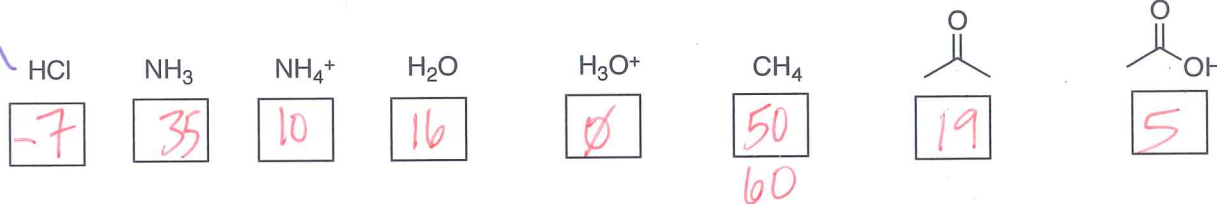


1. Fundamentals

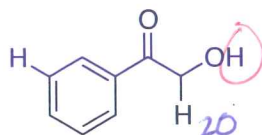
(a) (8 points) List the pKa values that belong to each compound in the boxes below.

1pt each

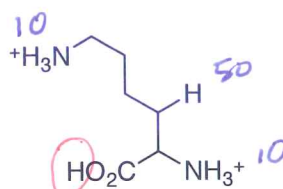
±2
OK

(b) (8 points) Circle the most acidic proton on each molecule and approximate its pKa (think pKa family).

(i)

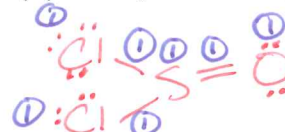
Approx. pKa 16

(ii)

Approx. pKa 5

consistent, wrong H OK pKa 2pts

(c) (17 points) Draw Lewis structures for the following compounds, including all lone pair and charges, where appropriate.

(ii) Hydrogen Peroxide (H₂O₂)(iii) Thionyl Chloride (SOCl₂)

(d) (9 points) Indicate whether the following types of compounds typically act nucleophiles (N) or electrophiles (E).

Acids EBases NAlkenes NAlkynes NAlkyl Halides EAlkoxides NGrignard Reagents NAmines NHalide ions N

(e) (5 points) Rank the following anions by their ability to act as a leaving group. Identify the best leaving group as "1" and the worst leaving groups (there's a tie!) with "4".

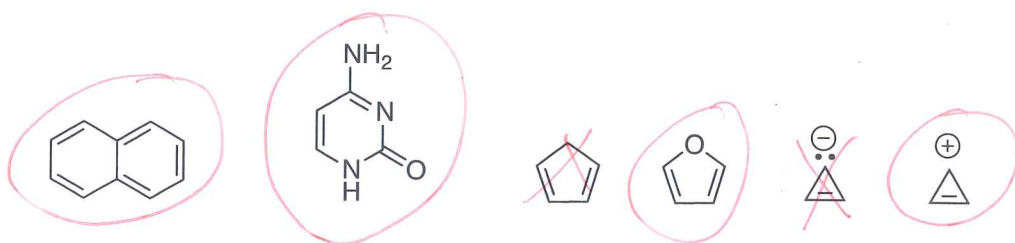
1 off, order OK → 4pts

otherwise 1pt/line

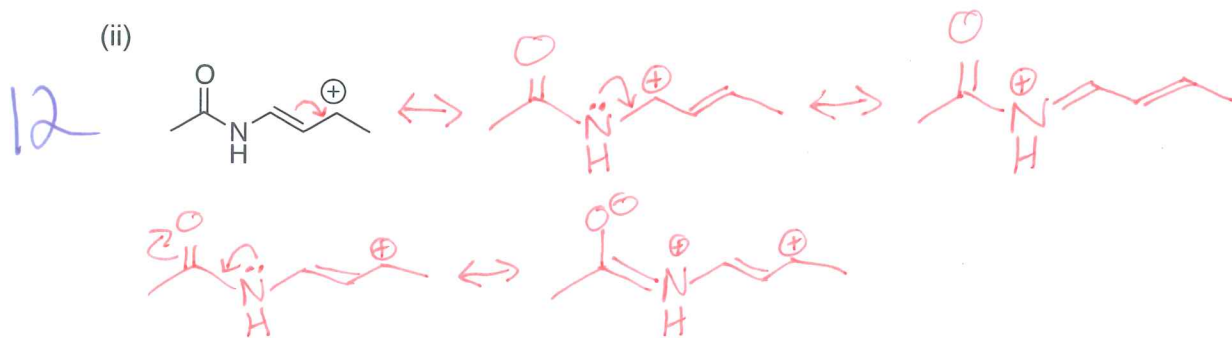


2. Resonance and Aromaticity

(a) (12 points) Circle all the compounds that are aromatic.

