

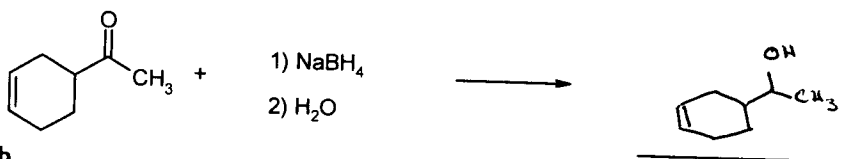
NAME \_\_\_\_\_ ID# \_\_\_\_\_

LAB SECTION (enter 'no lab' if in 232 or not taking one) \_\_\_\_\_

Note: Please answer on the test paper. There is an extra sheet for rough work at the back, but it will not be marked. In some questions, there is a choice of questions to answer. If all are answered, all will be marked.

I. Fill in the blanks with the structural formula required to complete the equation. Show any required catalysts over the arrow. Make sure your drawings show stereochemistry if it is important. **Do any ten (10)** (40 marks)

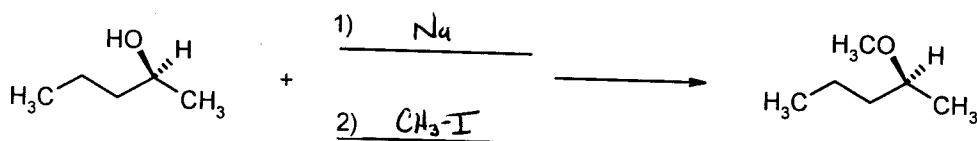
a.



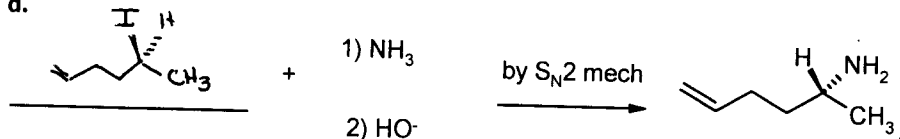
b.



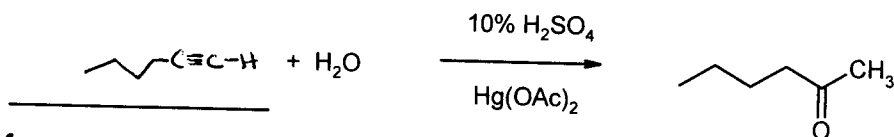
c.



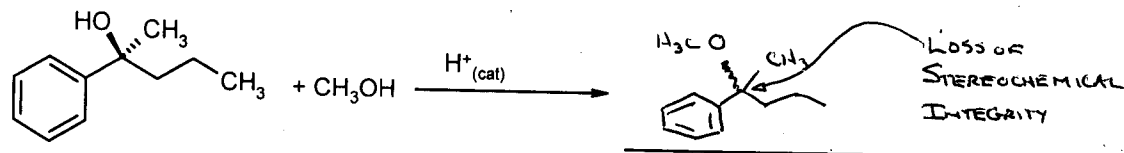
d.



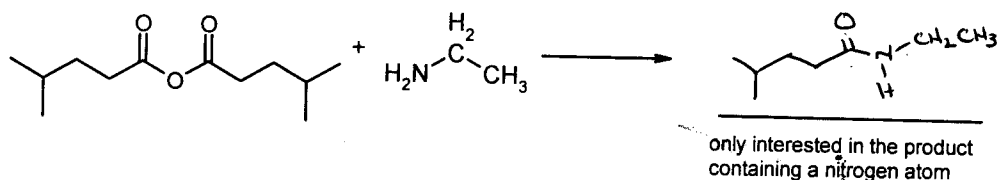
e.



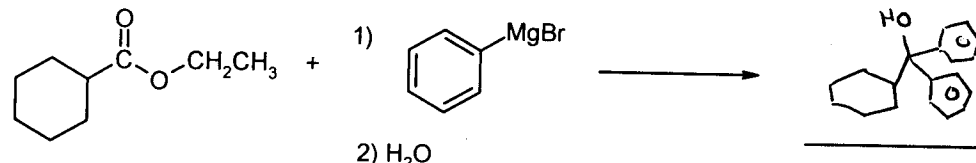
f.



