Organic Chemistry I Lecture Fall 2017 10/18/17 Wednesday Exam III 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, continue on the empty back pages but clearly label where the remaining answers can be found. (If I can't find your answer or cannot read it, I obviously cannot grade it.) Return the entire exam including the periodic table. (Please count your exam pages and make sure there are real pages and the periodic table.)

NA = Not attempt

It is your responsibility **to return the entire exam package** (with periodic table assembly inside the rest of the exam.) **directly into Dr. Hahn's hands.** If you do not and the exam disappears or sits around for days NOT in Dr. Hahn's possession, that exam will count as an UNEXCUSED missed exam.

BA = bad attempt

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

1) Which of the following statements is ***not*** true? 1) A

A) A half-headed curved arrow shows the movement of an electron pair. (→)
B) In polar reactions, a nucleophile reacts with an electrophile.
C) Carbanions are nucleophiles. (loves nuclei, is negative charged)
D) Carbocations are electrophiles. (loves electrons, is + charged)

2) Which of the following statements is true? 2) B

A) The size of the activation energy tells us about the reaction mechanism.
B) The size of the activation energy tells us about the reaction rate.
C) A slow reaction has low activation energy.
D) A fast reaction has high activation energy.

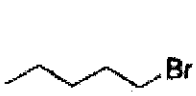
3) Which of the following is the definition for a pair of diastereomers? 3) B

A) A pair of stereoisomers that are not superimposable mirror images of each other.
B) A pair of stereoisomers that are not mirror images of each other.
C) A pair of stereoisomers with stereogenic centers but is not chiral.
D) A pair of stereoisomers that are superimposable mirror images of each other.

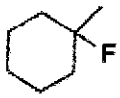
4) Which of the following reaction quantities will have an effect on reaction rate? 4) D

A) K_{eq} B) $\Delta G°$ C) $\Delta H°$ D) E_a

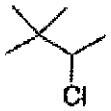
5) Which of the following alkyl halides is a primary alkyl halide? 5) A



I



II



III

IV

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

6) Which of the following alkyl halides would react the fastest with H_2O in S_N1 reaction? 6) B

$CH_3CH_2CH_2CH_2Br$, $(CH_3)_2CHCH_2Br$, $CH_3CH_2CH(CH_3)Br$, $(CH_3)_3CBr$

A) $CH_3CH_2CH_2CH_2Br$ (B) $(CH_3)_3CBr$
C) $CH_3CH_2CH(CH_3)Br$ D) $(CH_3)_2CHCH_2Br$

7) What is the percent *ee* of a mixture that has 70% of one enantiomer and 30% of the other? 7) C

A) 85 B) 70 (C) 40 D) 30 70 - 30 = 40

8) Which of the following statements about a catalyst is true? 8) B

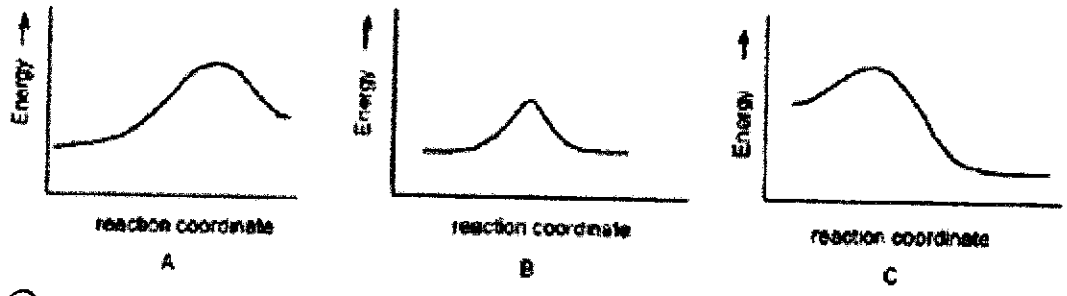
A) A catalyst accelerates a reaction by lowering the equilibrium constant.
(B) A catalyst accelerates a reaction by lowering the energy of activation.
C) A catalyst accelerates a reaction by raising the energy of activation.
D) A catalyst accelerates a reaction by changing the amount of reactant and product at equilibrium.

