Organic Chemistry I Lecture Fall 2016 12/5 Monday Final Exam Dr. Hahn Exam # _____

Name Key (print) Name _____(sign)

Please show work for partial credit and full credit on the Long Answers and in some of the Short Answer Questions. Multiple choice questions have no partial credit. Please write anything you want graded legibly. If you run out of space, please continue on the empty back pages but clearly label where the remaining answer can be found. (If I can't find your answer or cannot read it, I obviously cannot grade it). Return your entire exam including the seriodic table. (Please count your exam pages and make sure there are 12 real pages + periodic table)

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question. (2 pts each, 24 pts total)

1) In which of the following mechanisms (S_N1, S_N2, E1, E2) are alkenes the major reaction products? 1) E
A) E1 only
B) S_N2 only
C) S_N1 only
D) E2 only
(E) both E1 and E2

2) A mixture of equal amounts of two enantiomers _____. 2) D
A) is called a racemic mixture
B) is optically inactive
C) implies that the enantiomers are meso forms
(D) both A and B
E) none of the above

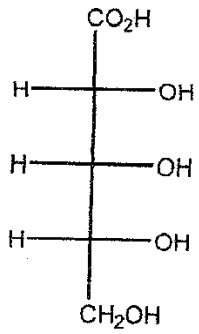
3) The atomic number of boron is 5. The correct electronic configuration of boron is: 3) E
A) $2s^22p^3$ B) $1s^22p^3$ C) $1s^22s^3$ D) $1s^22s^23s^1$ (E) $1s^22s^22p^1$

4) Which of the following additions to alkenes occur(s) specifically in an anti fashion? 4) D
A) hydroboration–oxidation B) addition of H_2
C) addition of H_2O in dilute acid (D) addition of Br_2

5) The carbon–carbon triple bond of an alkyne is composed of _____. 5) B
A) two σ bonds and one π bond (B) one σ bond and two π bonds
C) three σ bonds D) three π bonds

6) The electronegativity of elements on the periodic table increases going up a column and to the right in each row. (hint: where is F) 6) D
A) down; right B) up; left C) down; left (D) up; right

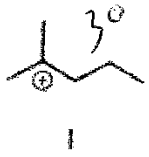
7) How many enantiomers are there of the molecule shown below? 7) E



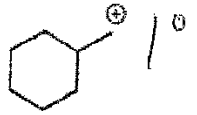
One enantiomer
multiple diastereomer

A) 3 B) 6 C) 0 D) 2 (E) 1

8) Rank the following carbocations in order of stability. (The most stable is first.) 8) D



I



II

III

$3° > 2° > 1°$

A) II > I > III B) III > I > II C) I > II > III (D) I > III > II

9) Which of the following intermediates is thought to occur in the mechanism by which alkenes are hydrated in the presence of acid? 9) E

A) carbene
B) alkyne
C) carbanion
D) free radical
(E) carbocation

10) Which of the following mechanisms (S_N1, S_N2, E1, E2) feature(s) a carbocation intermediate? 10) E

A) E1 only
B) S_N1 only
C) S_N2 only
D) E2 only
(E) both S_N1 and E1

11) Which of the following improperly describes the physical properties of an alkyne? 11) D

A) relatively nonpolar T
B) boiling point nearly the same as an alkane with similar carbon skeleton T
C) nearly insoluble in water T
(D) insoluble in most organic solvents F

12) Which of the following molecules contains a polar covalent bond? 12) C

A) H_2 B) NaCl (C) CH_3Cl D) He E) F_2

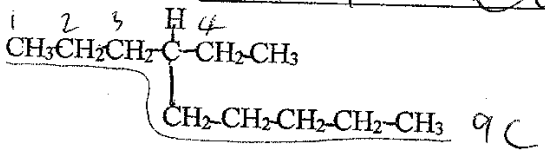
ionic

Part II: Short Answers (56 pts)

