

Memorial University of Newfoundland

Chemistry 2400

Sample

Final Examination

December, 2014

Time: 3 hours

Name: _____ MUN ID: _____

Dr. Y. Zhao

READ THE FOLLOWING CAREFULLY

- This examination contains **12** pages. **Read all questions carefully and use your time wisely.**
- The use of molecular models is permitted.
- Answer each question in the space provided. If you need more space you may use the back of pages; however, you should clearly indicate that you have done so.

Do not write in the enclosed area below

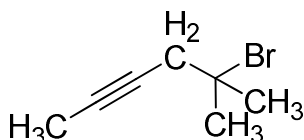
Question	Value	Mark
1-10	20	
11	15	
12	15	
13	30	
14	10	
15	10	
Bonus	5	
Total	105	

Part A. Multiple choice questions. [20 pts]

1. Which of the following statement is incorrect about benzene? A

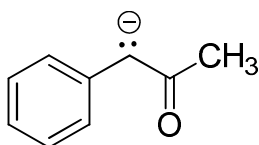
- (a) All of the carbon atoms are sp hybridized.
- (b) It has delocalized electrons.
- (c) The carbon-hydrogen bond lengths are all the same.
- (d) All twelve atoms lie in the same plane.
- (e) Its molecular dipole moment is zero.

2. What is the IUPAC name for the following compound? E



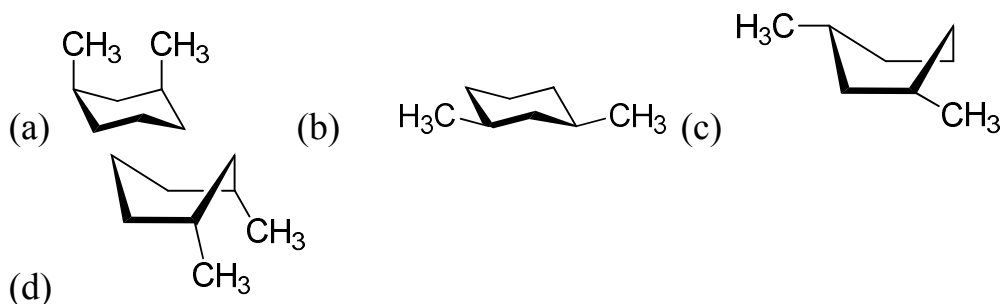
- (a) 5-Bromo-2-heptyne
- (b) 3-Bromo-5-heptyne
- (c) 2-bromo-2-methyl-4-hexyne
- (d) 5-bromo-5,5-dimethylhexyne
- (e) 5-bromo-5-methyl-2-hexyne
- (f) 5-methyl-2-hexynyl bromide

3. Which of the following is not a resonance form of the following anion? C



- (a)
- (b)
- (c)
- (d)
- (e)

4. Which of the following presents the most stable conformation of *cis*-1,3-dimethylcyclohexane? **B**



5. Which of the following is not normally considered to be a nucleophile? **E**

- (a) NH_3 (b) H_2O (c) Cl^- (d) $\text{CH}_2=\text{CHCH}_3$ (e) CH_3^+

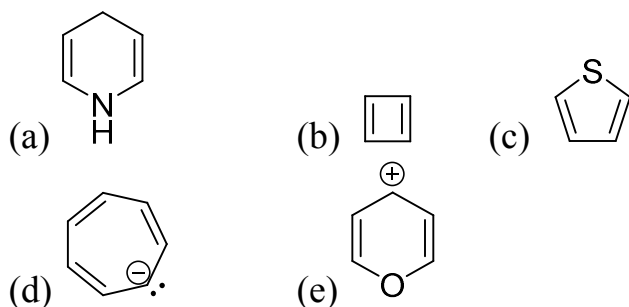
6. Which of the following compound will undergo an $\text{S}_{\text{N}}2$ reaction most readily? **E**

- (a) $(\text{CH}_3)_2\text{CCH}_2\text{I}$
 (b) $(\text{CH}_3)_3\text{CCl}$
 (c) $(\text{CH}_3)_2\text{CHI}$
 (d) $(\text{CH}_3)_2\text{CHCH}_2\text{CH}_2\text{CH}_2\text{Cl}$
 (e) $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{I}$

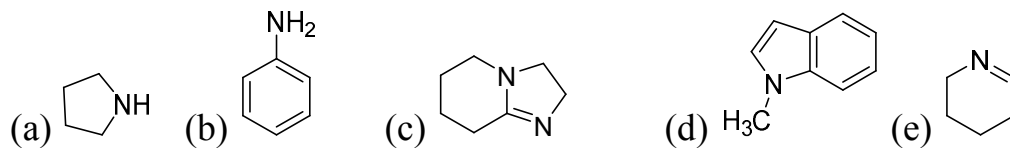
7. Which of the following species is the least nucleophilic? **D**