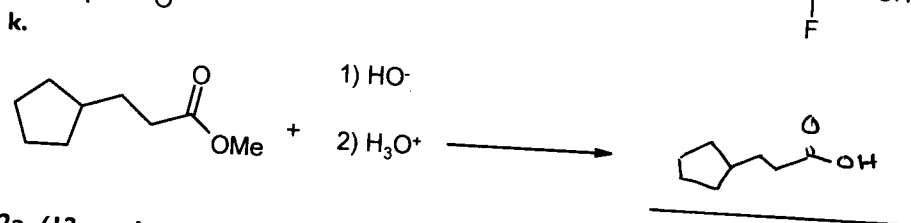
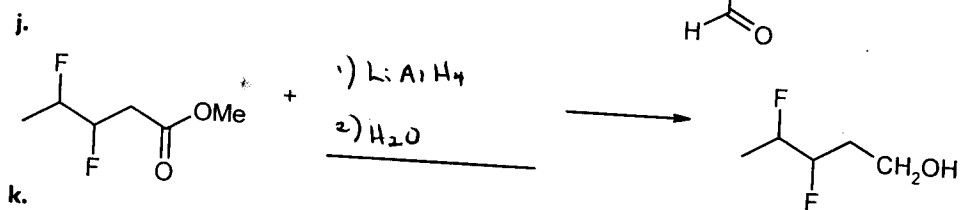
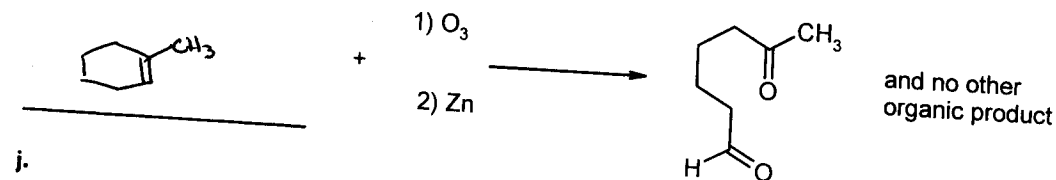
g.



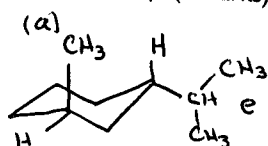
h.



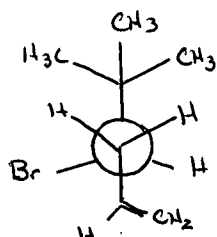
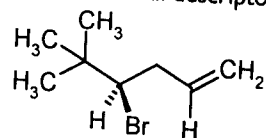
i.



2a. (12 marks total) Draw the structure of *trans* 1-isopropyl-3-methylcyclohexane in its most stable chair conformation. Label the non hydrogen substituents on the cyclohexane as axial or equatorial. In terms of size, an isopropyl group is larger than a methyl group. (5 marks)



b. Draw the Newman projection of the following compound in its most stable conformation, as viewed down the C3-C4 bond. With respect to size,  $C(CH_3)_3 > Br > H$ . What is the name of this compound, including its stereochemical descriptor? (7 marks)

