CHEM 3A_MIDTERM 2_SPRING 2001_FRECHET

Chemistry 3A - Spring 2001
Midterm 2

Professor Jean Fréchet

March 19, 2001

Please check the section number and

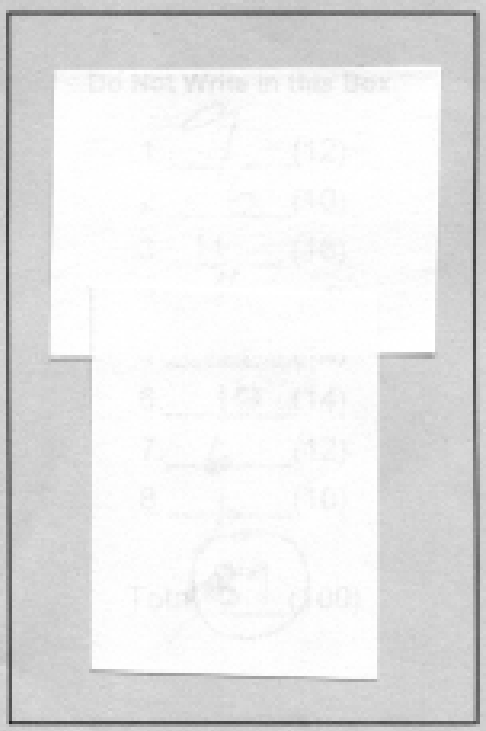
___161 Padilla-De Jesus,Omayra
___171 Fox,Daniel
___181 Furuta,Paul
___191 Ling,Frank
___111 Cordaro,Joseph
___121 Le,Scheherazade
___131 Thalji,Reema
___141 Catherine Seeley
___261 Peterka,Darcy
___271 Miljanic,Ognjen
___211 Dertz,Emily
___221 Simon,Matthew
___361 Barry,David
___371 Miljanic,Ognjen
___311 Sivamani,Raja
___321 Li, Ben
___461 Huang,Alan
___471 Liang,Catherine
___411 Phillips,Scott
___421 Saxon,Eliana
___431 Osterhout,Robin
___561 Merolle,Mauro
___511 Klopp,John
___521 Wu,Sarah
___531 Rao,Vikas

If you are making up an I-grade, indicate the semester you took 3A_____ and the Professor_____.

This exam has **10** pages; **make sure that you have them all.**

We will only grade answers that are in the designated spaces. Please do your scratch work on the backs of the exam pages. Write only **one** answer to each problem; multiple answers will receive **no** credit, even if one of them is correct.

Note: This examination runs for a total of 90 minutes. No questions will be answered by proctors after the exam begins. Please write legibly; ambiguous or messy answers will receive **no credit**.



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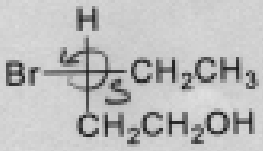
1. (12 points)

Name or draw, as appropriate, the following molecules. Do not forget **stereochemistry** where appropriate.

(a)

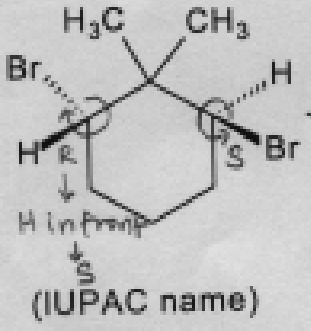


(IUPAC name)

(b) (2R,3S)-2-bromo-3-chlorobutane

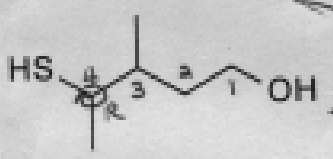
(Fischer Projection)

(c)



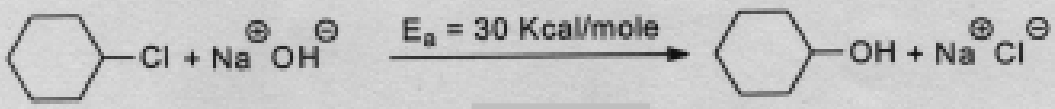
(IUPAC name)