A. Nomenclature: (6 pts total, 2 pts each)

1. Given the structural formula shown below, give the IUPAC name of the molecule.

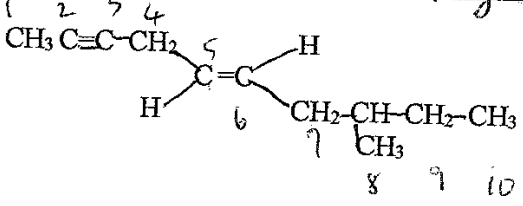
a. name 4 - ethylnonane



nonane

4 - ethyl

b. name E-8-methyl-dec-5-en-3-yne



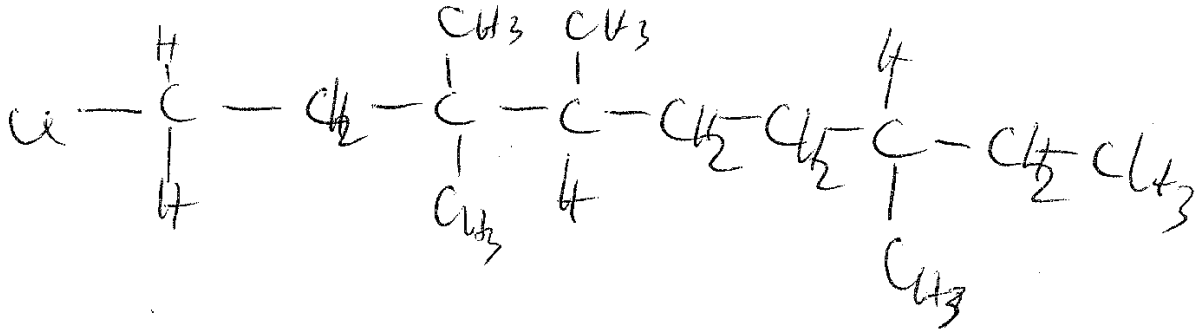
dec - 5 - en - yne
3

BA -1

-½ each wrong thing

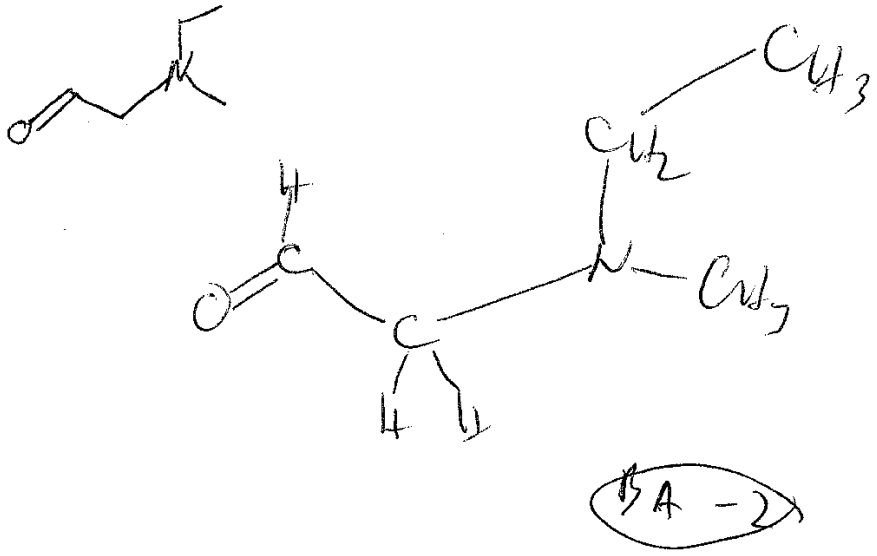
2. Given the following IUPAC name, draw a structural formula of the molecule (skeletal formula acceptable, condensed structure, Lewis Dot structure acceptable, molecular formula not acceptable - don't forget to show the hydrogens in your formula unless you are using the skeletal structure.)