9) Which of the following solvents is ***not*** a polar protic solvent? 9) B

CH_3OH	CH_3CN	CH_3COOH	H_2O
I	II	III	IV

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

10) Which reaction is slowest? 10) A



(A) A B) B C) C

11) What kind of reaction does the conversion of A to B represent? 11) C

A) Elimination reaction.
(C) Substitution reaction.
B) Addition reaction.
D) Acid-base reaction.

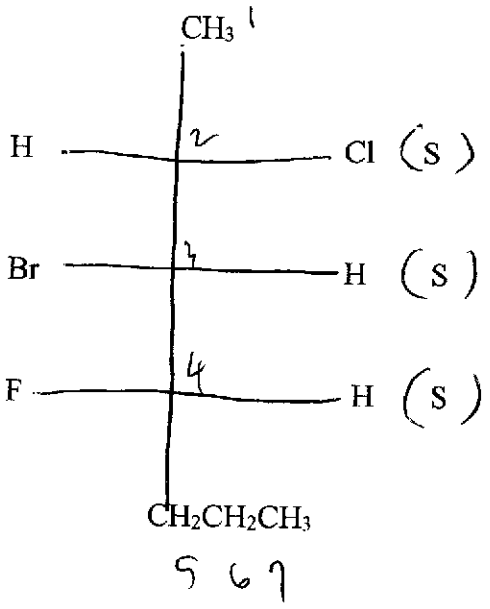
12) Which of the following statements about the S_N2 mechanism for nucleophilic substitution reactions is true? 12) C

A) Involves one step and occurs with retention of configuration.
B) Involves two steps and occurs with inversion of configuration.
(C) Involves one step and occurs with inversion of configuration.
D) Involves one step and occurs with racemization.

Part II: Short Answers (32 pts) Show work on all questions for partial and full credit even on questions which do not specify.

A. Nomenclature (4 pts total, 2 pts each)

1. Given the following structure, give the IUPAC name of the molecule. (don't forget the stereochemistry of the molecule in naming.) I have provided the R,S configuration at the chiral centers. (2 pts)



heptane

2-Chloro

3-bromo

4-fluoro

BA -1

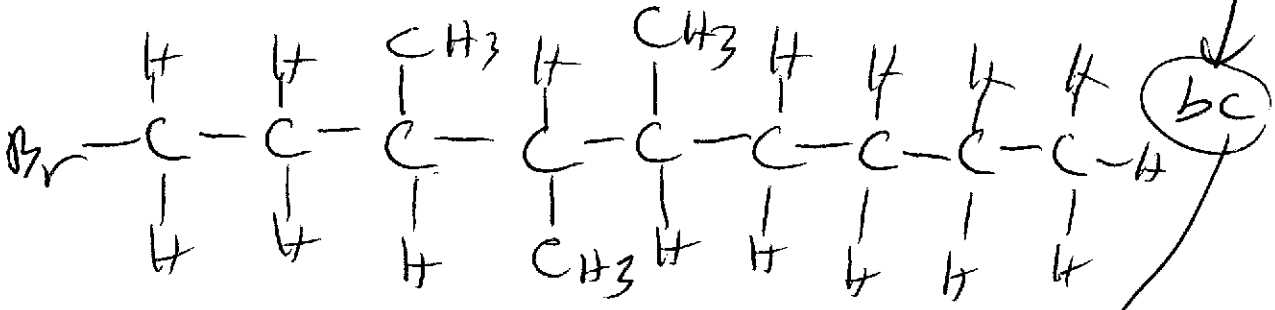
-1 each wrong up to BA

(2S, 3S, 4S)-3-bromo-2-Chloro-4fluoro-heptane

2. For the following name, give the structure of the molecule.

1-bromo-3,4,5-trimethylnonane

no stereo needed



bc

no stereo in name

B: Reactions: Complete the following organic reaction by giving the **organic product**. (4 pts, 2 pts each)

a. $CH_3Br + {}^{\ominus}O\text{-}CH_2CH_2CH_3 \rightarrow$ $CH_3-O-CH_2CH_2CH_3$