(d)



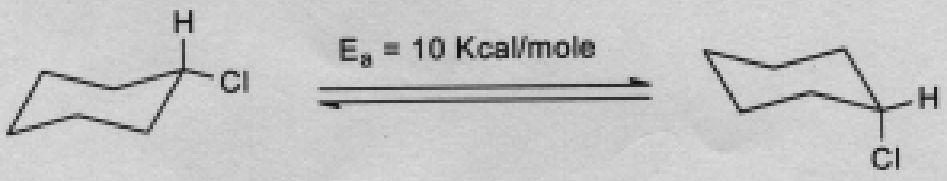
(6)

2. (10 Points). Consider the reaction of chlorocyclohexane with sodium hydroxide leading to cyclohexanol and sodium chloride as shown below.



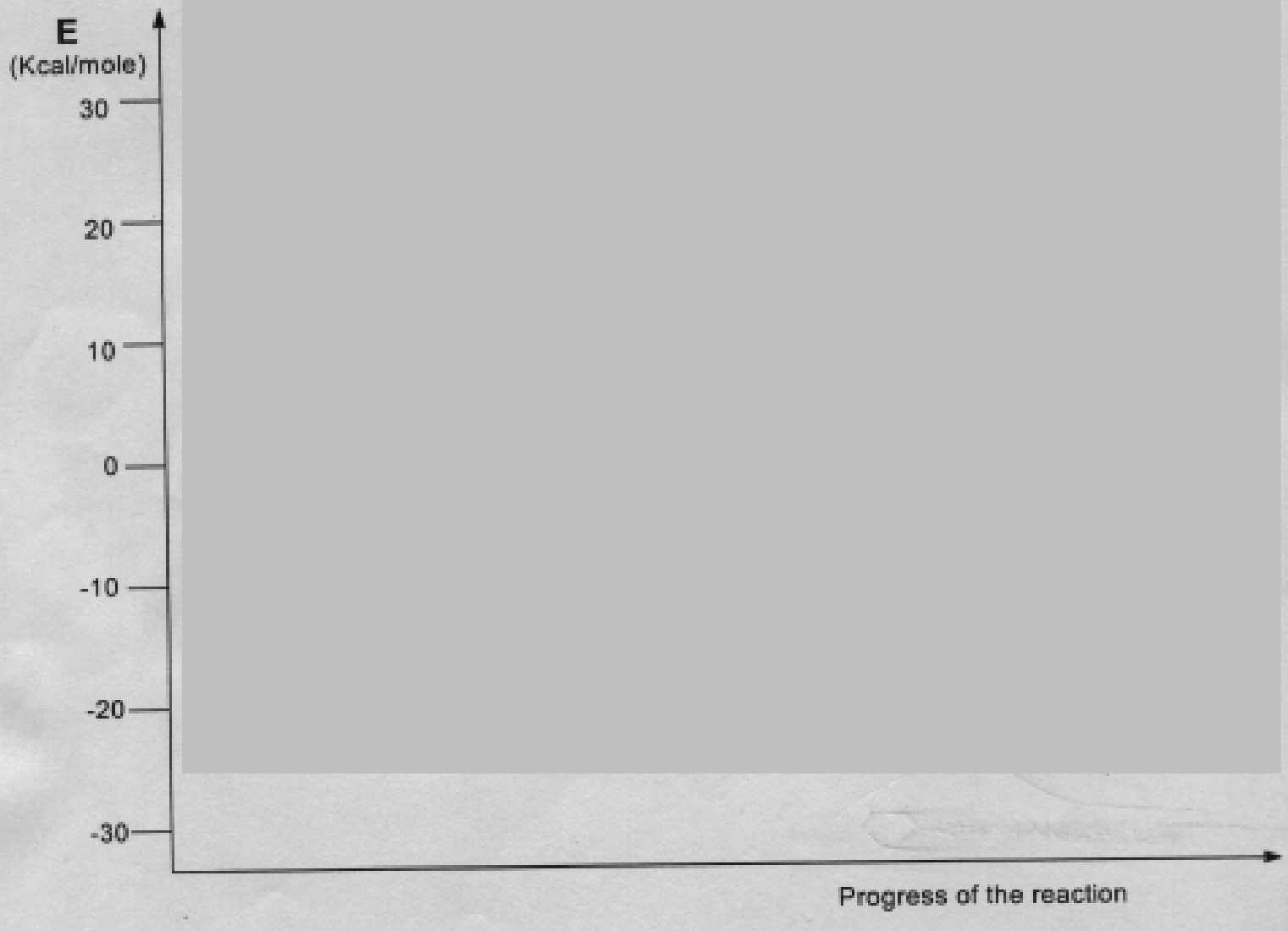
ΔG° = -20 kcal/mole

For the purpose of this exam, let us assume that the reaction not only follows second order kinetics but also that it proceeds through the axial form of chlorocyclohexane. Therefore, the equilibrium below precedes the attack by the hydroxide anion above.

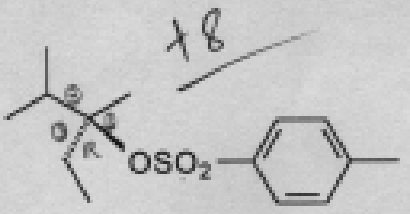


ΔG° = +0.5 kcal/mole

Using the thermodynamic data provided, draw a scaled and **fully labeled** potential energy diagram for the overall process, starting from equatorial chlorocyclohexane arbitrarily assigned the relative energy = 0 and ending with cyclohexanol. **Circle** the rate-determining **transition state**.

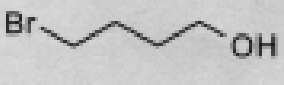


