1. The potential energy diagram below represents the π molecular orbitals in ethene.

\[ \text{Potential Energy} \]

a) Label the π and π* orbitals.

b) According to the drawing, which orbital is higher in energy?

c) How many electrons can each molecular orbital hold?

d) How many electrons are there in the π system of ethene?

e) Add these electrons to the drawing above.

f) What is a node, and do either of the molecular orbitals above have one? If so, draw it in using a dotted line.

2. Using the following rules for drawing a molecular orbital diagram, generate a diagram for 1,3,5-hexatriene (see below).

i) The number of atomic p orbitals in a π system equal the number of molecular orbitals possible.

ii) Molecular orbitals have 0,1,2,3, etc. nodes, from lowest to highest energy.

iii) The placement of nodes must be symmetric. For example, if there is only one node it must be in the center of the drawing. (see Figure 14.2 on page 468)

iv) Filling molecular orbitals follows the Aufbau rule, lowest to highest.

3. Indicate which of the molecules shown below contain conjugated double bonds. Indicate how many, if any, isolated double bonds are present in each structure.
4. Suggest reasonable explanations for the following observations:

a) The first order rate constant for the solvolysis of (CH₃)₂C=CHCH₂Cl in ethanol is over 6000 times greater than that of allyl chloride at 25°C.

b) After a solution of 3-buten-2-ol in aqueous H₂SO₄ had been allowed to stand for 1 week, it was found to contain both 3-buten-2-ol and 2-buten-1-ol.

c) Treatment of CH₂CH=CHCH₂OH with HBr gave a mixture of 1-bromo-2-butene and 3-bromo-1-butene.

d) Treatment of 3-buten-2-ol with HBr gave the same mixture of bromides as in part c.

e) The major product in both c and d was 1-bromo-2-butene.

5. Electrophilic additions to conjugated dienes are usually a mixture of 1,2 and 1,4 addition products. However, when Br₂ adds to 1,4-diphenyl-1,3-butadiene, only the 1,2 product is formed. Why?

6. Indicate which of the following molecules can function as dienes in a Diels-Alder reaction.

7. Which of the following molecules can be synthesized via a Diels-Alder reaction? If they can, indicate what the reactants would be. If not, explain why.