1-chloro-3,3,4,7-tetramethyl nonane



B. Short Answer Part of Short Answer (30 pts)

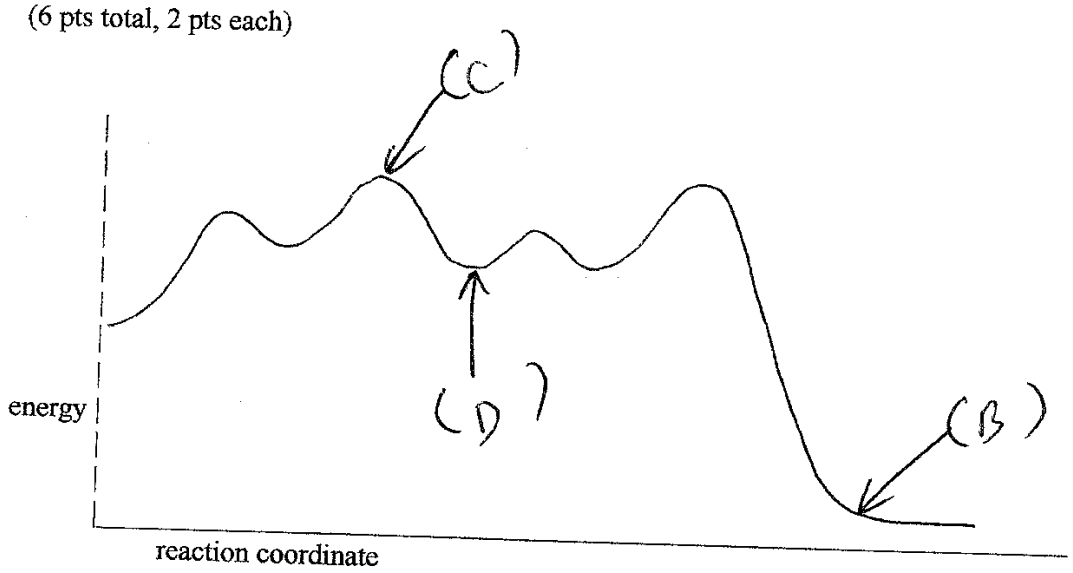
1. For the following **skeletal** molecular formula draw a Lewis Dot structure. (4 pts)



2 Given the following energy diagram, label by filling in all parenthesis with one and only one letter.

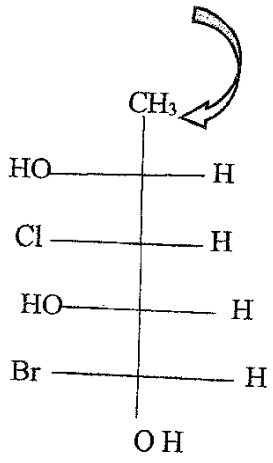
(A) reactant (B) product (C) label transition states with C (D) label intermediates as D

(6 pts total, 2 pts each)

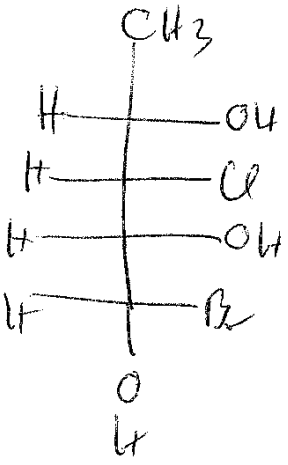


3 **Isomers** (8 pts total, 2 pts each)

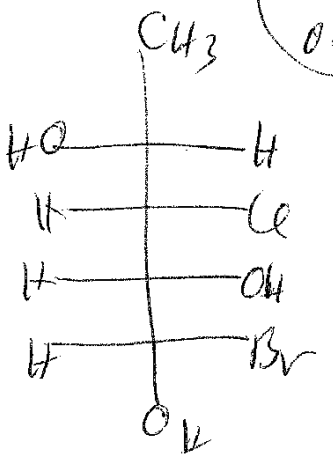
(1) Original molecule (a)



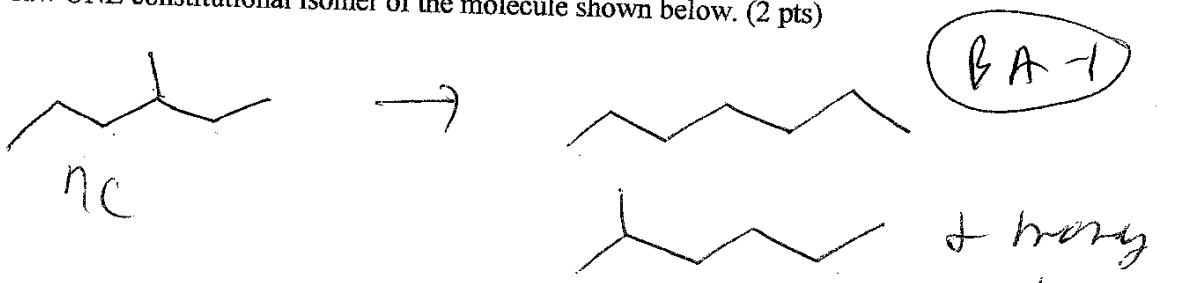
(b).Enantiomer of original (a) (2 pts)



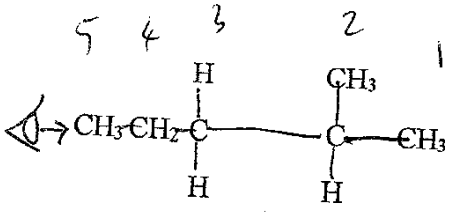
(c).diastereomer of the original (a) (2 pts)