2pts
circled
or
not

(b) (36 points) Draw two additional non-equivalent resonance structures for the following compounds. Use arrow-pushing to show electron movement from one structure to the next. Be sure to indicate formal charges where appropriate.



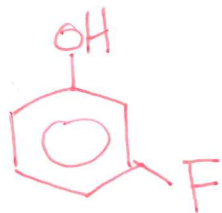
4pts/structure

2pts/arrow set — bond to atom, atom to bond, bond to atom

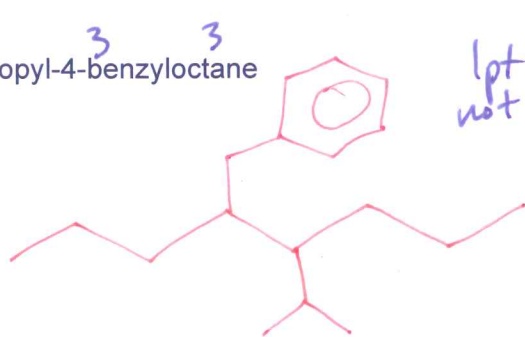
3. Nomenclature

(a) (18 points) Draw structures corresponding to the following names.

3 3 3
meta-Fluorophenol



3 3 3
5-isopropyl-4-benzyl-octane

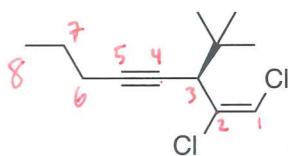


1pt →
not 3

with or
without
stereochem OK

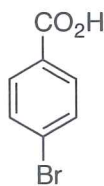
(b) (28 points) Name the following compounds. Include stereochemistry in the name, where appropriate.

(i)



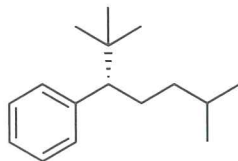
2 2 2
(1E, 3R)-3-tert-butyl
1,2-dichlorooct-1-en-4-yne

(ii)



(4)
para-bromobenzoic acid

(iii)



2
5-(2,2,6-trimethyl-3-phenyl)heptane

4. Substitution and Elimination Reactions

(a) (30 points) Each set of reactions below are happening under similar conditions, but with one variable changed. Indicate the **type of mechanisms** (S_N1 , S_N2 , E1, E2) are taking place to form the products below then **circle the fastest reaction** in each set.

