Name (**write clearly**) :___________________________________
First M. Last

ID#:___________________________________

O Please check here if you do NOT wish to have your exam returned in class.
Exams not returned in class can be picked up at my office during office hours.

Final Exam
Organic Chemistry 2301-1
Spring 2006
Wednesday, May 10, 2006
13 pages.

- Please write down your name on the Front Page, and last name on all pages.
- You may **NOT** use any notes or textbooks.
- You can use molecular models during the exam.
- Raise your hand if you have a question.
- Exam begins at 10:30 am and ends at 12:30 pm.
- Everyone is asked to **remain seated until the end of the exam** to minimize disturbance of students finishing the exam.
- Remember, some questions may be asked twice in different ways in the exam.
- If you request for regrading later, you must use ink pen to answer your exam.
- Good luck.

I. ___________________ / 90 pts (multiple choice)

II. ___________________ / 80 pts (single step reactions)

III. ___________________ / 50 pts (mechanisms and short answers)

IV. ___________________ / 40 pts (multiple step synthesis)

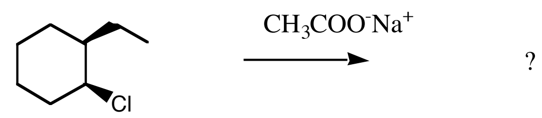
V. ___________________/ 40 + 10 pts (structures + bonus)

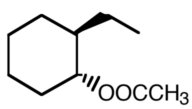
Total: ___________________ / (300 + 10) pts

Part I. Multiple choice or simple questions (100 pts total)

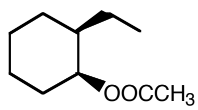
Circle the letter corresponding to your best answer for each of the following questions.

1. (6 pts.) Predict the **major** product if the following reaction went by the S_N1 pathway.

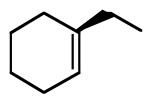




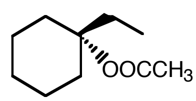
(A)



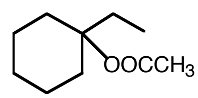
(B)



(C)



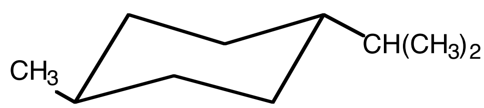
(D)



(racemic)

(E)

2. (6 pts) Give the full IUPAC name for the following compound?



____

3. (6pts) The greatest strength of infrared (IR) spectroscopy is in determining:

(A). the degree of unsaturation.

(B). the relationship of structural fragments.

(C). the functional groups present.

(D). the exact structure of the molecule.

(E). if rings are present.

4. (6 pts) Which of the following reagents might serve as the basis for a simple test that would distinguish between pure cyclohexene and cyclohexane?

(A) Br_2/CCl_4

(B) dilute $KMnO_4$/NaOH

(C) none of (A) and (B)

(D) both of (A) and (B)

(E) dilute $NaOH/H_2O$

5. (6 pts) A compound with the molecular formula $C_3H_6Cl_2$ gave a proton NMR spectrum consisting of a triplet (3) centered at δ3.7 and a quintet (5) centered at δ2.2. What is the most likely structure for the compound?

(A). $CH_3CH_2CHCl_2$

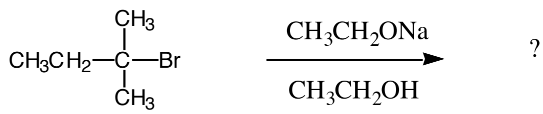
(B). $CH_3CHClCH_2Cl$

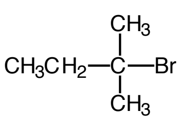
(C). $ClCH_2CH_2CH_2Cl$

(D). $CH_3CCl_2CH_3$

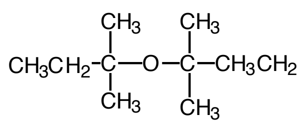
(E). none of the above.

6. (6 pts) Which compound listed below would you expect to be the major product of the following E2 elimination reaction?

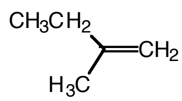




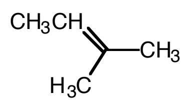
(A)



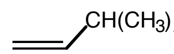
(B)



(C)



(D)



(E)

7. (6 pts) What characteristics of alkynes would make it difficult to prepare cyclohexyne?