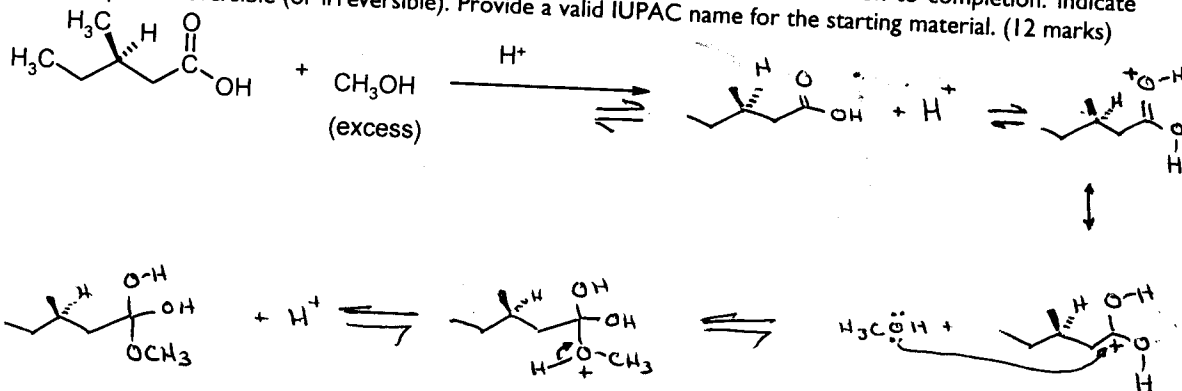


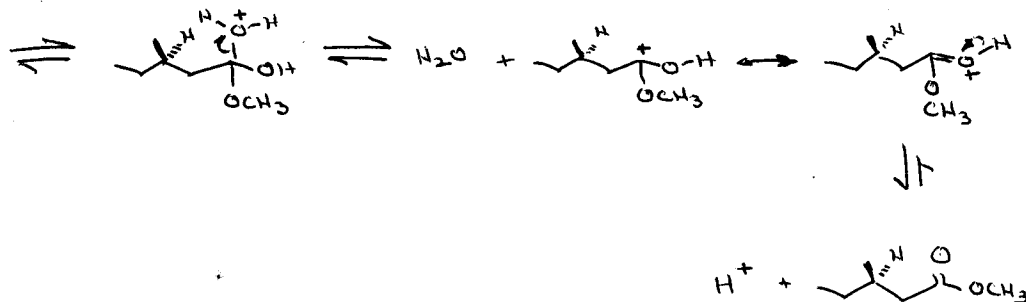
R) 4-Bromo-5,5-Dimethyl-1-Hexene

..... DIMETHYLHEX-1-ENE IS OK, TOO

3. a. (17 marks total)

Draw the complete mechanism for the following reaction. Take the reaction to completion. Indicate which steps are reversible (or irreversible). Provide a valid IUPAC name for the starting material. (12 marks)

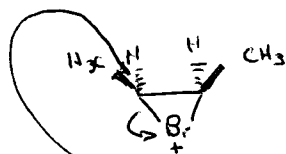




R) 3-METHYLPENTANOIC ACID.

b. In the attempt to convert an alkene (let's use (E) 2-butene) to a dibromoalkane rapidly, a student tried adding bromine using methanol as a solvent, figuring that a polar solvent would speed up the reaction. Unfortunately, the dibromoalkane was obtained only as a minor product. Explain what went wrong and why, using structures of the intermediates to indicate the point, but I am *not* looking for the complete, detailed mechanism of this addition. (5 marks).

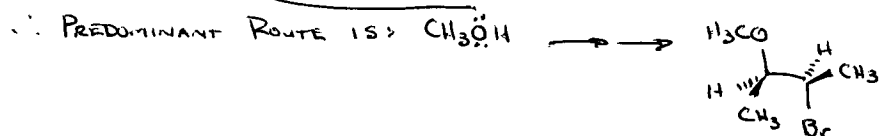
THE PROBLEM: THE INTERMEDIATE BROMONIUM ION



AND TWO POTENTIAL NUCLEOPHILES

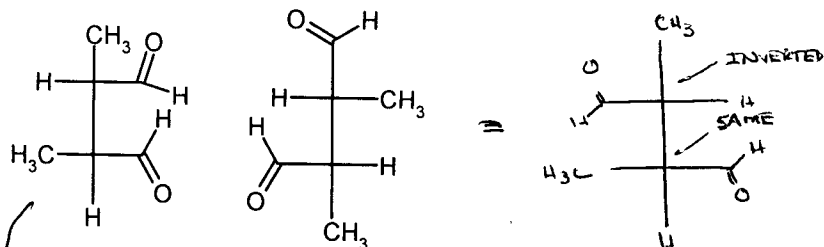
1)  $\text{Br}^-$  IN LOW CONCENTRATION

2)  $\text{CH}_3\text{OH}$  IN HIGH CONCENTRATION



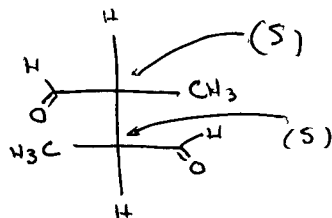
4. (15 marks total) Describe the relationship that exists between the following sets of compounds (i.e., enantiomer, diastereomer, geometric isomer, structural isomer, identical)

a.