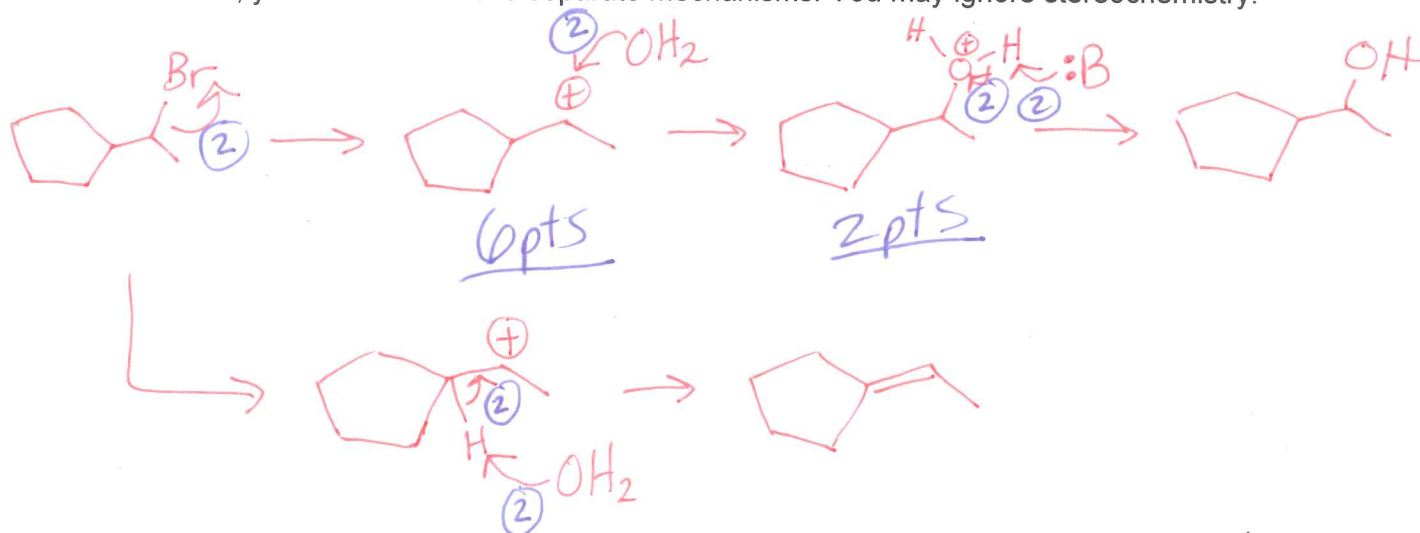
Set A Mechanisms: S_N2 and $E2$

I	
<u>II</u>	
<u>III</u>	

Set B Mechanisms: S_N1 and $E1$

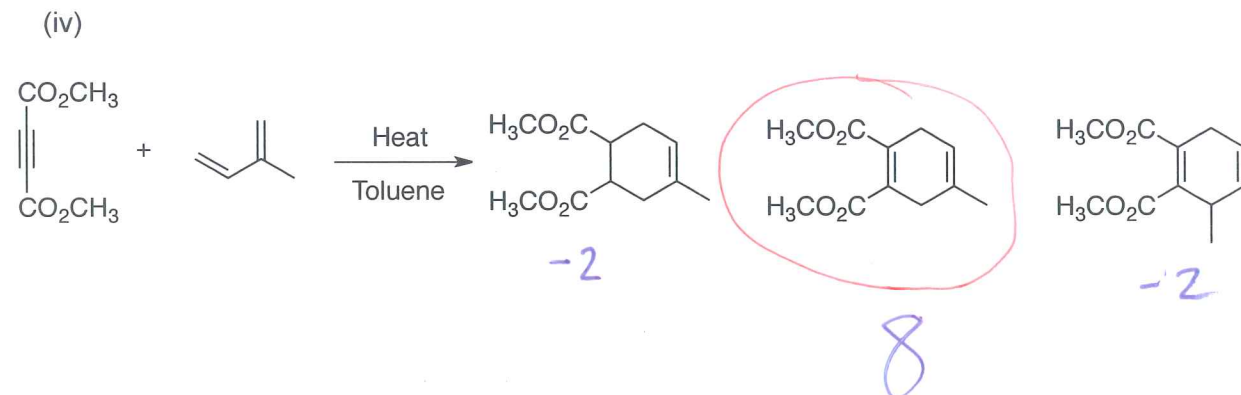
