1) Identify the type of hybridization (type of hybrid orbitals) around the central atom in each of the structures listed below.
   a. Sulfate ion
   b. Water
   c. Carbon dioxide
   d. Ammonia
   e. Nitrate ion
   f. Carbonate ion
   g. Ozone (O₃)
   h. Boron trichloride
   i. Sulfur hexafluoride
   j. Sulfur dichloride
   k. Xenon tetrafluoride
   l. Phosphorus pentfluoride
   m. Nitrogen trifluoride
   n. Phosphorus trifluoride
   o. CH₄
   p. CCl₂F₂
   q. OF₂
   r. ICl₄⁻
   s. IOF₅
   t. I₃⁻
   u. BrF₃
   v. SOF₄
   w. XeOF₄
   x. XeO₂F₂

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 BCl₃.
   • 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 BrF₃.
   • 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.

   ![Structure Image]

   a. What type of hybrid orbitals form around the first carbon?
   b. Describe what happens during the hybridization of the first carbon atom. Include details about the promotion of electrons.
   c. What type of hybrid orbitals form around the second carbon?
   d. Describe what happens during the hybridization of the second carbon atom. Include details about the promotion of electrons.
   e. 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.

   ![Structure Image]

   a. What type of hybrid orbitals form around the carbon?
   b. How many $\sigma$ bonds are there between the carbon and the nitrogen?
   c. How many $\pi$ bonds are there between the carbon and the nitrogen?
   d. How many unmorphed $p$-orbitals remain on the carbon atom in this compound?

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

    ![Structure Image]

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