- (a) $(\text{CH}_3)_3\text{CO}^-$
 (b) H_2O
 (c) $(\text{CH}_3)_3\text{N}$
 (d) BF_3
 (e) CN^-

8. Which of the following structure(s) is (are) aromatic? **C, E**



9. Which of the following compound has the strongest basicity? C

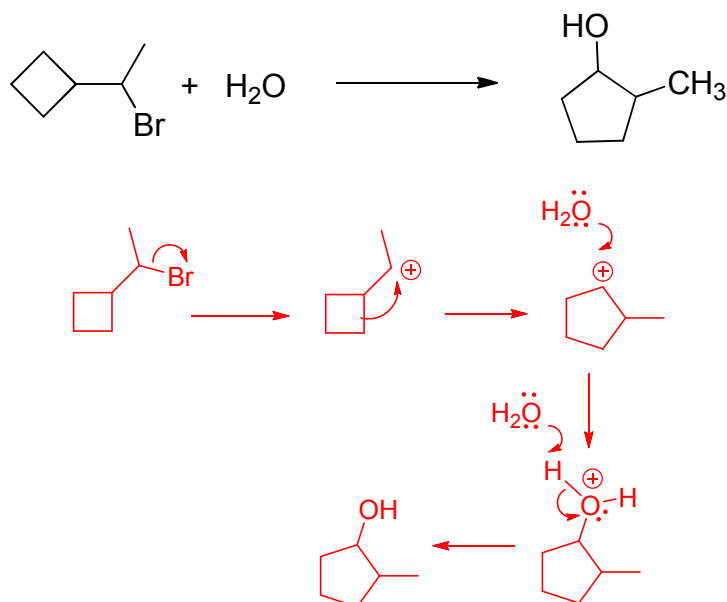


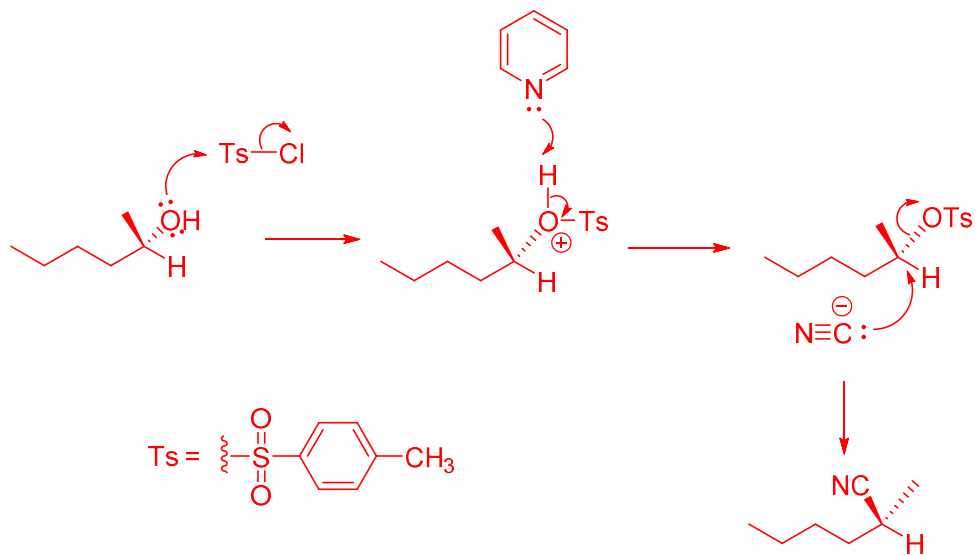
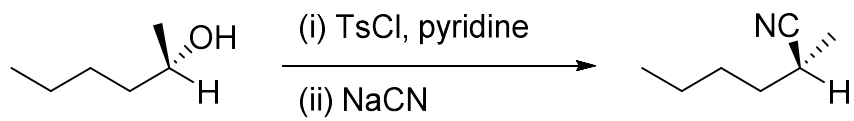
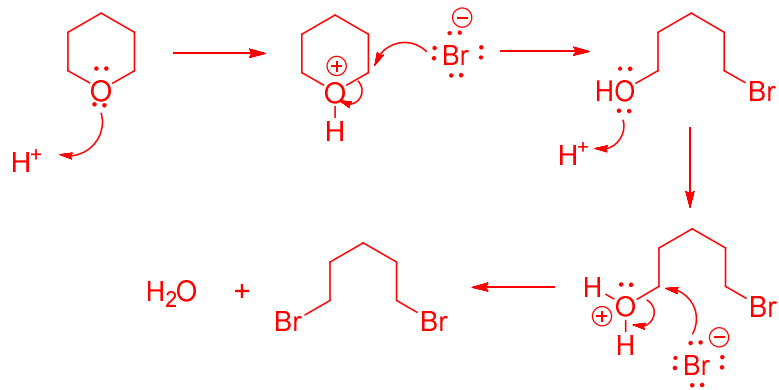
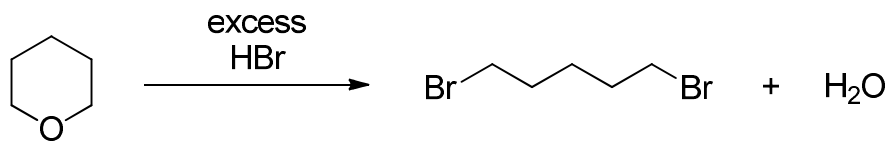
10. Which statement below best describes the collection of all the stereoisomers of 1,2-dibromocyclohexane? B