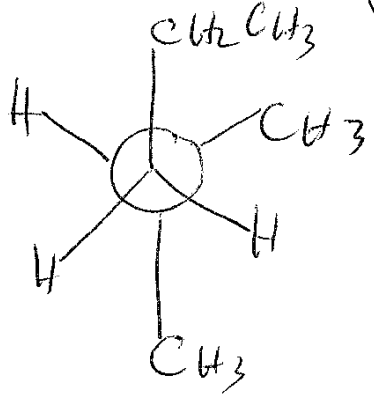


(2) Draw ONE constitutional isomer of the molecule shown below. (2 pts)



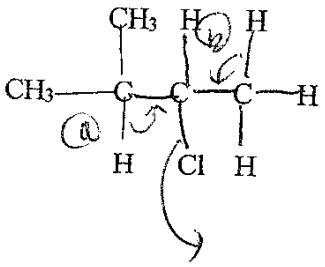
(3) Draw **the most stable Newman Projection** formula for the molecule shown below. Draw the Newman Projection formula between carbon 2 and carbon 3 with carbon 3 drawn in front. Please note the **eye** (shown in the normal organic chemist's notation). (2 pts)





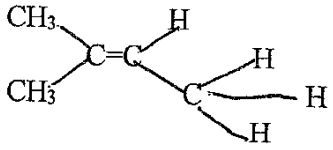
The most stable form Newman

4 (a) Given the following elimination reaction, **circle the letter** of the expected product. (6 pts total, 4 pts this letter)

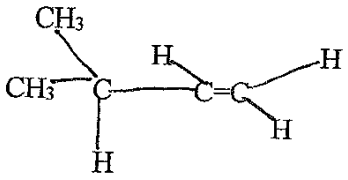


small base
normal conditions

(a)

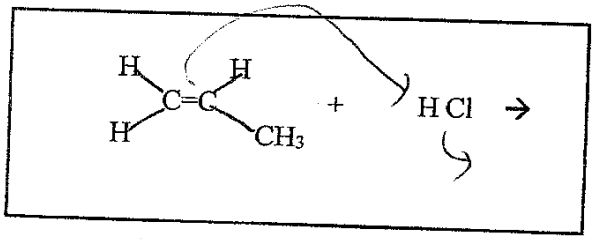


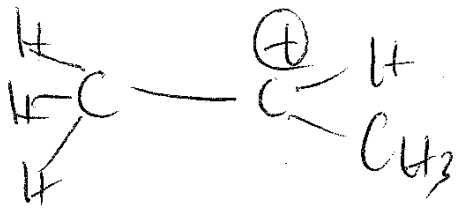
(b)



(b) What is the name of the product ? [(Zaitsev product) or (Hoffmann product)] (circle one) (2 pts)

5. The following shows a reaction for the addition of H Cl to an alkene, draw the Markovnikov's carbocation which leads to the product. (6 pts)

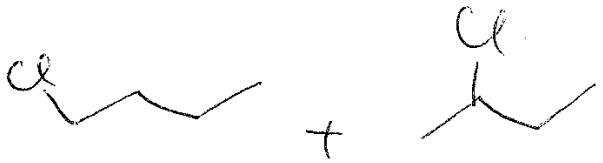


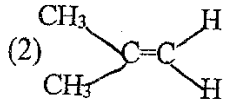


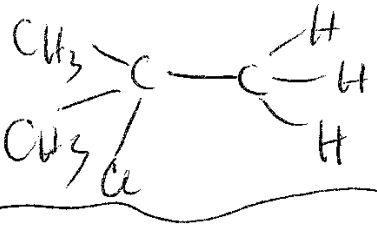
Markovnikov carbocation intermediate mechanism step

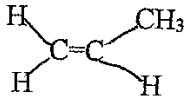
C. Reactions: **Circle 10 of the following reactions you want graded**. (2 pts each, 20 pts total) If you do not circle, I will just grade the first 10 reactions.