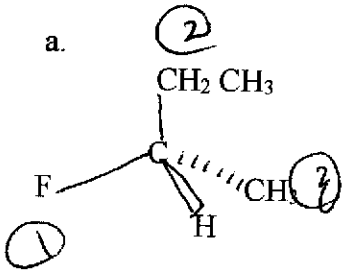
b. $CH_3CH_2Cl + {}^{\ominus}O-C(=O)-CH_3 \rightarrow$ $CH_3CH_2-O-C(=O)-CH_3$

Full Credit — Correct — or stereoisomer or intermediate — ½ Credit

C. Short Answer Part of the Short Answers: (24 pts)

1. Given the following structures, assign R,S: Show work by showing your assignment of priority and the R or S arrow and any thought process. If phantom atoms are necessary, please draw in any phantom atoms. (8 pts total, 4 pts each)

a.

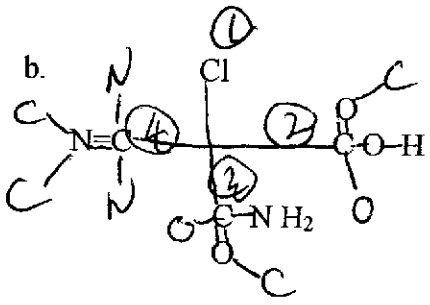


R but H comes out

so (S)

BA-2

b.