- (a) Two pairs of enantiomers
- (b) A pair of enantiomers and a meso compound
- (c) Two diastereomers
- (d) A meso compound
- (e) Four diastereomers

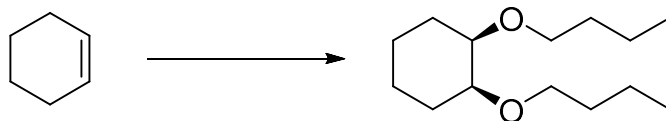
Part B. Non-multiple choice questions.

11. Propose reasonable mechanisms for the following reactions. [15 pts]

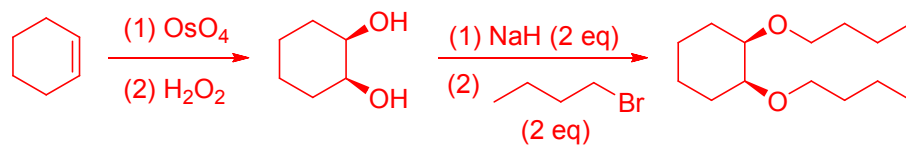




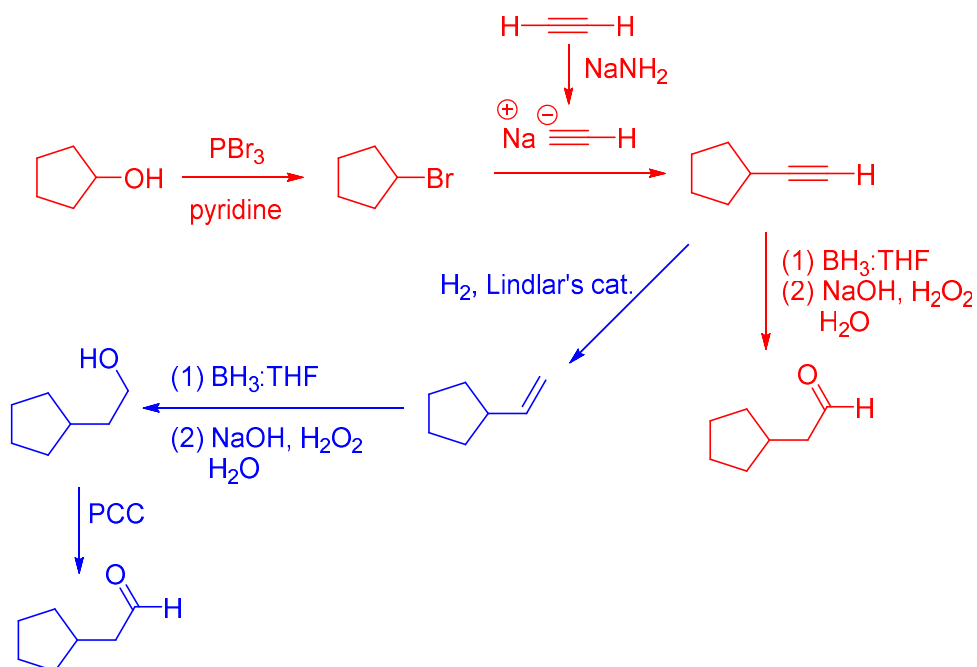
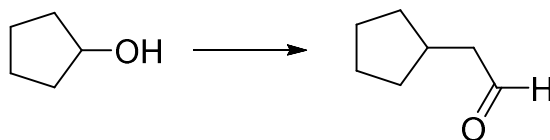
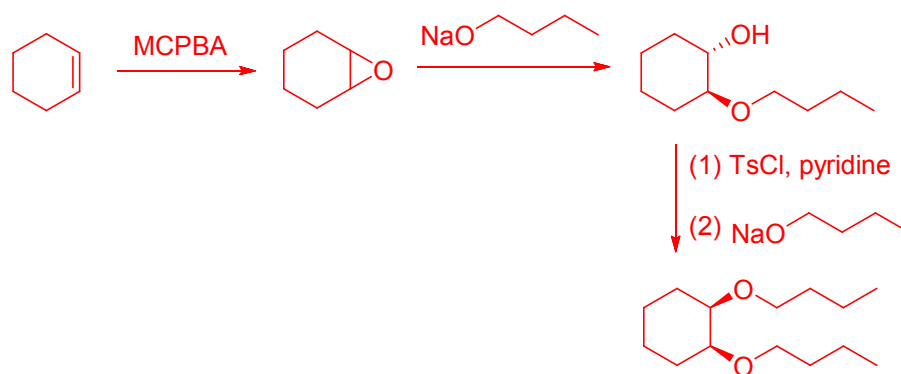
12. Propose reasonable multistep synthesis using the provided starting materials and any necessary reagents. [15 pts]