(A). the requirement for linearity at the triple bond carbons.

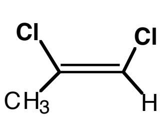
(B). the large electron density between carbons of a triple bond.

(C). the short carbon-carbon triple bond length.

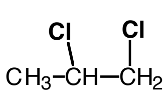
(D). carbon-carbon triple bonds are more reactive than alkanes.

(E). all of these.

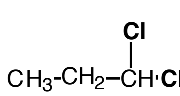
8. (6 pts) What major product is expected from the reaction shown below ?



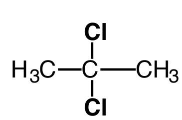
(A)



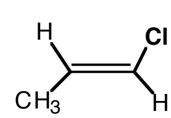
(B)



(C)



(D)



(E)

9. (6 pts) What is the relationship between alcohols I and II below?

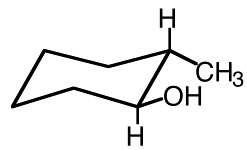
(A). different conformations of the same compounds (conformers).

(B). constitutional isomers.

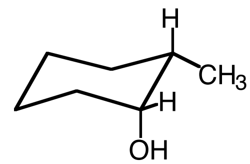
(C). enantiomers.

(D). diastereomers.

(E). identical.



(I)



(II)

10. (6 pts) Which is the strongest nucleophile?

(A). OH^-

(B). CH_3CH_2OH

(C). $CH_3CH_2O^-$

(D). CH_3COO^-

(E). H_2O

11. (6 pts) Markovnikov addition of HCl to propene involves:

(A). initial attack by a chloride ion.

(B). initial attack by a chlorine atom.

(C). isomerization of 1-chloropropane.

(D). formation of a 1-propyl cation ($CH_3CH_2CH_2^+$)

(E). formation of an isopropyl cation ($(CH_3)_2CH^+$)

12. (6 pts). Which of the following would be a reasonable synthesis of $CH_3CH_2CH_2CH_2OH$?

(A). 1-butene $\xrightarrow{H_3O^+,\ H_2O,\ heat}$

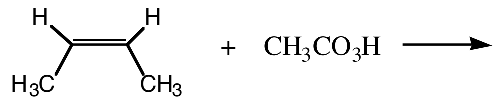
(B). 1-butene $\xrightarrow[2).\ H_2O_2,\ NaOH]{1).\ BH_3:THF}$

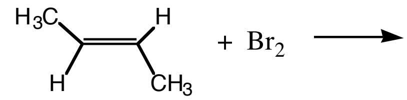
(C). 1-butene $\xrightarrow[2).\ NaBH_4]{1).\ Hg(OAc)_2/H_2O}$

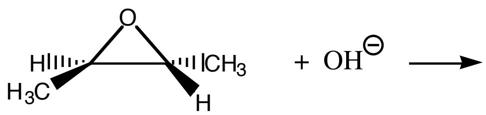
(D). more than one of these.

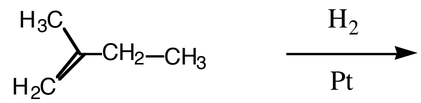
(E). none of these.

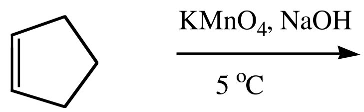
13. (6 pts) Which reaction is NOT stereospecific?

(A) 

(B) 

(C) 

(D) 

(E). 

14. (6 pts). Which ion is the weakest base?

(A). $CH_3CH_2^-$

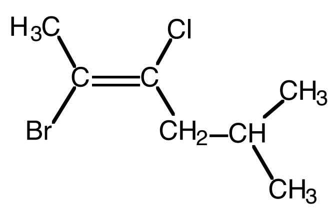
(B). $CH_2{=}CH^-$

(C). $HC{\equiv}C^-$

(D) HO^-

(E) H_2N^-

15. (6 pts). The correct IUPAC name for the following compound is:

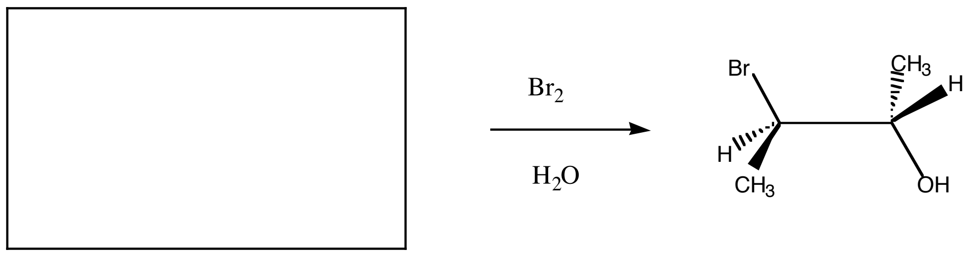


(A). (E)-2-bromo-3-chloro-5-methyl-2-hexene.
(B). (E)-2-bromo-3-chloro-5-methyl-3-hexene
(C). (Z)-2-bromo-3-chloro-5-methyl-2-hexene.
(D). (Z)-2-bromo-3-chloro-5-methyl-3-hexene.
(E). (Z)-2-methyl-5-bromo-4-chloro-4-hexene

Part II. (80 pts) single step reactions

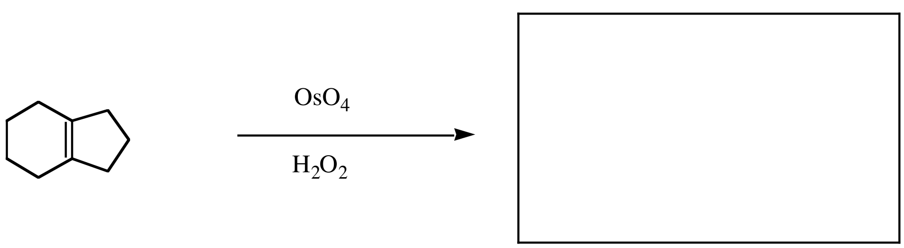
Complete the following questions, by providing the product(s), reagents, or reactants **in** the appropriate boxes. Assume aqueous work up has been performed. **Pay attention to stereochemistry where necessary**.

16 (10 pts).

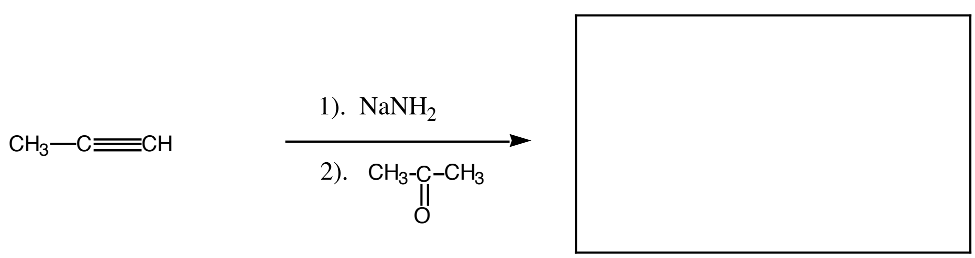


17 (10 pts) .

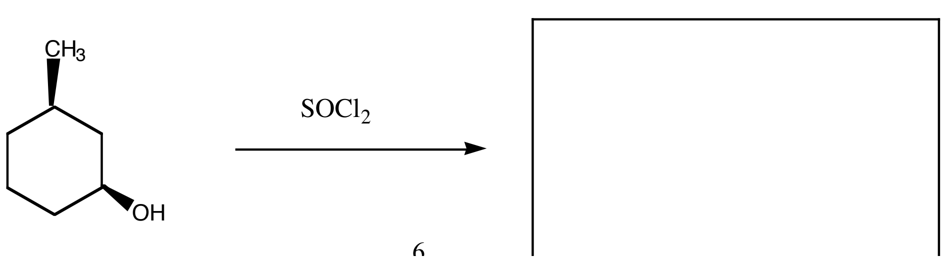
18 (10 pts) .



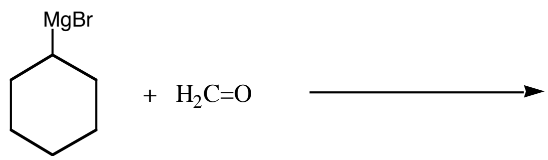
19 (10 pts) .