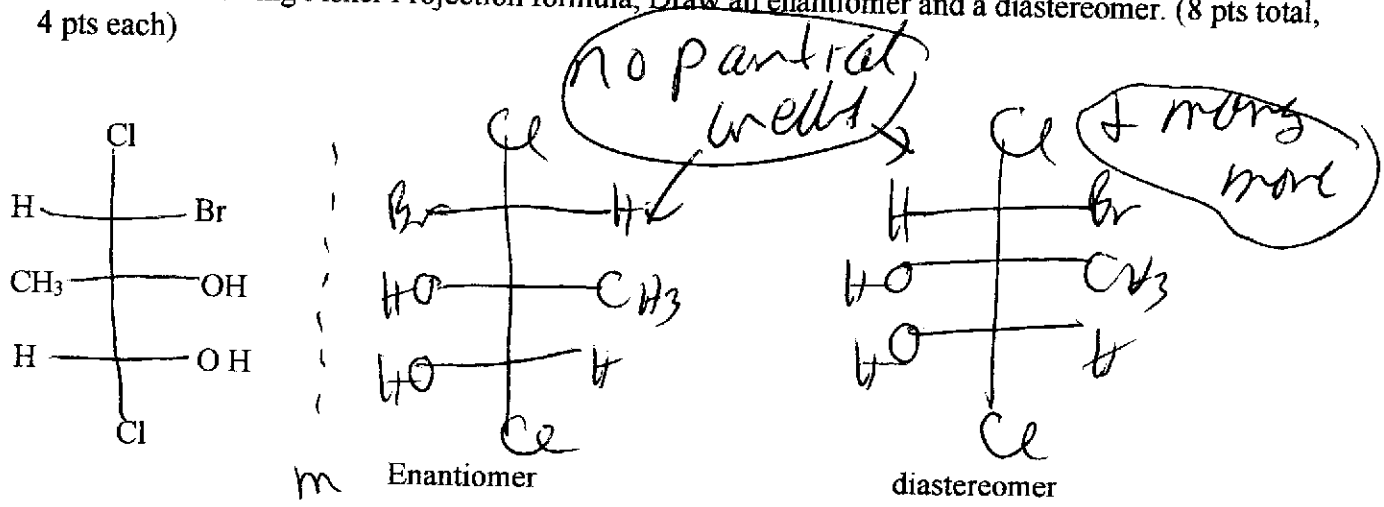


R but H comes out

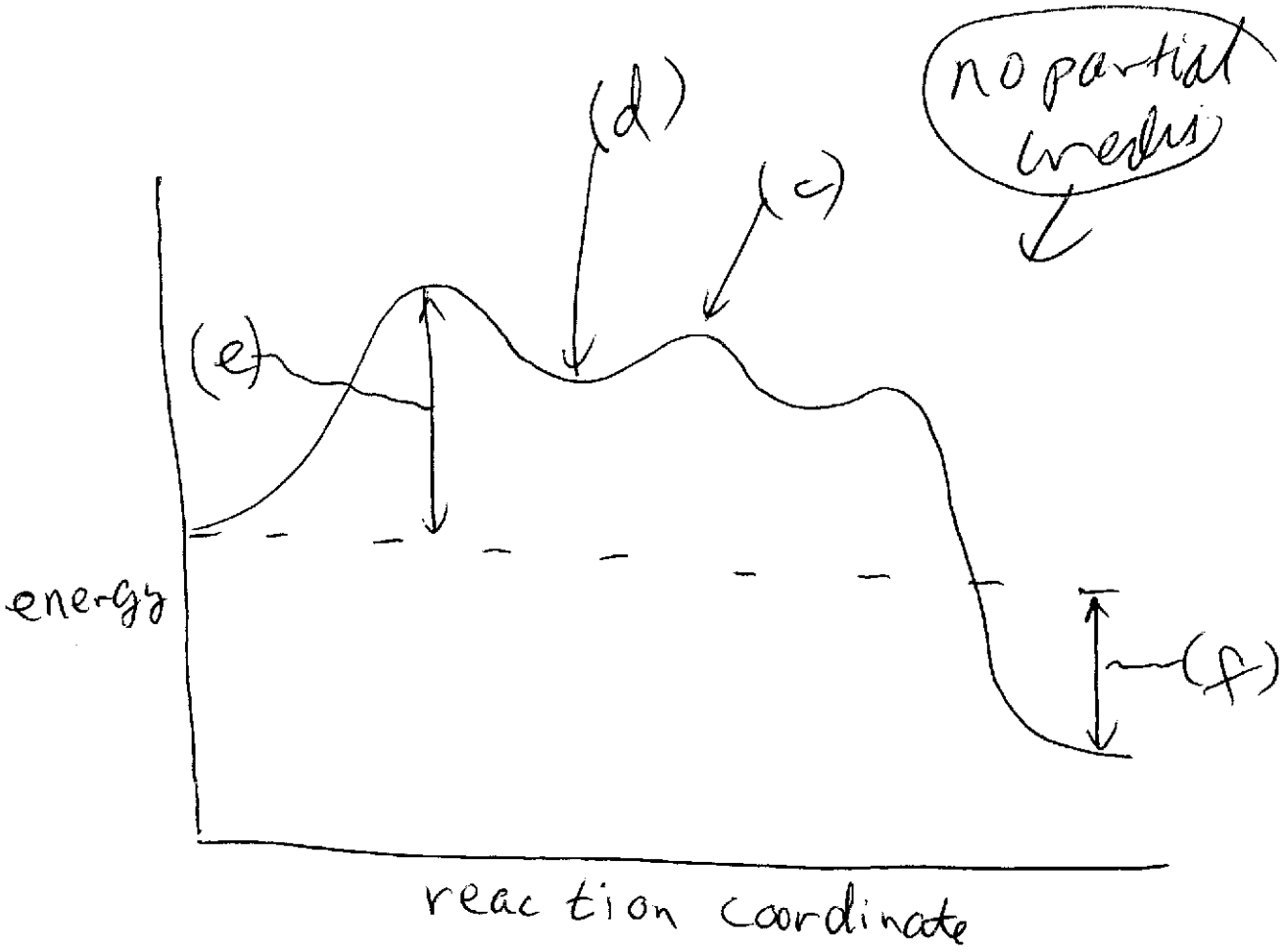
(S)