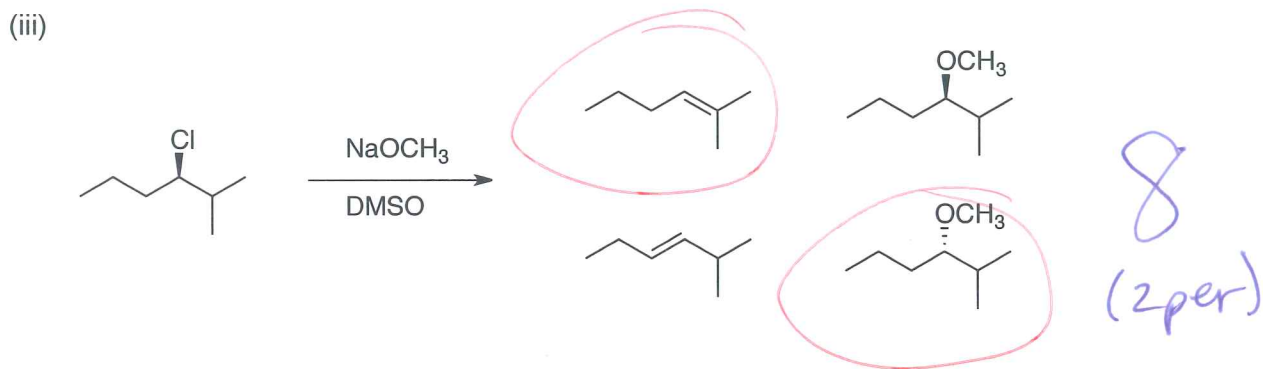
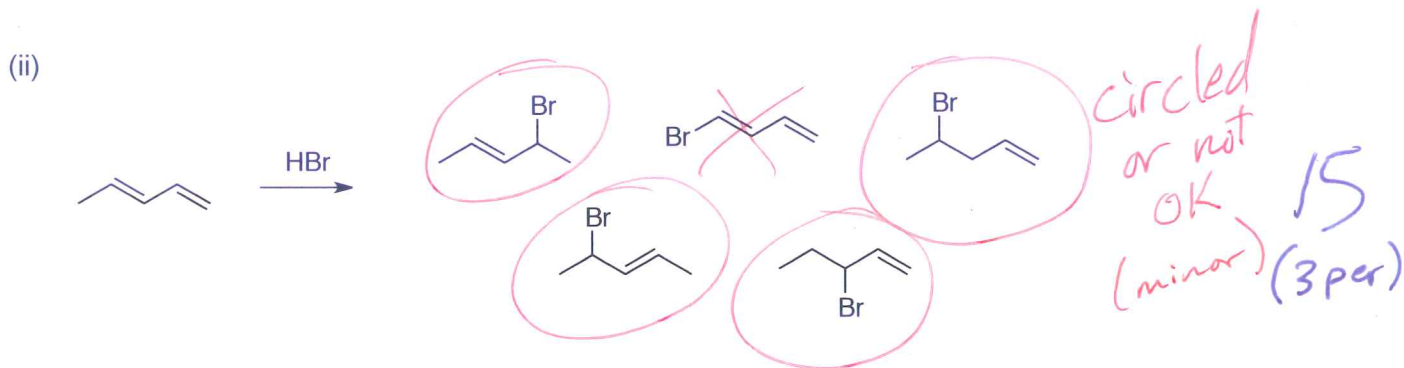
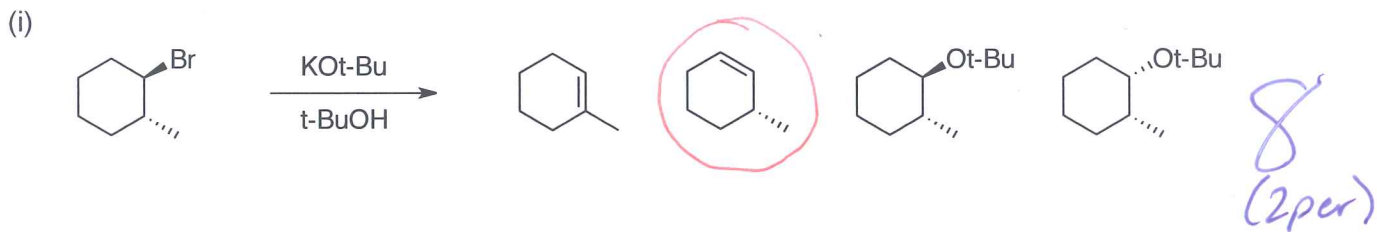
I	1 mol
<u>II</u>	10 mol
<u>III</u>	1 mol