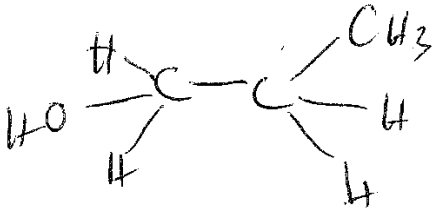
(1) $CH_3\text{-}CH_2\text{-}CH_2\text{-}CH_3 \xrightarrow[\text{(give all possible monohalogenation products)}]{h\nu} Cl_2$

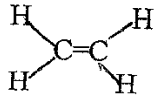


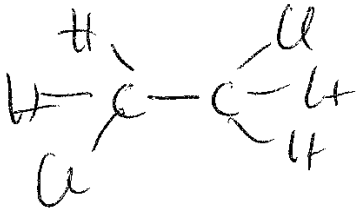
(2)  + HCl → mark



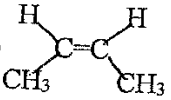
(3)  $\xrightarrow{BH_3\text{: THF},\ H_2O_2,\ OH^-}$ anti mark

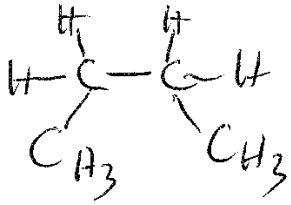


(4)  $\xrightarrow{Cl_2}$

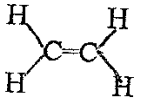


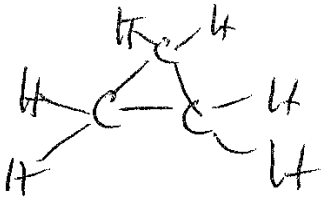
BA -1
regio
stereo $-\frac{1}{2}$
NFE

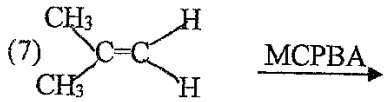
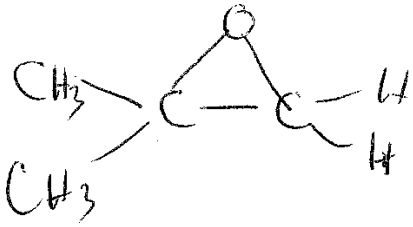
(5)  $\xrightarrow{H_2,\ Pt}$

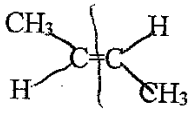
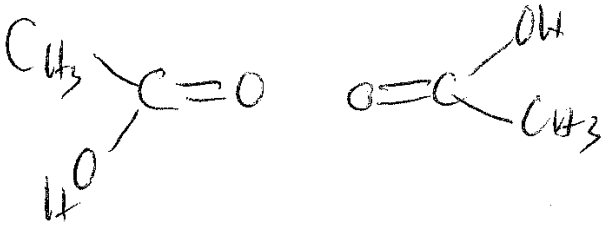


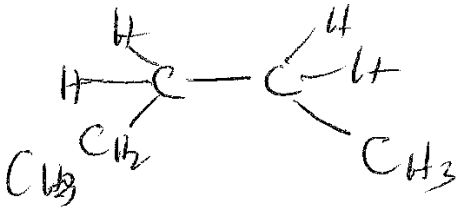
NFE = not oxidized, reduced far enough

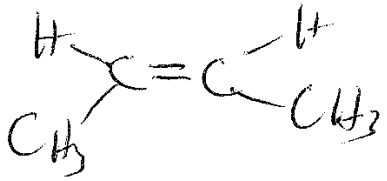
(6)  $\xrightarrow[Zn(Cu)]{CH_2I_2}$

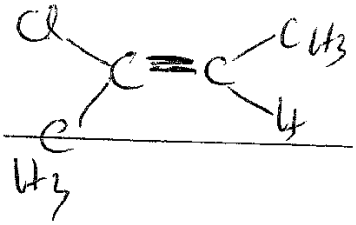
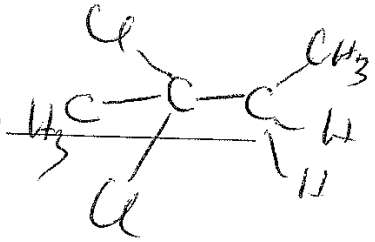


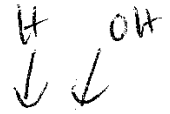
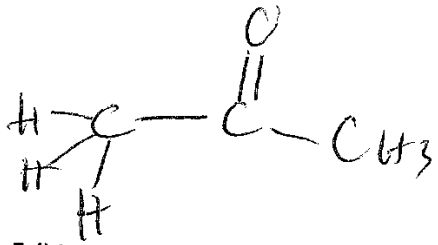
(7)  MCPBA 