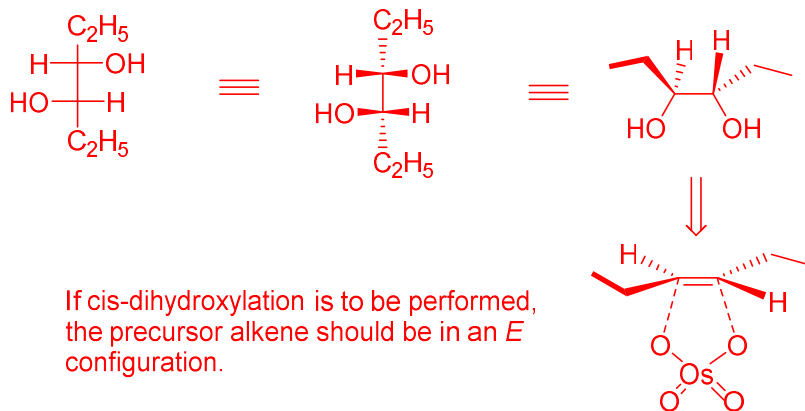
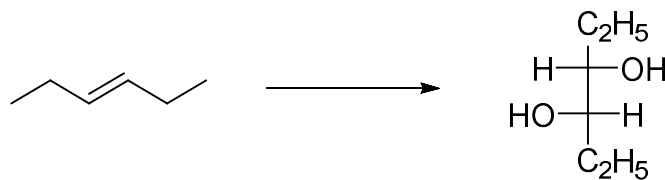


Route 1

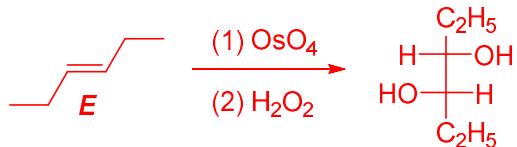


Route 2

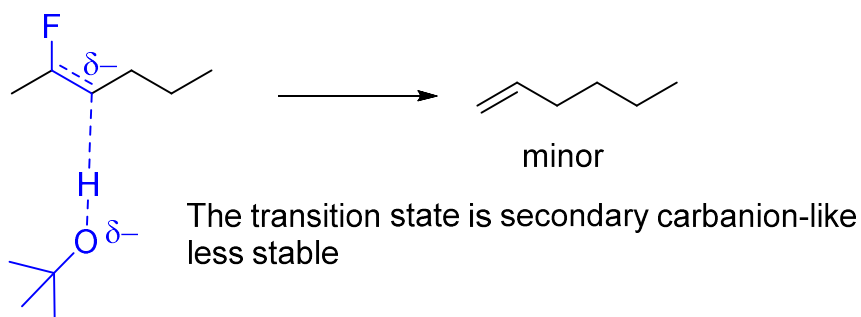
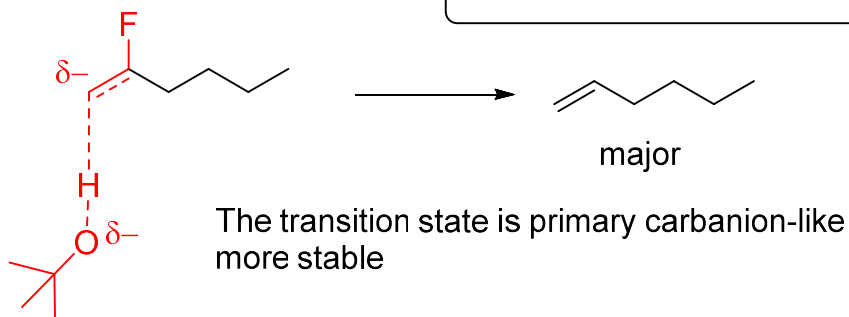
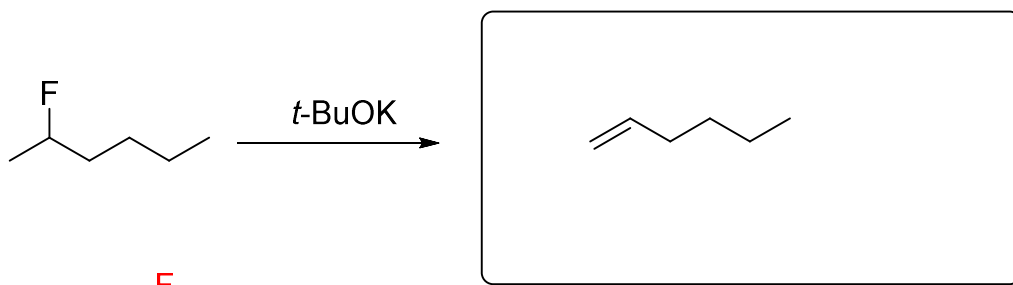