(b) (20 points) Show the **arrow-pushing mechanisms** for the reaction in Set B. Since the products are a mixture, you should draw two separate mechanisms. You may ignore stereochemistry.



5. Reaction Puzzles

(39 points) Circle the major product(s) in each reaction. More than one is possible for several reactions.



6. Single Step Reactions

±1 C -2pts

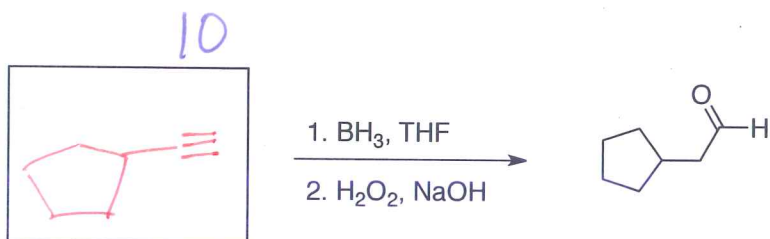
(40 points) WHAT'S IN THE BOX??

Choose any four of the five reactions below and fill in the missing reactant, reagent, or product. If no reaction occurs as written, fill in the box with "NR." Put a large "X" over the problem you are skipping. Otherwise the first four will be graded.

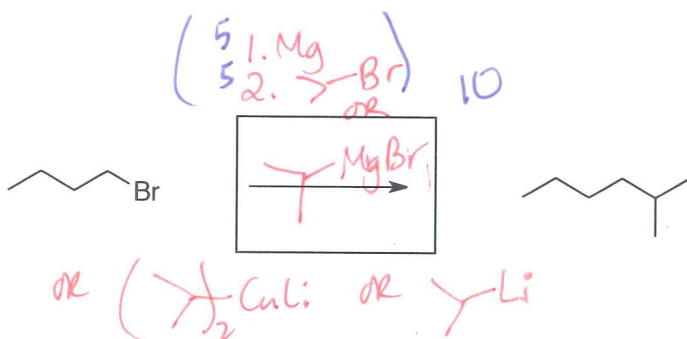
(a)



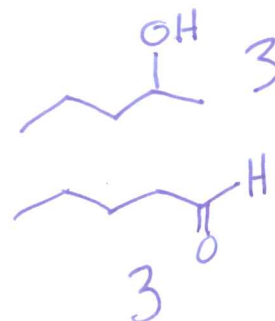
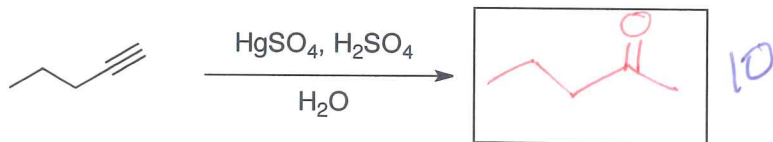
(b)



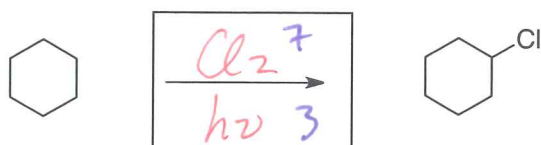
(c)



(d)



(e)

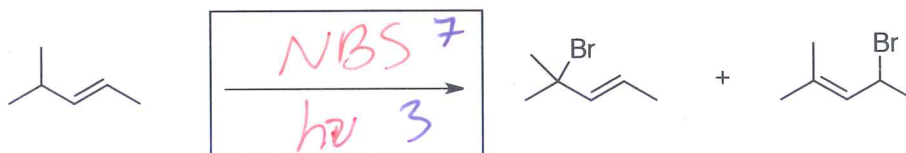


7. Single-Step Reactions

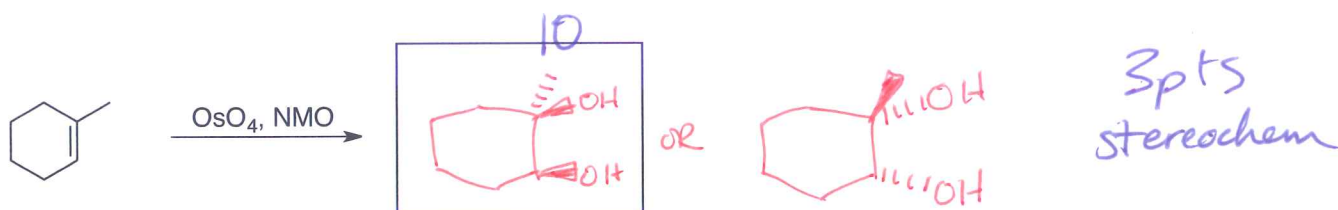
(40 points) WHAT'S IN THE BOX??

Choose any four of the five reactions below and fill in the missing reactant, reagent, or product. If no reaction occurs as written, fill in the box with "NR." Put a large "X" over the problem you are skipping. Otherwise the first four will be graded. Indicate stereochemistry where appropriate.

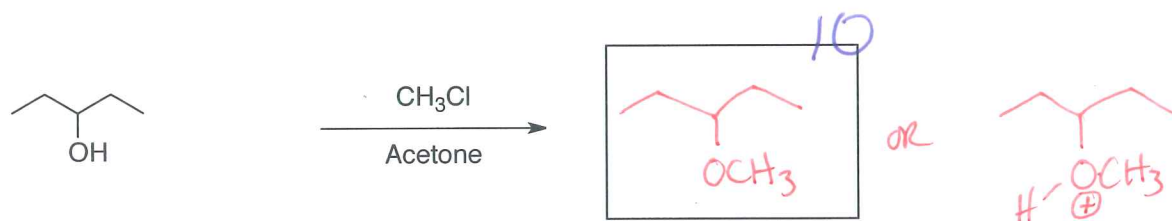
(a)