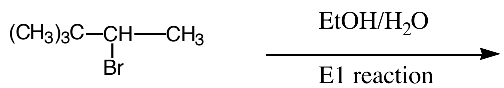
20 (10 pts).



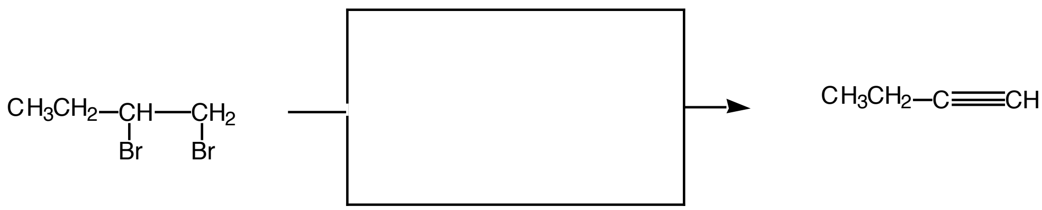
21 (10 pts).



22 (10 pts).

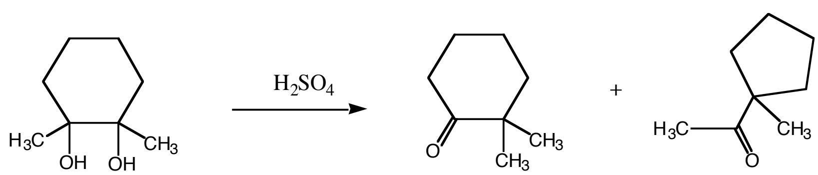


23 (10 pts).

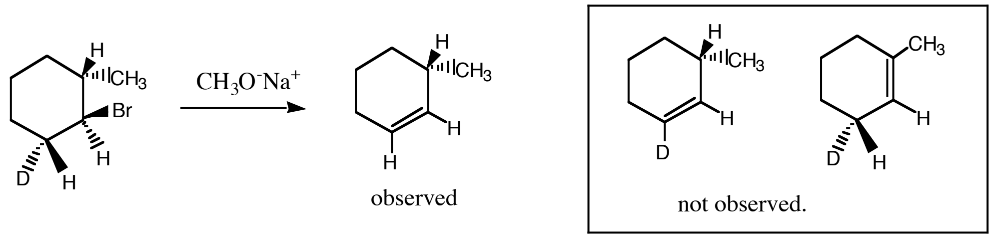


Part III. (50 pts) Mechanism and short answers

24. (15 pts) 1,2-diols may undergo rearrangements in acid-catalyzed reactions. Propose a mechanism for the following reaction to account for the formation of both products.

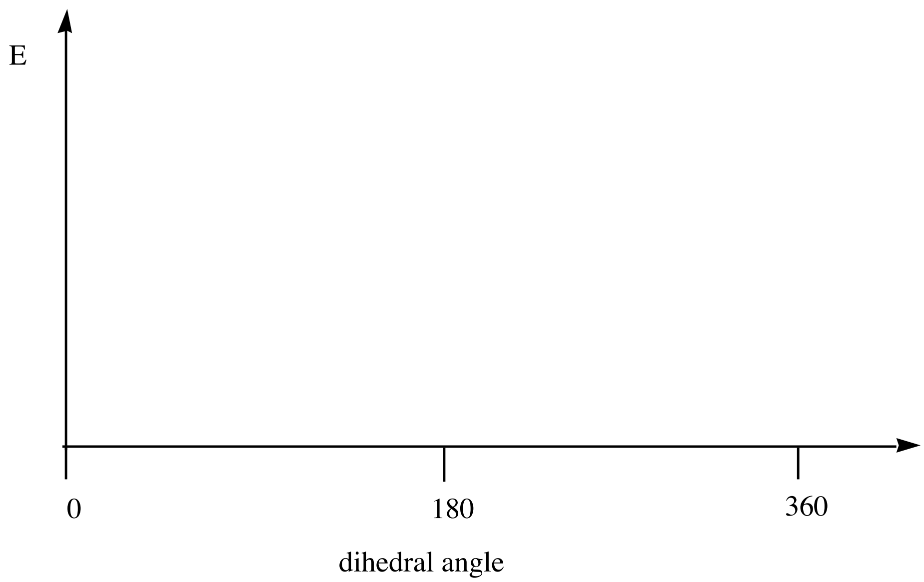


25. (15 pts). Explain why the following deuterated 1-bromo-2-methylcyclohexane undergoes dehydrohalogenation by the E2 mechanism, to give only the indicated product, but two other alkenes are not observed.