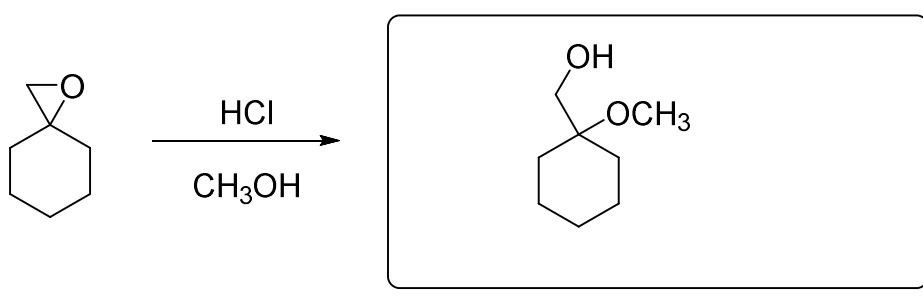
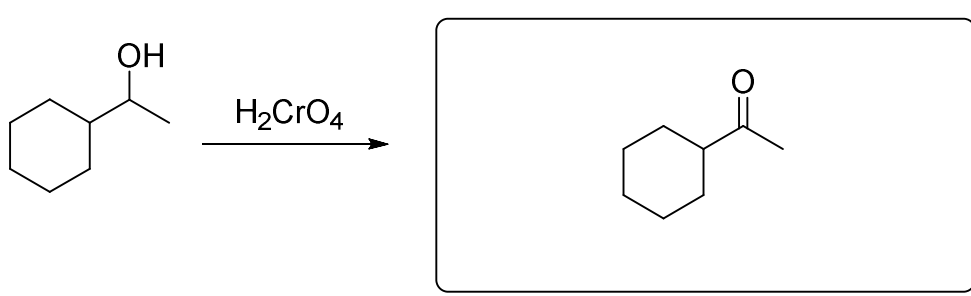
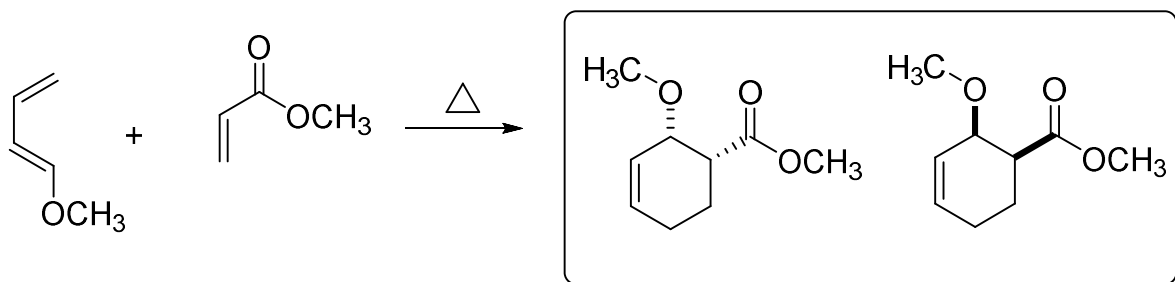
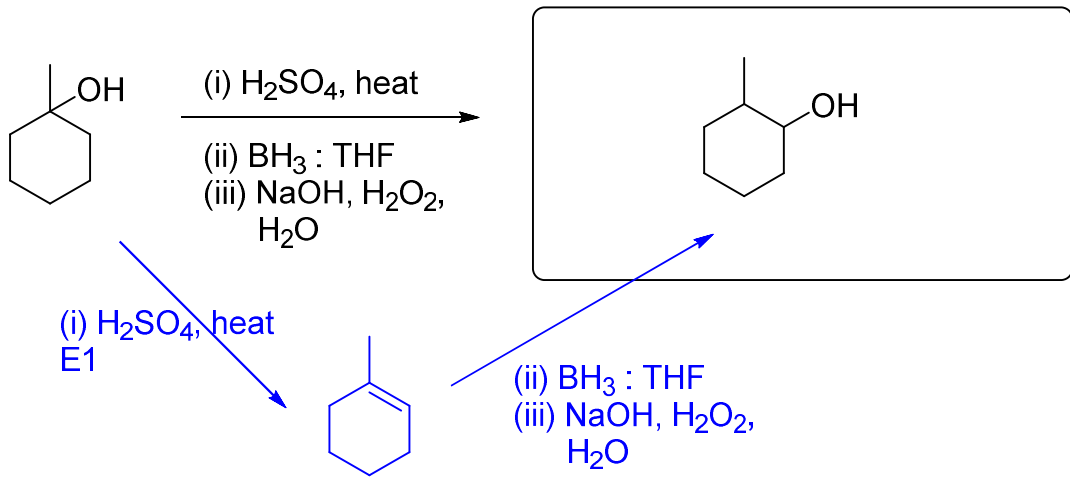
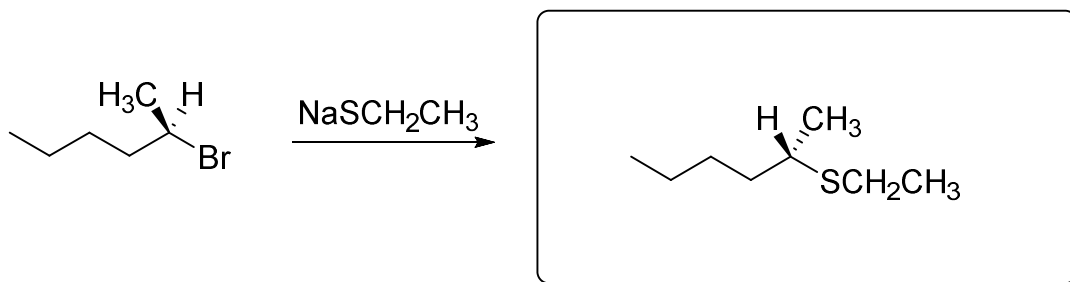