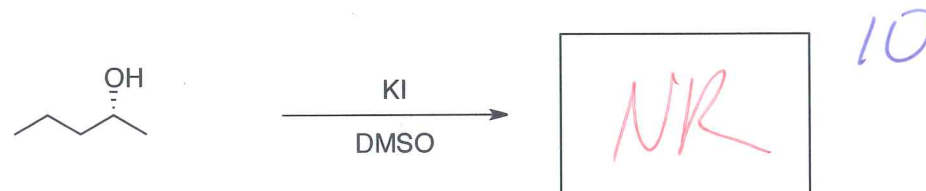
(b)



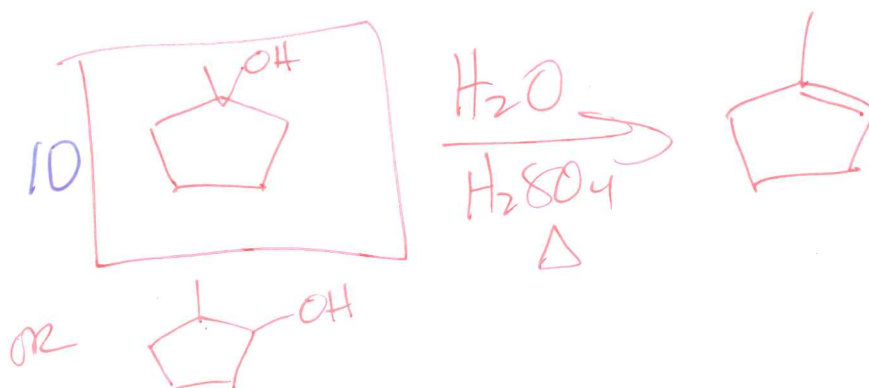
(c)



(d)

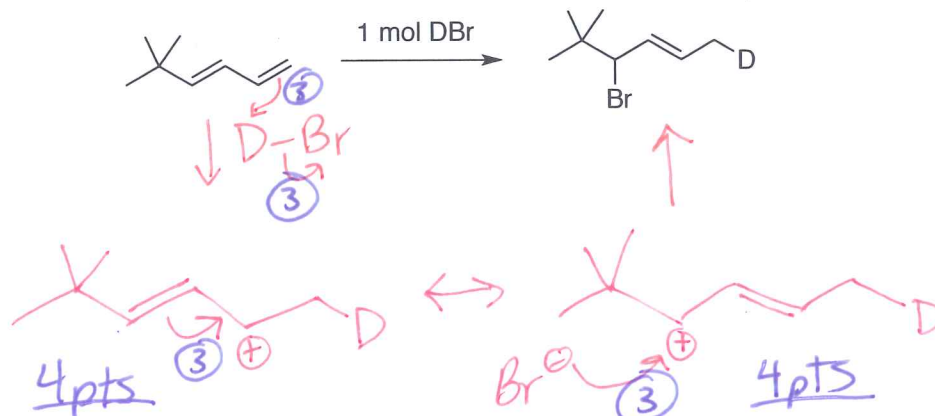


(e)

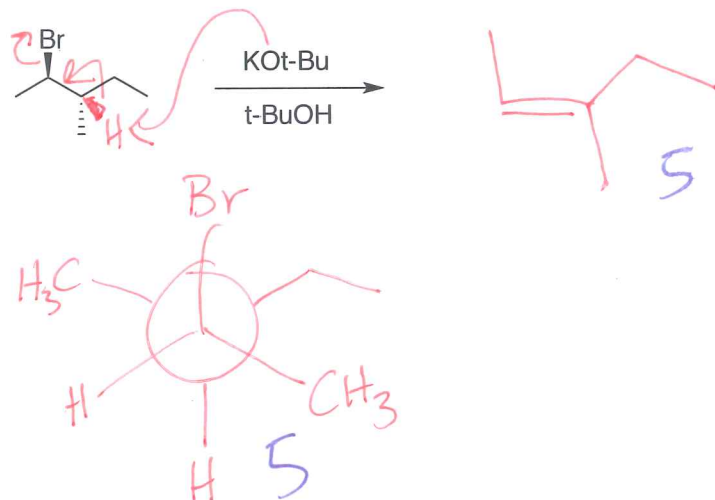
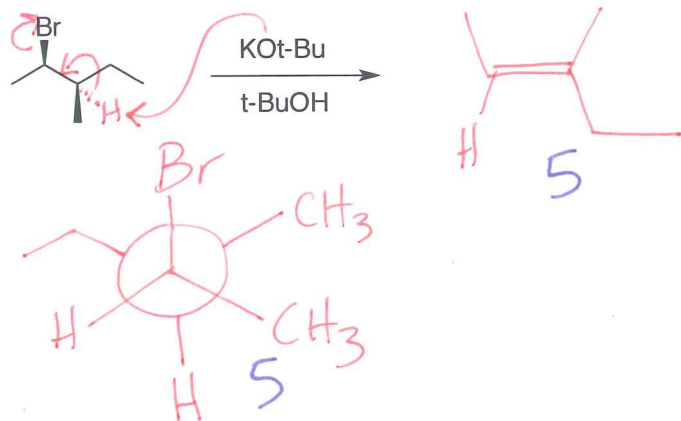