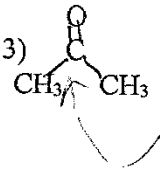
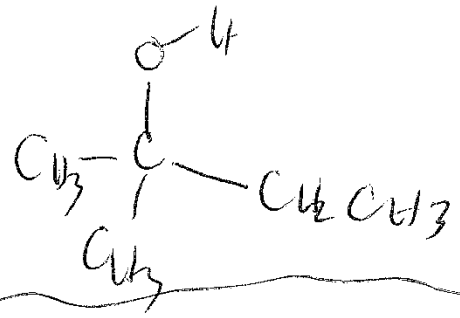
(8)  $KMnO_4$, hot (strong oxi) 

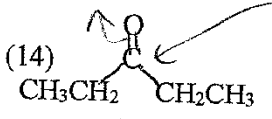
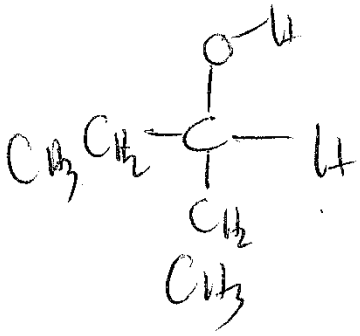
(9) $CH_3-CH_2-C\equiv C-CH_3$ H_2, Pd (Syn) 

(10) $CH_3-C\equiv C-CH_3$ Lindlar's catalyst (Syn) 

(11) $CH_3-C\equiv C-CH_3$ H Cl (1st mole)  H Cl (2nd mole) 

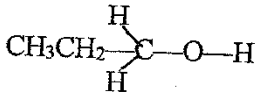
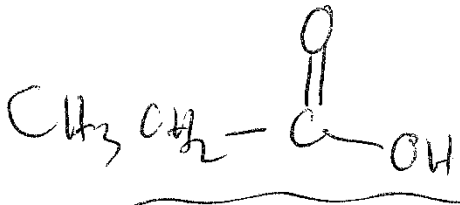
(12)  H_2O, $HgSO_4$, H_2SO_4 (Mark) 

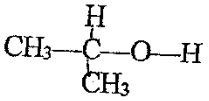
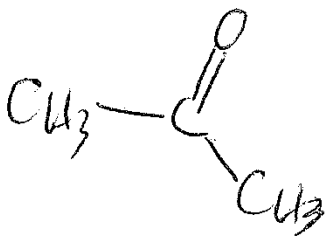
(13)  (a) CH_3CH_2MgBr, THF (b) H_3O^+ → 

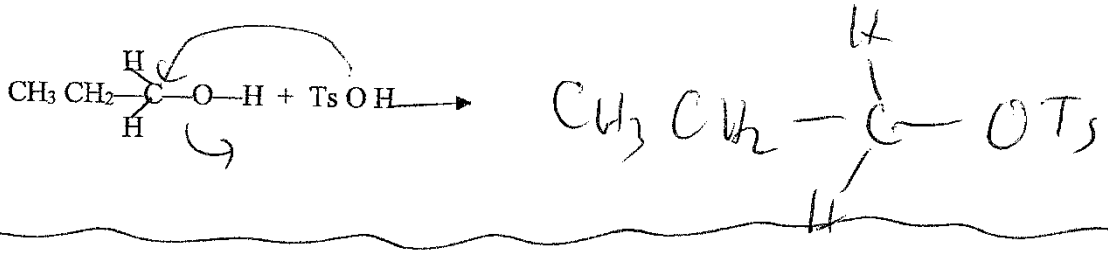
(14)  $NaBH_4$ → 

(15) $CH_3Cl + Mg^o \rightarrow$ CH_3MgCl

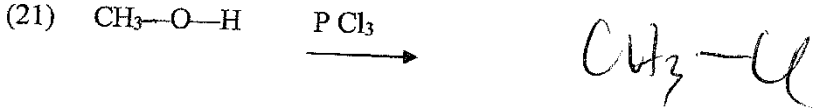
(16) $(CH_3)_2CuLi$ $CH_3CH_2CH_2Br$ → $CH_3-CH_2CH_2CH_3$

(17)  $\xrightarrow[H^+]{Na_2Cr_2O_7}$ (strong ox) 

