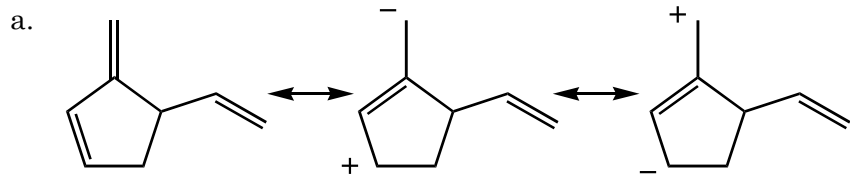


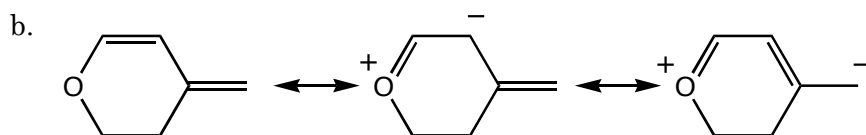
1. (12 pts.) Draw resonance structures for the following molecule. Any insignificant contributors to the resonance hybrid should be labeled as such.

1. _____



2. _____

3. _____



4. _____

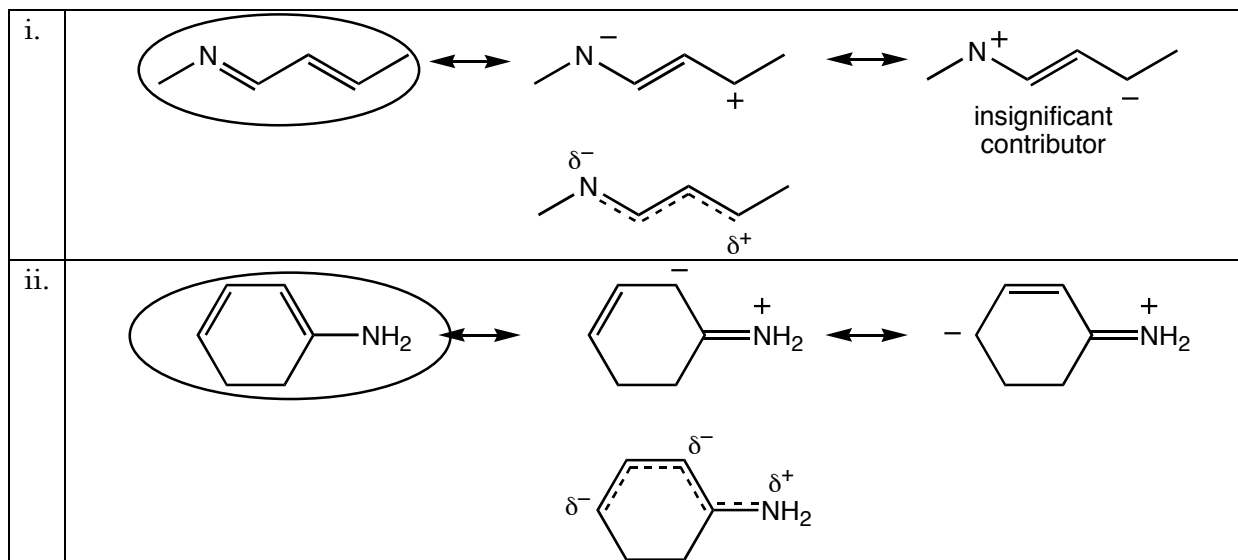
5. _____

2. a. (12 pts.) Draw the resonance hybrid for the following resonance structures. If any resonance structures that are considered to be insignificant contributors to the resonance hybrid are drawn below, label them as such.

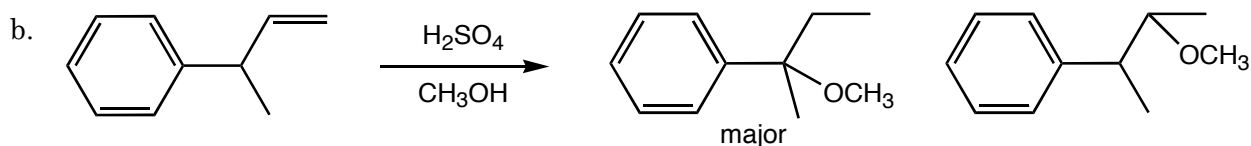
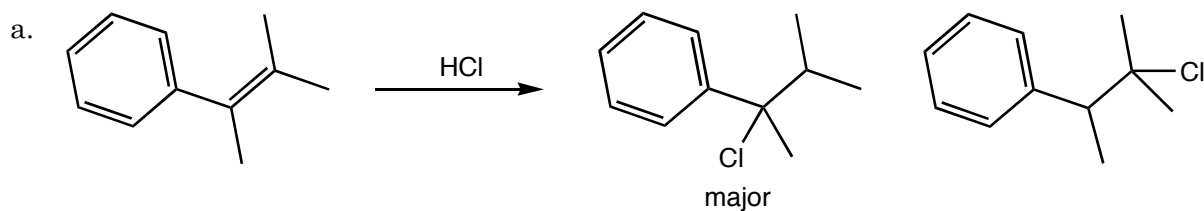
6. _____