BA-2

2. Given the following Fisher Projection formula, Draw an enantiomer and a diastereomer. (8 pts total, 4 pts each)

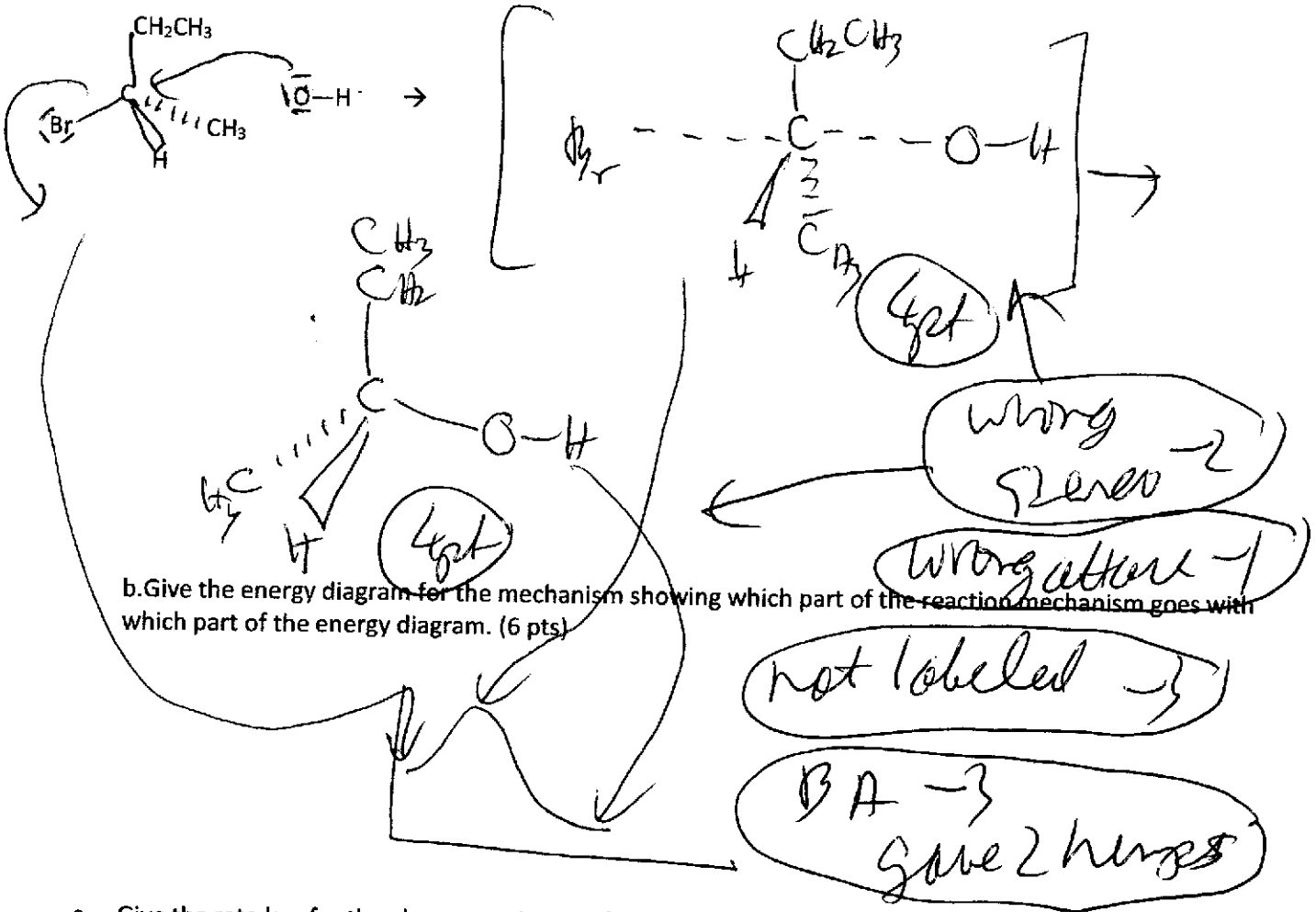


3. Given the following energy diagram, fill in the blank with the letters. Each letter may be used once, many times or not at all. (a) reactant (b) product (c) transition state (d) intermediate (e) activation energy Ea (f) Δ H (8 pts, 2 pts each)