26. (10 pts). What is the percent composition of a mixture of (S)-(+)-2-butanol, $[\alpha]_D = +13.52^o$, and (R)-(-)-2-butanol, $[\alpha]_D = -13.52^o$, with a specific rotation $[\alpha]_D = +6.76^o$?

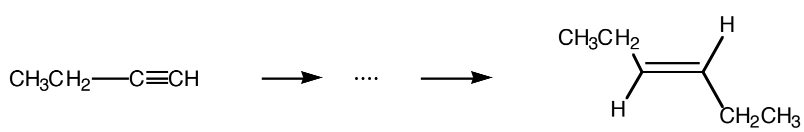
27. (10 pts). Draw the potential energy curve for the rotation of butane about its C2-C3 single bond. Show Newman projection formulas for the energy maxima and minima. You do not need to specify the exact energy values, but you should pay attention to the relative energies of different conformers.



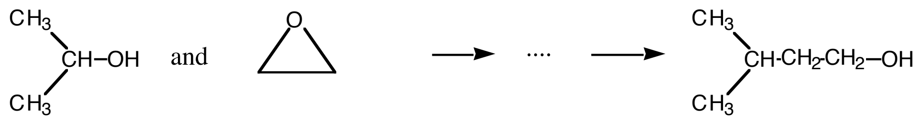
Part IV (40 points). Multiple step synthesis

Propose a synthesis for the following target molecules, starting from the compound(s) specified. You may use any inorganic reagents or organic compounds with two (2) or less carbon atoms.

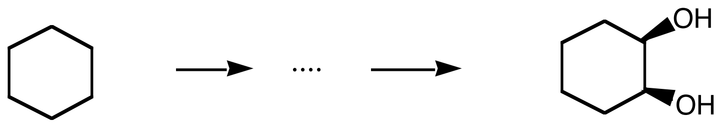
28. (15 pts).



29. (10 pts).

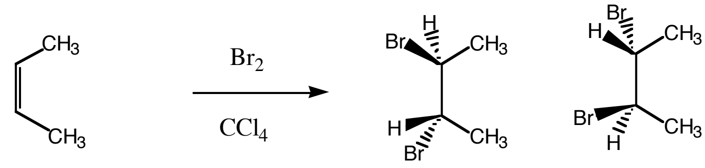


30. (15 pts).



Part IV (40 points). Structure and Identification of unknowns

31. (20 pts) **Reaction of (Z)-2-butene and Bromine yields a mixture of 2 compounds**.



(X) (Y)

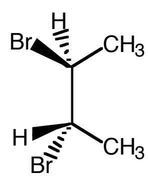
(a). (1 pts). Are compounds (X) and (Y) above formed in equal amount? ________

(b). (2 pts). What is this mixture called? _______________________

(c). (2 pts). Is a solution of the reaction mixture (X) and (Y) optically active? _______

(d). (1 pts). How many stereocenters are there in compound (X)? ___________

(e). (2 pts). Use a star (*) to indicate the stereocenters of compound (X) below:

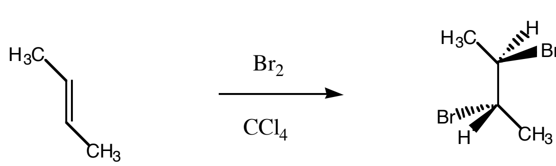


(X)

(f). (4 pts). Assign the appropriate "R" or "S" label to each of the stereocenters above.