8. Mechanisms

(a) (20 points) The bromination of the conjugated diene below with deuterium bromide results in a mixture of products. Show the arrow-pushing mechanism to explain only the formation of the one product shown.



(b) (30 points) The elimination of (2R,3R)-2-bromo-3-methylpentane affords an E-alkene but its diastereomer, (2R,3S)-2-bromo-3-methylpentane produces the Z-alkene. Draw the appropriate Newman projection of the starting material to explain the stereochemistry in the product. Then draw the arrow-pushing mechanism of the reaction and the product.

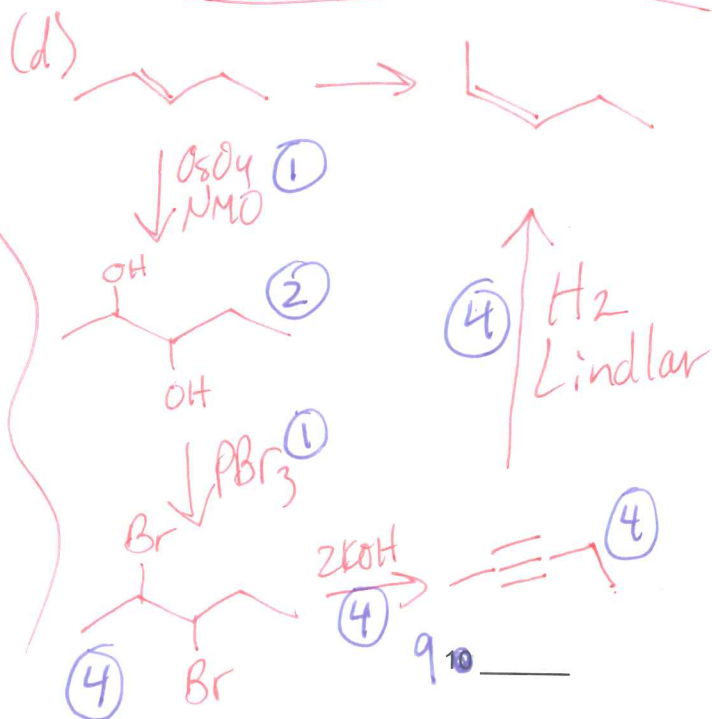
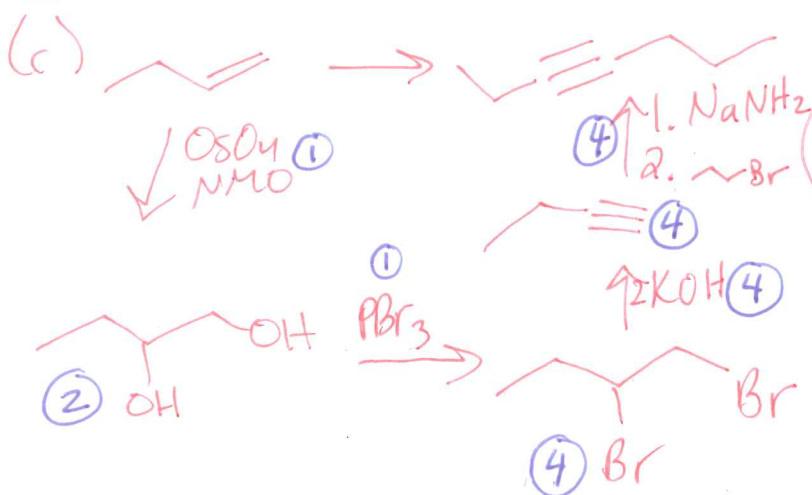
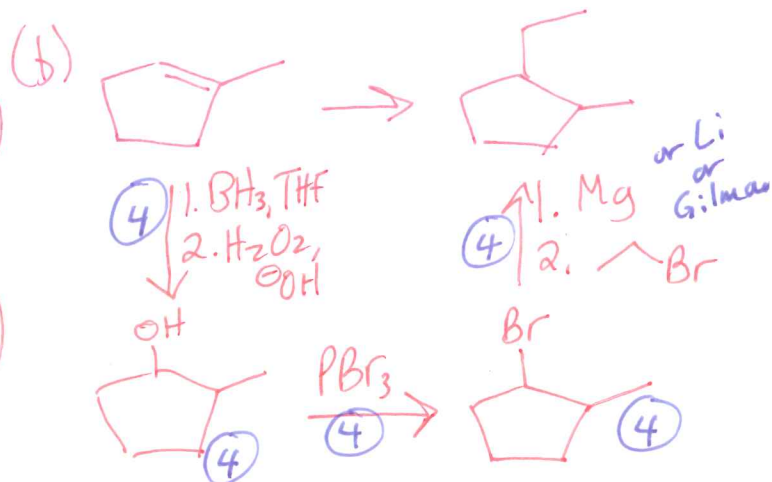
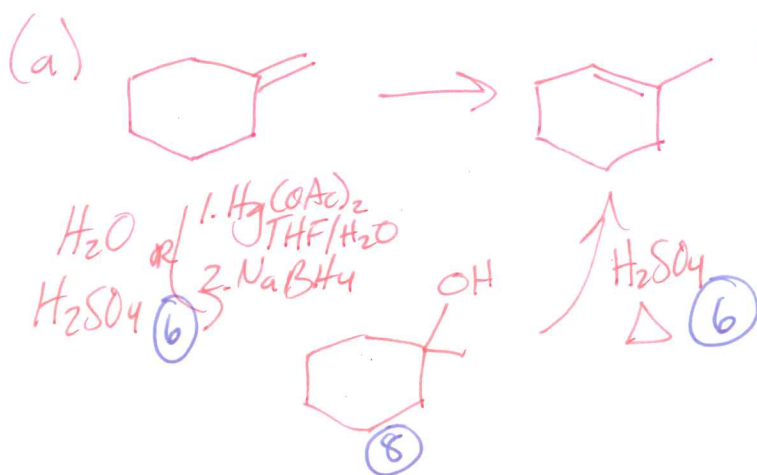
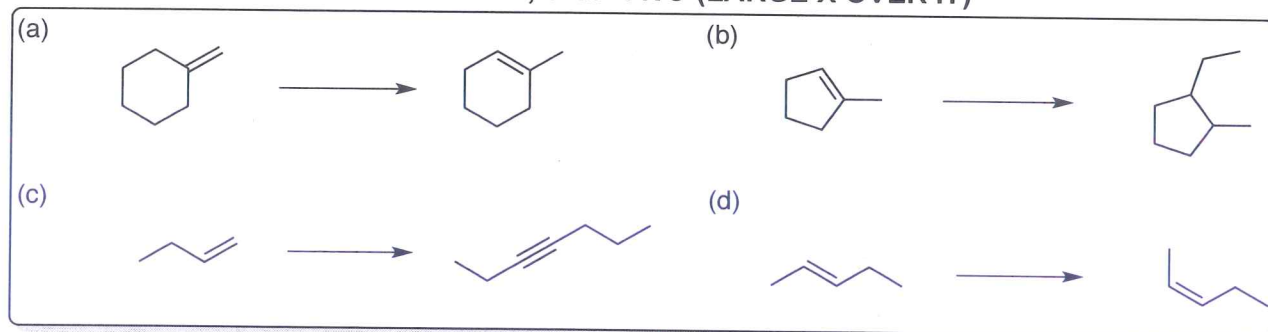


10pts - arrows

9. (40 points) Multi-Step Synthesis

Choose any two of the following synthetic problems. Clearly cross out which problems you are skipping with a large "X." You may use any alkyl halide or organometallic reagent to introduce new carbons and any other reagents necessary. Show the product after each step. If there is a mixture of products, assume the products are separable so you can move forward with the desired product. No mechanisms or stereochemistry.

CHOOSE TWO, SKIP TWO (LARGE X OVER IT)



alternate methods for each
on the next page

9. (30 points) Multi-Step Synthesis

20 pts each

Choose any two of the following synthetic problems. Clearly cross out which problems you are skipping with a large "X." You may use any alkyl halide or organometallic reagent to introduce new carbons and any other reagents necessary. Show the product after each step. No mechanisms yesterday.

or stereochem necessary.
CHOOSE TWO, X OUT 2