

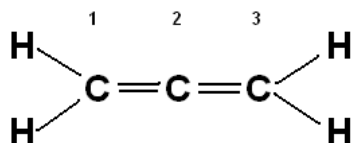
**Chemical Bonding 4.8**  
**Valence Bond Theory and Hybrid Orbital Theory**  
**Worksheet**

- 1) Identify the type of hybridization (type of hybrid orbitals) around the central atom in each of the structures listed below.
- Sulfate ion
  - Water
  - Carbon dioxide
  - Ammonia
  - Nitrate ion
  - Carbonate ion
  - Ozone ( $O_3$ )
  - Boron trichloride
  - Sulfur hexafluoride
  - Sulfur dichloride
  - Xenon tetrafluoride
  - Phosphorus pentafluoride
  - Nitrogen trifluoride
  - Phosphorus trifluoride
  - $CH_4$
  - $CCl_2F_2$
  - $OF_2$
  - $ICl_4^-$
  - $IOF_5$
  - $I_3^-$
  - $BrF_3$
  - $SOF_4$
  - $XeOF_4$
  - $XeO_2F_2$
- 2) Explain how valence bond theory differs from hybrid orbital theory.
- 3) What is the main problem with valence bond theory?
- 4) Describe what happens during the hybridization of the boron atom in  $BCl_3$ .
- Include orbital diagrams and details about the promotion of electrons.
  - This structure is taken from question 1) h.
- 5) Describe what happens during the hybridization of the bromine atom in  $BrF_3$ .
- Include orbital diagrams and details about the promotion of electrons.
  - This structure is taken from question 1) u.

- 6) Describe what happens during the hybridization of the sulfur atom in sulfur dichloride.
- Include orbital diagrams and details about the promotion of electrons.
  - This structure is taken from question 1) j.

7) What is the difference between a  $\sigma$  bond and a  $\pi$  bond?

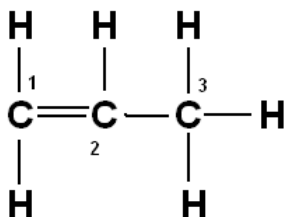
8) Use the structure below to answer the following questions.



- What type of hybrid orbitals form around the first carbon?
  - Describe what happens during the hybridization of the first carbon atom. Include details about the promotion of electrons.
  - What type of hybrid orbitals form around the second carbon?
  - Describe what happens during the hybridization of the second carbon atom. Include details about the promotion of electrons.
  - How is the double bond between the first and second carbon formed? Reference the types of orbitals involved in the bonds and the methods of bonding.
- 9) Use the structure below to answer the following questions.



- What type of hybrid orbitals form around the carbon?
  - How many  $\sigma$  bonds are there between the carbon and the nitrogen?
  - How many  $\pi$  bonds are there between the carbon and the nitrogen?
  - How many unmorphed p-orbitals remain on the carbon atom in this compound?
- 10) Use the structure below to answer the following questions.



- What type of hybrid orbitals form around the second carbon?
- What type of hybrid orbitals form around the third carbon?
- How many unmorphed p-orbitals remain around the first carbon?
- How many  $\sigma$  bonds exist in the entire structure?
- How many  $\pi$  bonds exist in the entire structure?