b. (6 pts.) Circle the resonance structure that the resonance hybrid would most resemble.

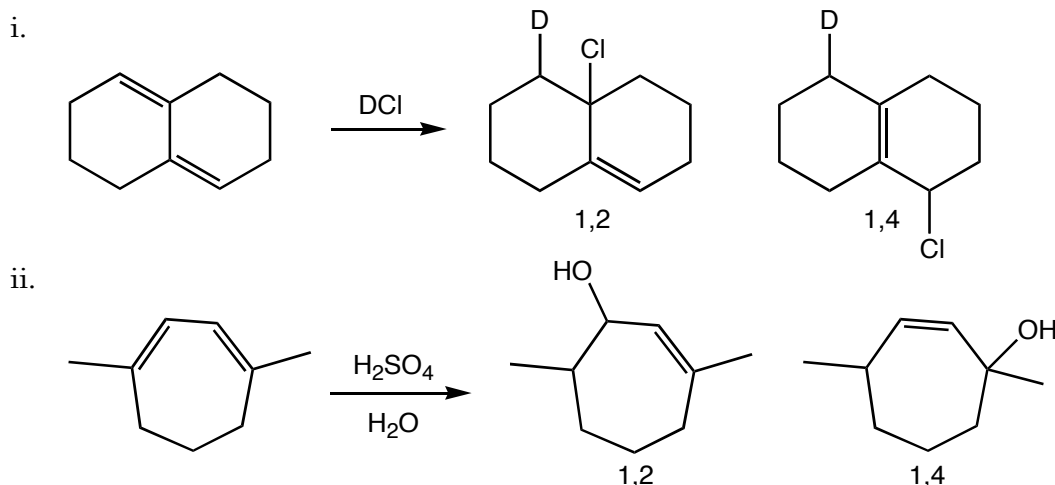
7. _____



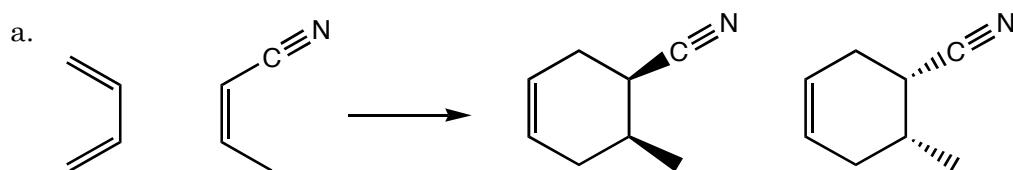
3. (12 pts.) Predict the products of the following electrophilic addition reactions.



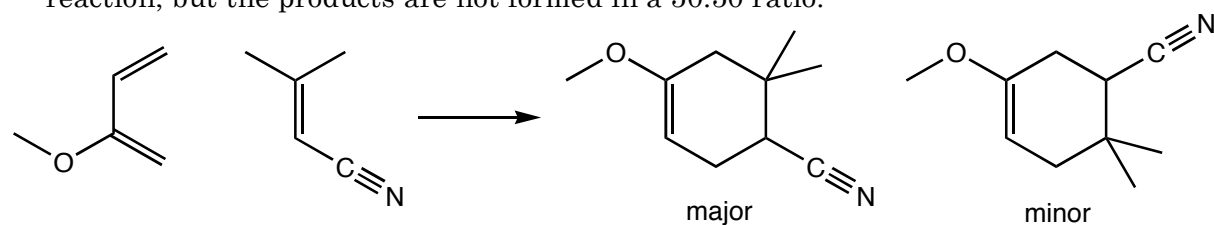
4. a. (12 pts.) Predict the products of the following reaction, and (b. 4 pts) identify the 1,2- and 1,4- addition products.