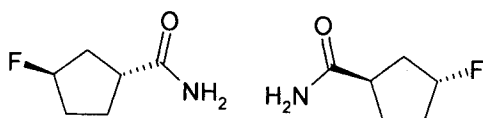


∴ DIASTEREOMERS

Also, identify the chiral centres for the left compound as (R)- or (S)-

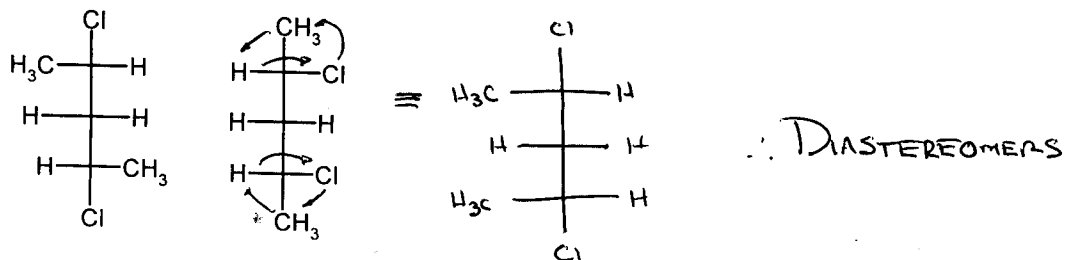


b.

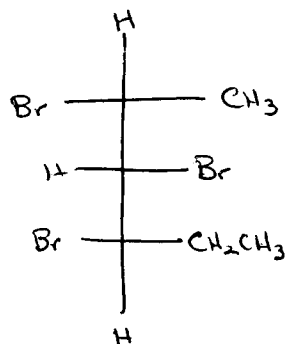


IDENTICAL

c.



d. Draw the Fischer projection of (2S, 3S, 4R)-tribromohexane. (5 of the 15 marks).

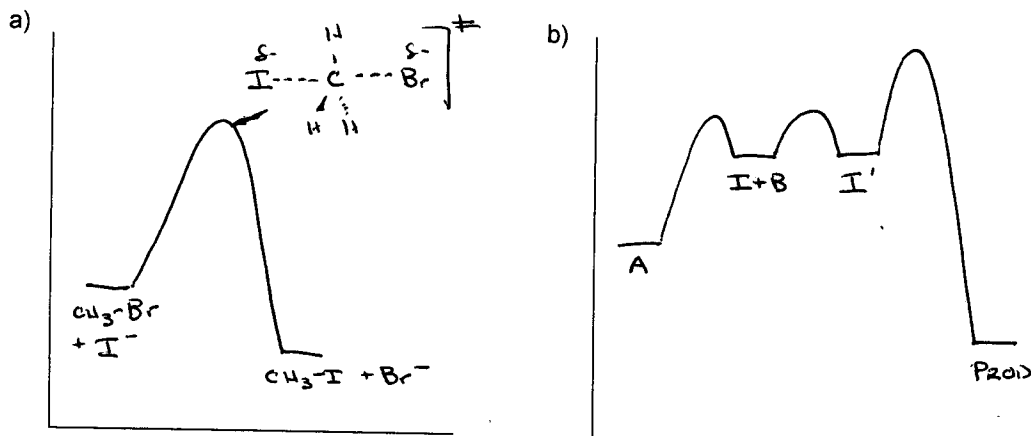


5. On the axes below, draw the energy reaction coordinate profile for:

a. The  $S_N2$  reaction between bromomethane and  $I^-$  ion.

b. A three step reaction between A and B, where A is involved in the 1<sup>st</sup> step and B is involved in the 2<sup>nd</sup> step. The 3<sup>rd</sup> step is the slowest one.