(18)  PCC → 

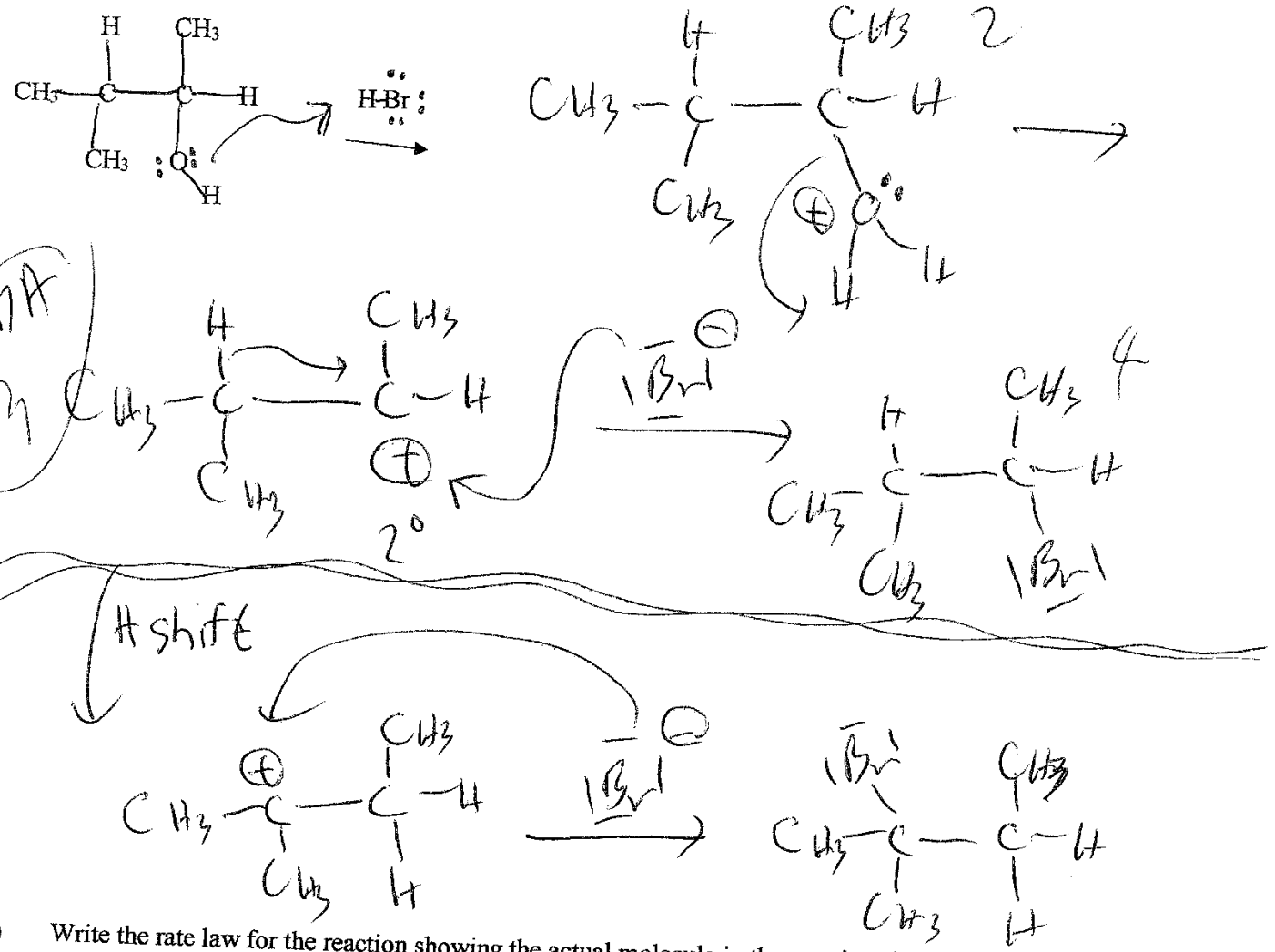
(19) 

(20) 

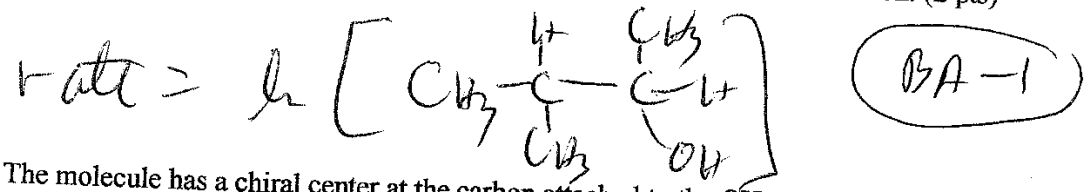
(21) 

Part III: Long Answers (20 pts)

1. (a) Give the reaction mechanism of the following reaction assuming **SN1 (substitution nucleophilic unimolecular)** mechanism. Must show all steps stepwise. Just showing the intermediate is NOT a MECHANISM. (10 pts total, 6 pts for (a))