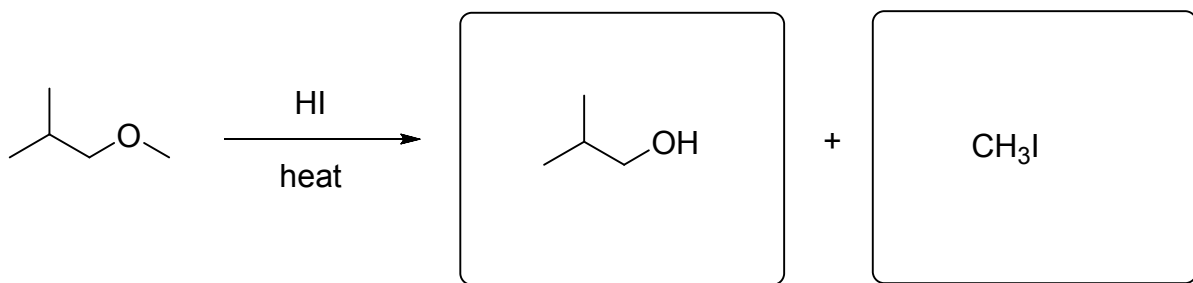
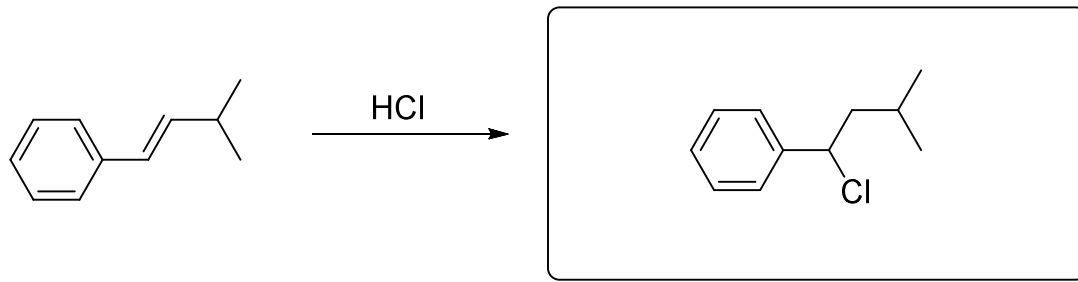
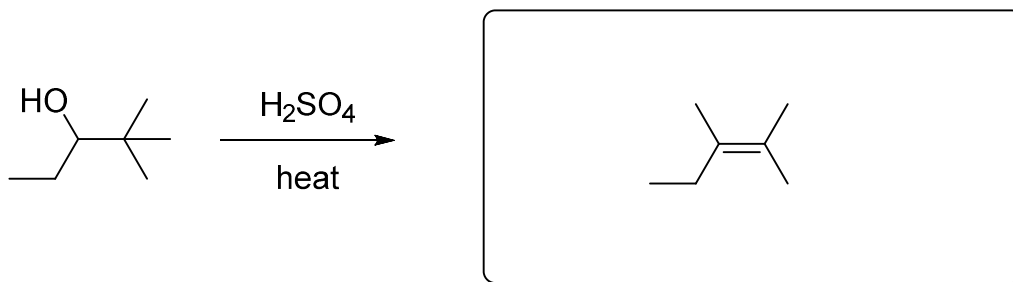
Synthesis