(g). (2 pts). What is the relationship between compounds (X) and (Y) (Use the proper stereochemistry term, NOT symmetry operations). _____________________

Reaction of (E)-2-butene and Bromine yields a single compound (Z):



(Z)

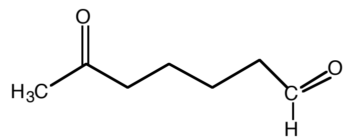
(h). (1 pt). How many stereocenters are there in compound (Z)? _______________

(i). (1 pts). Is compound (Z) optically active? ________________

(j). (2 pts). What stereochemical term is used to describe compound (Z)? ___________

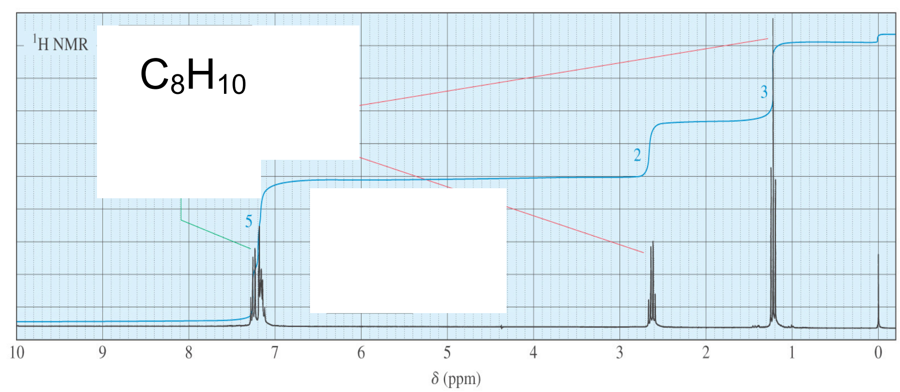
(k). (2 pts). What is the stereo relationship between (X) and (Z)? ______________

32. (10 pts). Compound, W, has the molecular formula C_7H_{12}. On catalytic hydrogenation, 1 mole of C absorbs 1 mole of hydrogen and yields a compound with the molecular formula C_7H_{14}. On ozonolysis and subsequent treatment with $(CH_3)_2S$, it yields only:



What is the structure of compound W? (As usual, you must provide explanations).

33 (10 points). Propose a structure for the compound whose proton NMR is shown. You must show your work to receive credits. (the peaks at δ1.2 are triplet, and δ2.6 is quartet).



Bonus (10 points). Propose a structure for the compound whose proton NMR is shown. You must show your work to account for each NMR peak to receive credits.

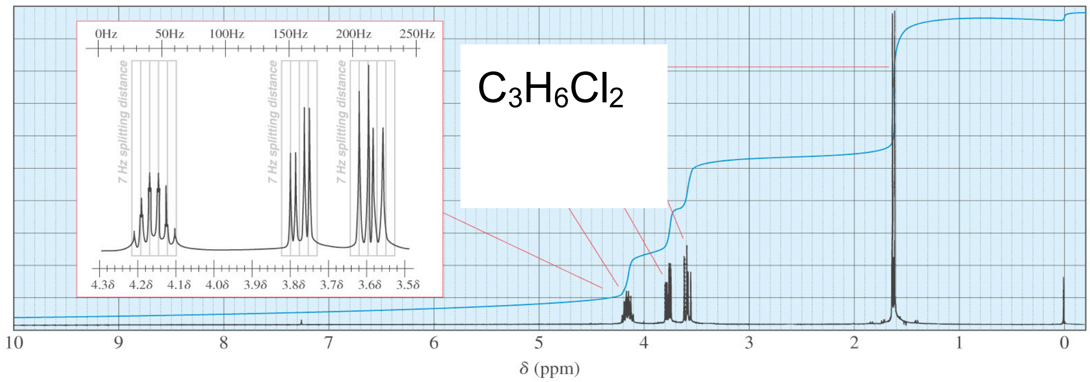


TABLE 13-3 Typical Values of Chemical Shifts

Type of Proton	Approximate δ	Type of Proton	Approximate δ
alkane (—CH_3)	0.9	$\rangle C{=}C\langle CH_3$	1.7
alkane (—CH_2—)	1.3	Ph—H	7.2
alkane (—CH—, with a third bond)	1.4	Ph—CH_3	2.3
—C(=O)—CH_3	2.1	R—CHO	9–10
—C≡C—H	2.5	R—COOH	10–12
R—CH_2—X (X = halogen, O)	3–4	R—OH	variable, about 2–5
$\rangle C{=}C\langle H$	5–6	Ar—OH	variable, about 4–7
		R—NH_2	variable, about 1.5–4

Note: These values are approximate, as all chemical shifts are affected by neighboring substituents. The numbers given here assume that alkyl groups are the only other substituents present. A more complete table of chemical shifts appears in Appendix 1.