In each of these cases, give the rate equation for the reaction. (10 marks total)

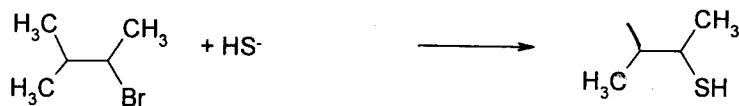


$$\text{rate (v)} = k [I^-] [CH_3Br]$$

$$\text{rate (v)} = k [A] [B]$$

6. (13 marks total) Rank the following in terms of tendency to undergo  $S_N1$  substitution (as opposed to  $S_N2$ ). Give reasons for your ordering. (10 of the 13 marks)

a.



b.



c.



a) 2° ALKYL HALIDE - MARGINAL S<sub>N</sub>1 or S<sub>N</sub>2  
HS<sup>-</sup> GOOD NUCLEOPHILE - TOWARDS S<sub>N</sub>2

b) 1° ALKYL HALIDE - FAVOURS S<sub>N</sub>2  
HS<sup>-</sup> GOOD NUCLEOPHILE - TOWARDS S<sub>N</sub>2

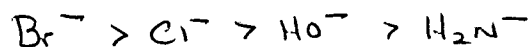
c) 2° ALKYL HALIDE - MARGINAL S<sub>N</sub>1 or S<sub>N</sub>2  
H<sub>2</sub>S SO, SO NUCLEOPHILE - TOWARDS S<sub>N</sub>1

∴ FOR S<sub>N</sub>1 CHARACTER VS. S<sub>N</sub>2

c) 1 FACTOR MARGINAL 1 FACTOR S<sub>N</sub>1 > a) 1 FACTOR MARGINAL 1 FACTOR S<sub>N</sub>2 b) BOTH FACTORS S<sub>N</sub>2

d. Rank the following from best leaving group to worst leaving group ? (3 of the 13 marks)

Cl<sup>-</sup>, Br<sup>-</sup>, H<sub>2</sub>N<sup>-</sup>, HO<sup>-</sup>

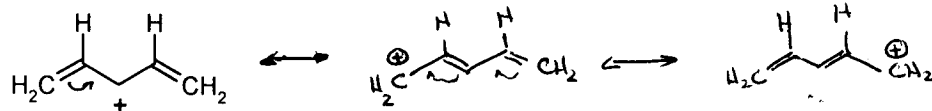


7. (12 marks) Indicate all reasonable resonance forms of the following ions, using curved arrows to indicate electron movement. If there are unreasonable resonance forms, either do not draw them or label them as unreasonable. If there is a case for which there are no other resonance forms, state that fact.

a.



b.

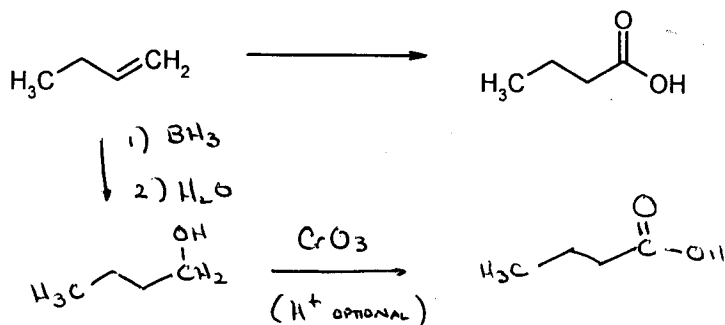


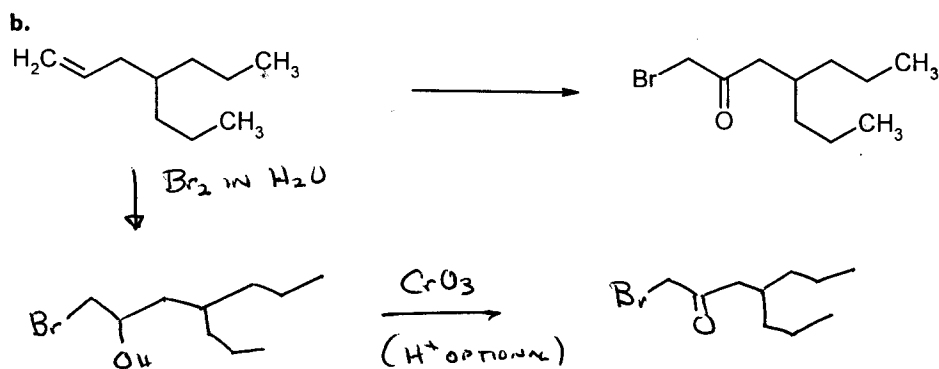
c.