13. Provide the major organic products for the following reactions. [30 pts]

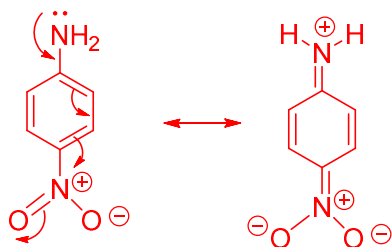
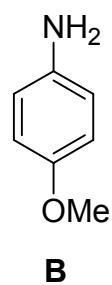
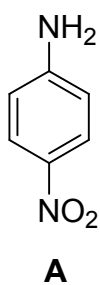




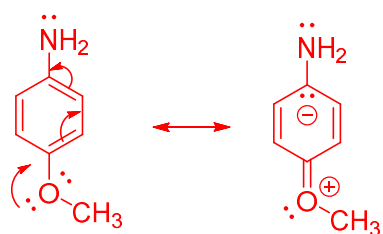


14. Explain each of the following statements. [15 pts]

(a) Compound **A** is a weaker base than compound **B**.

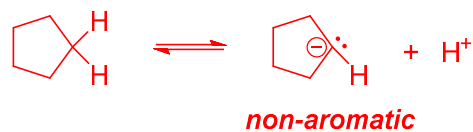
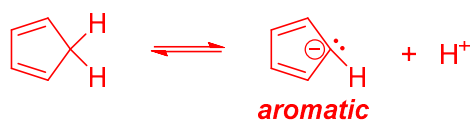


The lone pair electrons on the amino group can be delocalized to the electron-withdrawing NO_2 group through resonance effect. As such, the lone pair is deactivated and stabilized, which in turn reduces the basicity of the amino group.



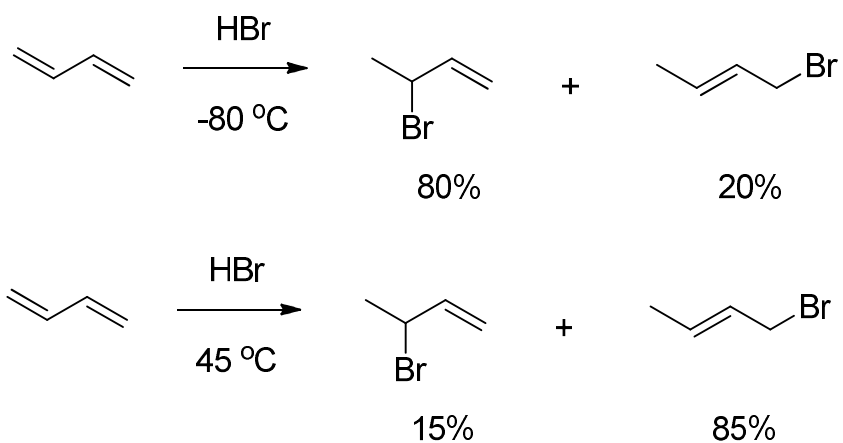
The electron-donating methoxy group pushes electrons to the carbon adjacent to the amino group. Through resonance effect, a carbanion character is revealed. The electron pushing activates the lone pair of the amino group, making them more readily to donate. As such, the amino group becomes a stronger base.

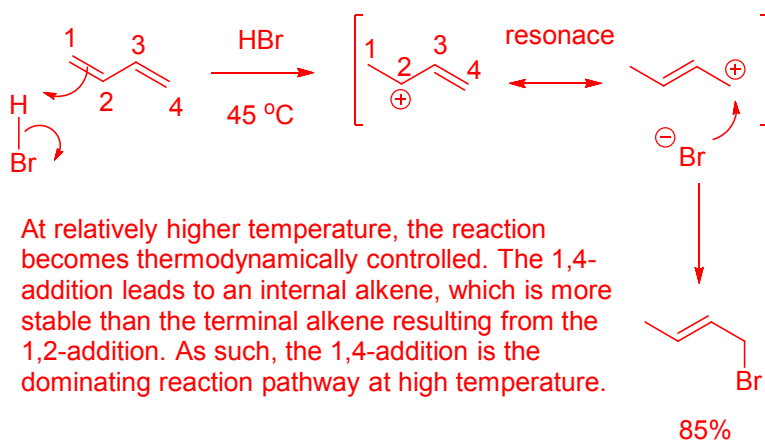
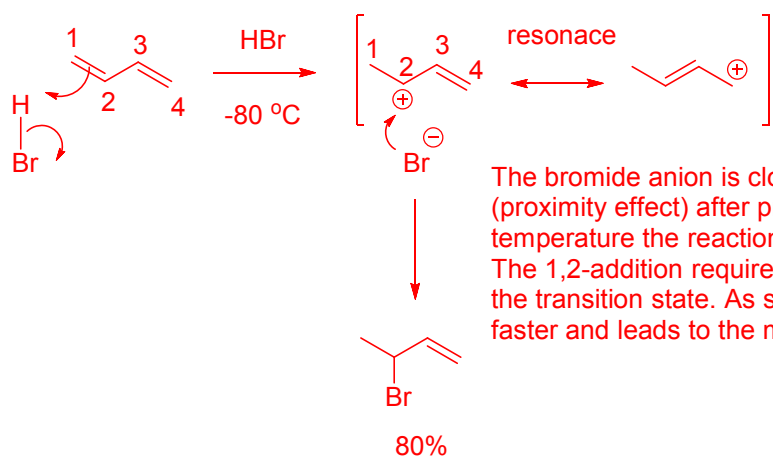
(b) Cyclopentadiene is more acidic than cyclopentane.