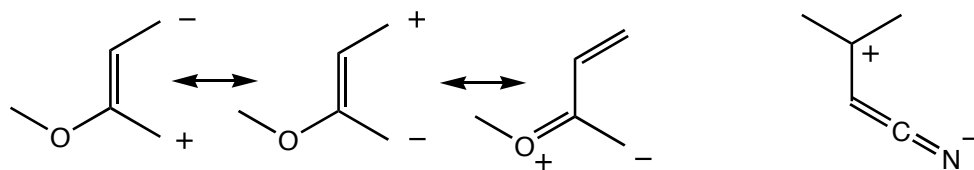
5. (8 pts.) Predict the products of the following Diels-Alder reactions. Remember to indicate the stereochemistry of the product(s) by drawing 3-D wedge (▲) and dashed (▬) structures where appropriate.



6. Consider the outcome of the following reaction. Two structural isomers can be produced by the reaction, but the products are not formed in a 50:50 ratio.



a. (8 pts.) Draw resonance structures for the reactants.

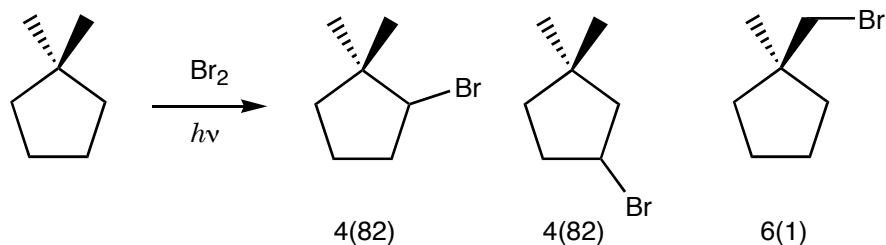


b. (6 pts.) Considering the charge distribution on the resonance structures of the reactants, explain why the molecule on the left is the major product.

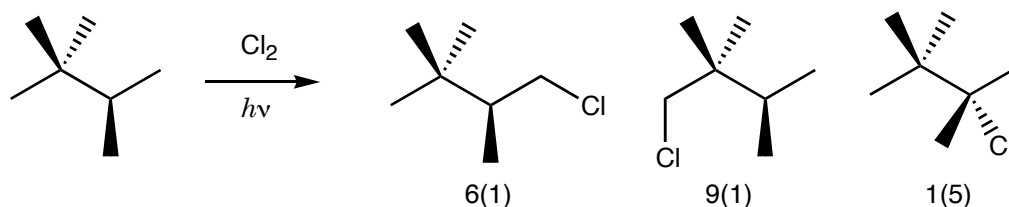
The terminal carbon on the diene closest to the O atom bears a partial negative charge because it's in resonance with the O atom. The negative charge will be attracted to the partial positive charge on the 3° carbon of the dienophile.

7. (12 pts.) Predict the products of the following radical substitution reactions and determine the relative yields for the various products. Useful ratios 1:3:8:5 and 1:82:1600.

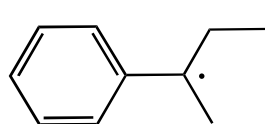
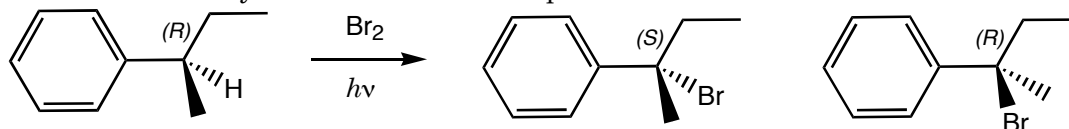
a.



b.



8. a. (8 pts.) Draw the alkyl radical intermediate for the reaction drawn below and (b. 4 pts.) explain why the *R* starting material can produce both the *S* and *R* products. Remember, hybrid orbitals are needed only for σ bonds and lone pairs.



The radical electron is in a half-filled p orbital. Since the p orbital has lobes on both faces of the C atom, the C–Br bond can form on the back face, producing the *S* enantiomer, or the front face, producing the *R* enantiomer.

9. (8 pts.) During radical substitutions using bromine radicals, substitution occurs preferentially at tertiary C–H bonds as opposed to primary and secondary C–H bonds. Chlorine is less selective than bromine for tertiary C–H bonds. Would fluorine be more or less selective? Explain your response.

Fluorine would be even less selective. Since a fluorine atom would be attracting an electron into the second principle energy level, a level that is close to the fluorine's nucleus, it is very good at abstracting hydrogen atoms. Because fluorine is so reactive, it is able to abstract hydrogen atoms without regard for the alkyl radical that would form. In other words, the fluorine atom doesn't have to wait to find a hydrogen atom that is easy to remove, it just abstracts the first hydrogen atom that it comes across.