8. (11 marks total) Show by equation how you carry out the following overall transformations. Show all reagents and the structures of each reaction product. There is quite possibly more than one correct way to accomplish this overall transformation. DO one of a and b, but answer c regardless.

a.



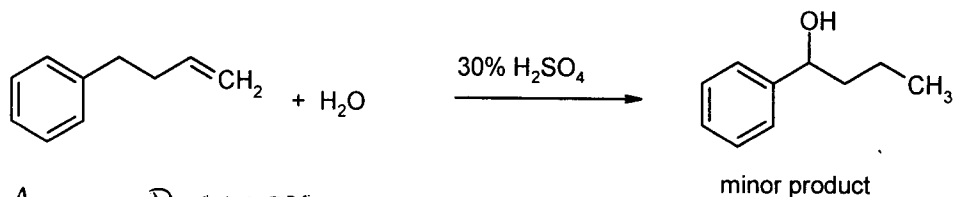


c. What is the name of the final product compound in **8b**? (3 of the 11 marks)

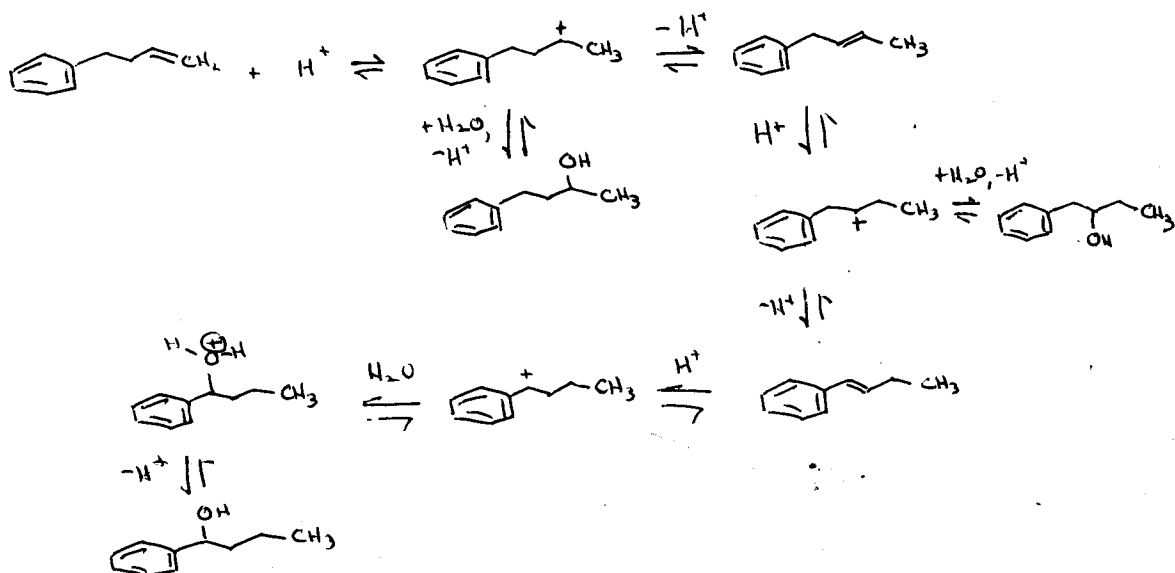
1-Bromo-4-Propylheptan-2-one  
or ... 4-Propyl-2-Heptanone.

**Bonus:** (up to +5)

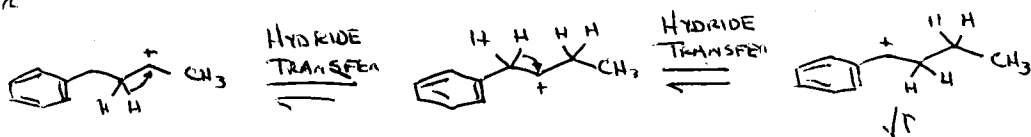
In the following attempted addition of water to the indicated alkene, a small amount of the indicated (non-intended) alcohol was isolated (as a minor product). Suggest a reasonable mechanism for the formation of this compound.



A couple Possibilities



OR



AND THEN AS BEFORE.