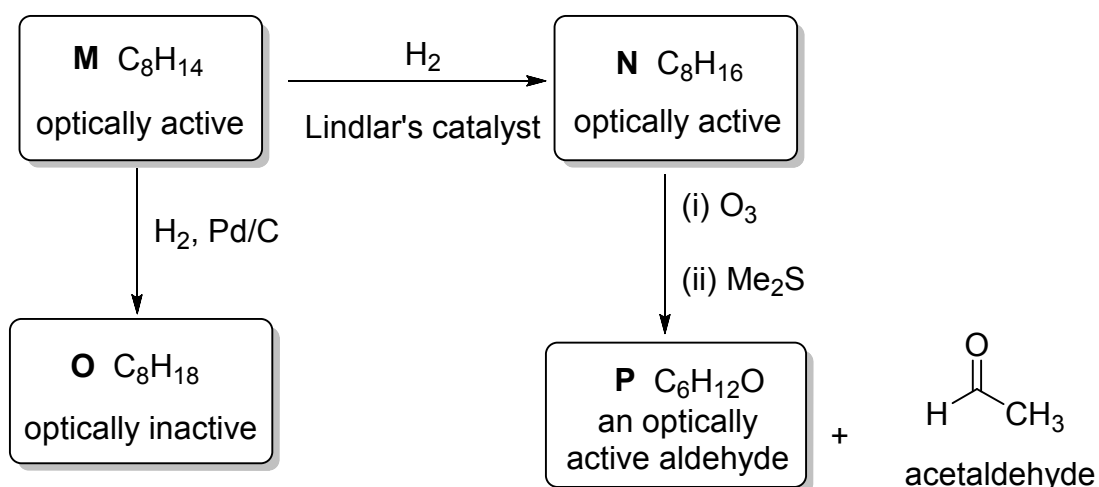
The conjugate base of cyclopentadiene is an aromatic anion, which shows remarkable stability. The conjugate base of cyclopentane is a secondary carbanion, which does not gain as much stability as the aromatic cyclopentadiene anion. The considerably stable conjugate base of cyclopentadiene makes cyclopentadiene a relatively stronger acid.

(c) The reaction between HBr and 1,3-butadiene gives 1,2-addition product as the major product at $-80\text{ }^{\circ}\text{C}$. When the reaction temperature is raised to $45\text{ }^{\circ}\text{C}$, 1,4-addition product becomes the major product.



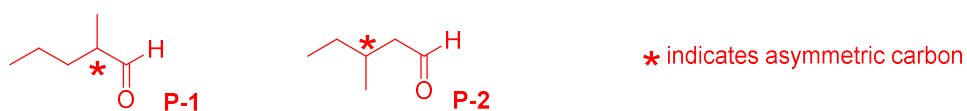


15. Deduce the structures of compounds **M–P**. Draw structures that show stereochemistry where appropriate. [10 pts]

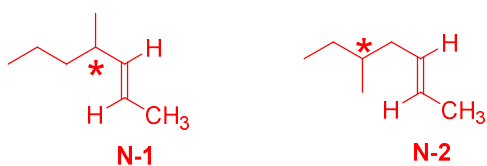


Analysis:

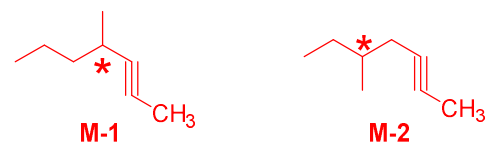
(1) **P** is an optically active aldehyde with six carbons. the formula $\text{C}_6\text{H}_{12}\text{O}$ suggests it has only one degree of unsaturation. Therefore, the possible structures that are optically active aldehydes can be enumerated as:



(2) From the ozonolysis, the structure of **N** is deduced to be as two possible alkenes.



(3) From the catalytic hydrogenation using Lindlar's catalyst, it is deduced that compound **M** is an alkyne. Therefore, the following two possible structures can be reasoned.



(4) From the hydrogenation reaction, it is reasoned that only **O-1** is an optically inactive hydrogenation product. Therefore, the structures for the above compounds should be **P-1**, **N-1**, **M-1**, and **O-1**.

