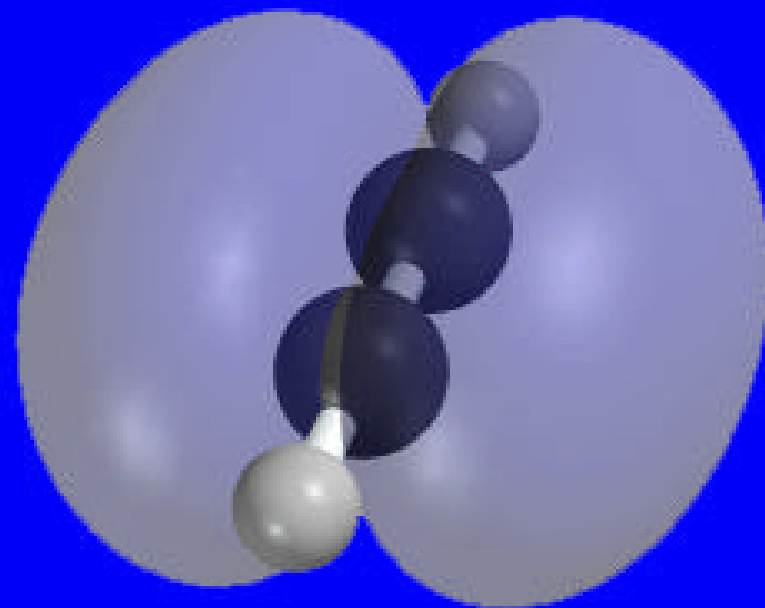
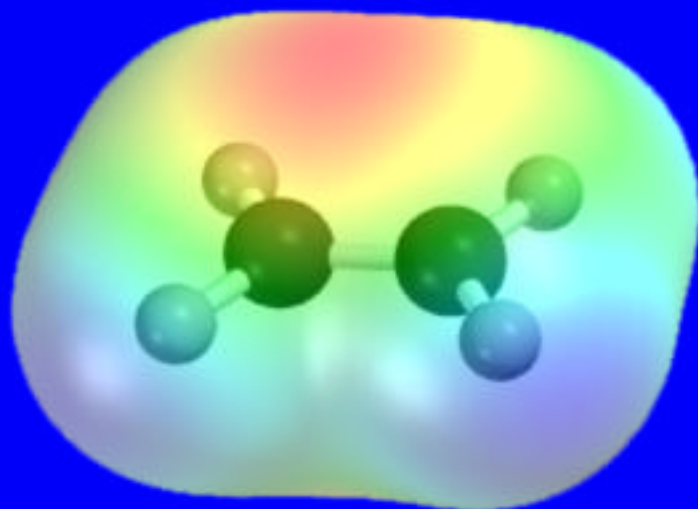
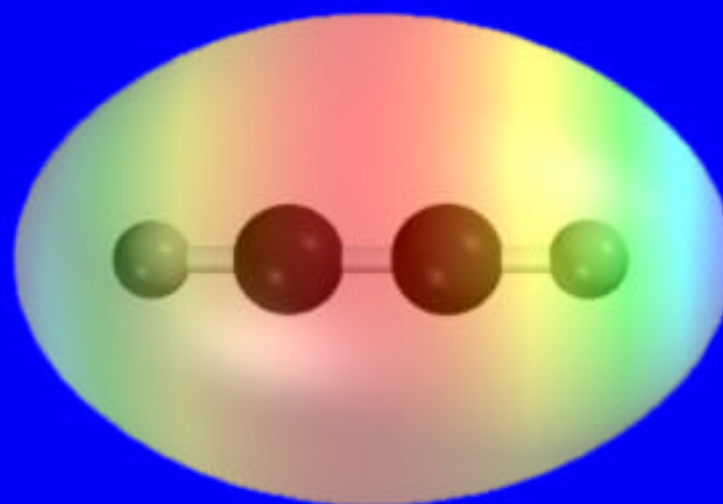


Figure 9.2 (c)

Figure 9.3 Electrostatic Potential in Acetylene



The region of highest negative charge lies above and below the molecular plane in ethylene.



The region of highest negative charge encircles the molecule around its center in acetylene.

Table 9.1
Comparison of Ethane, Ethylene, and Acetylene

	Ethane	Ethylene	Acetylene
C—C distance	153 pm	134 pm	120 pm
C—H distance	111 pm	110 pm	106 pm
H—C—C angles	111.0°	121.4°	180°
C—C BDE	368 kJ/mol	611 kJ/mol	820 kJ/mol
C—H BDE	410 kJ/mol	452 kJ/mol	536 kJ/mol
hybridization of C	sp^3	sp^2	sp
% s character	25%	33%	50%
pK_a	62	45	26