(b) Write the rate law for the reaction showing the actual molecule in the reaction. (2 pts)



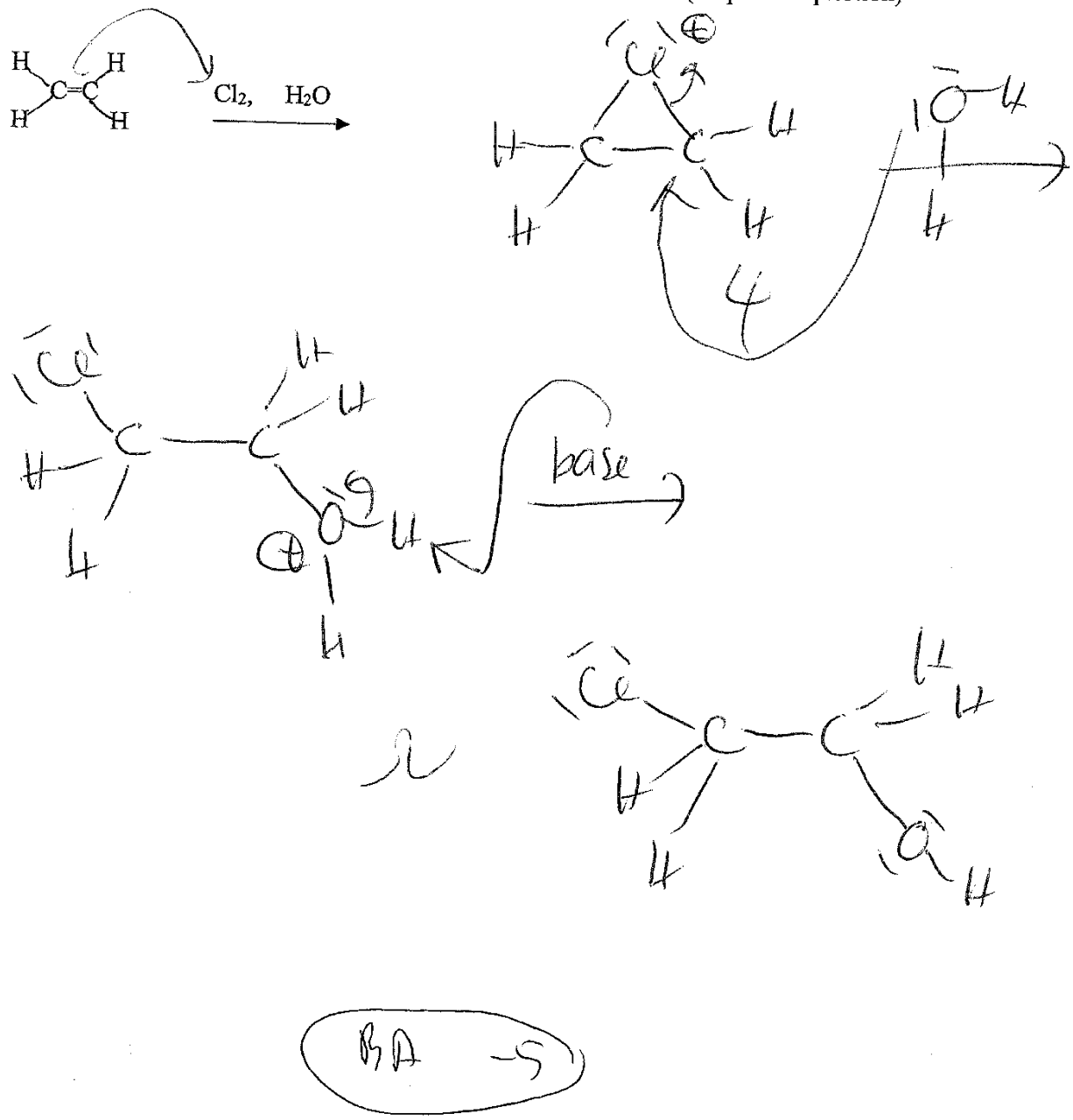
(c) The molecule has a chiral center at the carbon attached to the OH. If the starting molecule was R Cahn Ingold Prelog orientation, after the reaction what would be the Cahn Ingold Prelog orientation of the product ?

(if no rearrangement)

[(R) or (S) or (racemic)] (circle one) (2 pts)

if rearrangement no chiral Cntr

2. Given the following reactant give the reaction mechanism. (10 pts this question)



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