SHORT ANSWER (10 pts each)

1. What is the IUPAC name of the compound shown below?

![Compound Image]

2. What is the major product of the reaction shown below?

![Reaction Image]

3. What is the major product that results when the diene shown below is treated with HBr at -80 °C?

![Diene Image]

4. (a) Show the product(s) that would result from the Diels-Alder reaction below. (6 pts)

![Diels-Alder Reaction Image]

(b) How many signals would you expect to see in the $^{13}$C NMR spectrum of the product(s) of the above reaction? (1 pt)

(c) What are the frequencies of two absorption bands that you'd see in the IR spectrum for the product(s) of the above reaction? (2 pts)

(d) Would the product(s) of the above reaction be optically active? (1 pt)
MULTIPLE CHOICE (6 pts each)

5. Which of the following is a cumulated diene?
   (a) \( \text{\includegraphics[width=1cm]{cumulated_diene1}} \)  (b) \( \text{\includegraphics[width=1cm]{cumulated_diene2}} \)  (c) \( \text{\includegraphics[width=1cm]{cumulated_diene3}} \)  (d) \( \text{\includegraphics[width=1cm]{cumulated_diene4}} \)

6. Which of the following is an isolated diene?
   (a) \( \text{\includegraphics[width=1cm]{isolated_diene1}} \)  (b) \( \text{\includegraphics[width=1cm]{isolated_diene2}} \)  (c) \( \text{\includegraphics[width=1cm]{isolated_diene3}} \)  (d) \( \text{\includegraphics[width=1cm]{isolated_diene4}} \)

7. Which of the following is a conjugated diene?
   (a) \( \text{\includegraphics[width=1cm]{conjugated_diene1}} \)  (b) \( \text{\includegraphics[width=1cm]{conjugated_diene2}} \)  (c) \( \text{\includegraphics[width=1cm]{conjugated_diene3}} \)  (d) \( \text{\includegraphics[width=1cm]{conjugated_diene4}} \)

8. Which of the following is the most stable diene?
   (a) \( \text{\includegraphics[width=1cm]{most_stable_diene1}} \)  (b) \( \text{\includegraphics[width=1cm]{most_stable_diene2}} \)  (c) \( \text{\includegraphics[width=1cm]{most_stable_diene3}} \)  (d) \( \text{\includegraphics[width=1cm]{most_stable_diene4}} \)

9. Which of the following dienes would not react with a dienophile in a Diels--Alder reaction?
   (a) \( \text{\includegraphics[width=1cm]{non_reactive_diene1}} \)  (b) \( \text{\includegraphics[width=1cm]{non_reactive_diene2}} \)  (c) \( \text{\includegraphics[width=1cm]{non_reactive_diene3}} \)  (d) \( \text{\includegraphics[width=1cm]{non_reactive_diene4}} \)

10. What is the kinetic product from the reaction shown below?
   \[
   \text{\includegraphics[width=1.5cm]{reaction}} \quad \text{H-Br}
   \]
   (a) \( \text{\includegraphics[width=1cm]{kinetic_product1}} \)  (b) \( \text{\includegraphics[width=1cm]{kinetic_product2}} \)  (c) \( \text{\includegraphics[width=1cm]{kinetic_product3}} \)  (d) \( \text{\includegraphics[width=1cm]{kinetic_product4}} \)
11. What is the hybridization state of the central carbon atom of allene (or 1,2-propadiene, shown below)?

\[ \text{H}_2\text{C} = \text{C} = \text{CH}_2 \]

(a) sp (b) sp\(^2\) (c) sp\(^3\) (d) p (e) none of these

12. What kind of diene is 1,5-octadiene?

(a) conjugated (b) cumulated (c) isolated (e) none of these

13. Which one of the following is a correct statement considering thermodynamic versus kinetic control of organic reactions?

(a) When a reaction is under thermodynamic control, the relative amounts of products depend on the activation energies of the steps leading to their formation.
(b) The kinetic product always predominates when the reaction is reversible.
(c) Higher temperatures and longer reaction times typically favor the kinetic product over the thermodynamic product.
(d) When the products are in equilibrium under the reaction conditions, the relative amounts of products depend on their stabilities and the reaction is under thermodynamic control.

14. What is the IUPAC name for the following compound?

(a) isoprene
(b) 3-methyl-1,3-butadiene
(c) 2-methyl-1,3-butadiene
(d) 2-methyl-2,3-butadiene
(e) isobutadiene

**Bonus: What is the IUPAC name of the compound shown below? (5 pts)**