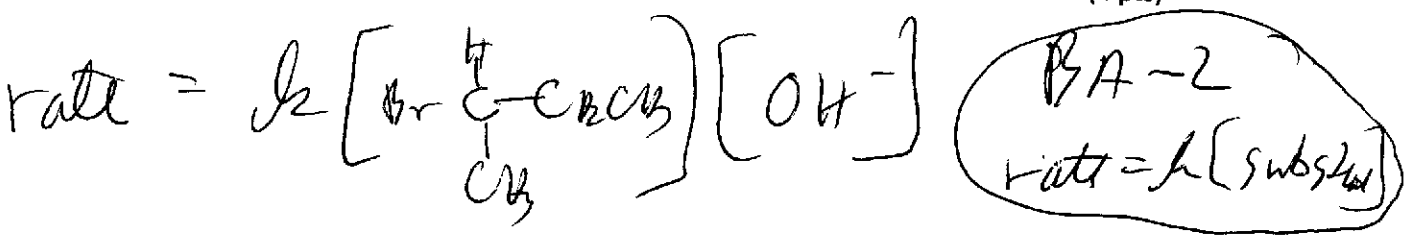
Part III: Long Answers (44 pts) Show work on all questions for partial and full credit even on questions which do not specify.

1. a. Assume that the following reaction goes by the S_N2 reaction mechanism for the following reactants. Show the reaction mechanism in 3D. (show the transition state) (22 pts total) (8 pts)



b. Give the energy diagram for the mechanism showing which part of the reaction mechanism goes with which part of the energy diagram. (6 pts)

c. Give the rate law for the above reaction mechanism with specific molecules in the rate law. (4 pts)

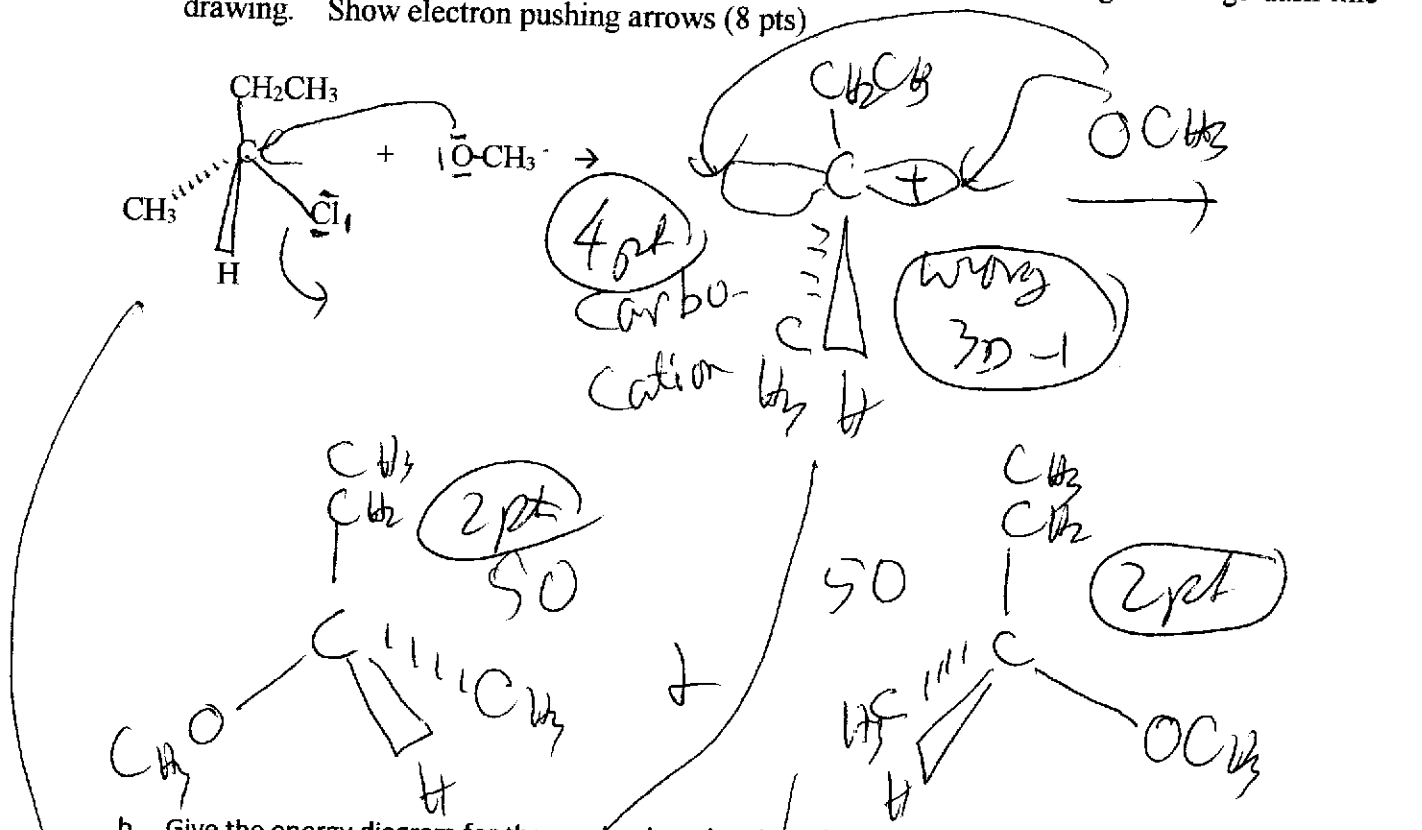


d. If you started the reaction with S reactant (as shown above), the product would be [(R) or (S) or (racemic)] (circle one) (4 pts)

no partial credit

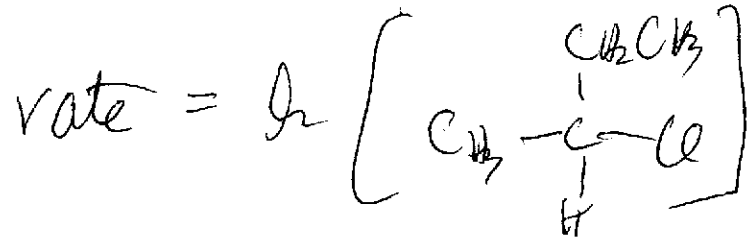
2. For the following reaction, assume the reaction goes by an S_N1 reaction mechanism. (22 pts total)

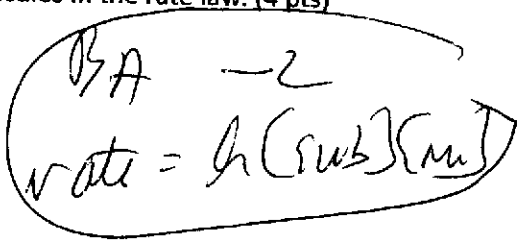
a. Give the SN1 reaction mechanism for the following reactant in 3D using the wedge-dash-line drawing. Show electron pushing arrows (8 pts)



b. Give the energy diagram for the mechanism showing which part of the reaction mechanism goes with which part of the energy diagram. (6 pts)

c. Give the rate law for the above reaction mechanism with specific molecules in the rate law. (4 pts)





d. If you started ~~the reaction~~ with R reactant (as shown above), the ~~product would be~~ [(R) or (S) or (racemic)] (circle one) (4 pts)