3. (16 Points) (a) Show the **major** product (or major products) obtained in the reactions below.



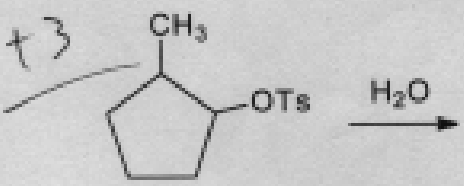
CH_3OH →

NaOH →



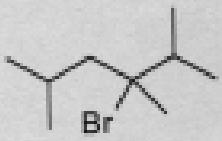
$CH_3S^{\ominus}\ Na^{\oplus}$ →

(b) Write clear structures for all of the plausible products of the reaction below and **circle** the major product. Do not write extra structures or mechanisms.

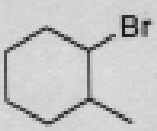


H_2O →

4. (14 points). (a) Complete the following reactions showing the structure of the **MAJOR** product. Show clear **stereochemistry** where appropriate. Write **NR** if there is no reaction.



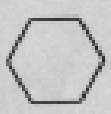
$EtO^{\ominus}$ $Na^{\oplus}$ in EtOH

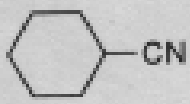


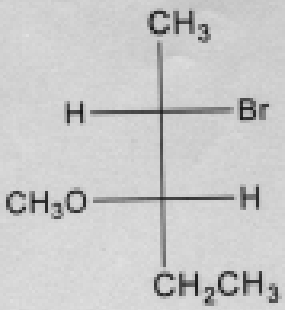
$K^{\oplus}$ $t\text{-BuO}^{\ominus}$ in t-BuOH

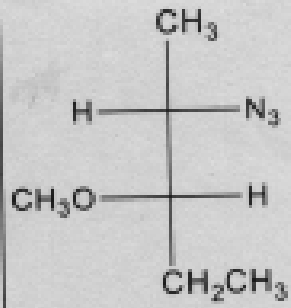
$(CH_3)_2CHOSO_2CH_3$ + $HOCH(CH_3)_2$ →

(b) Complete the following reactions showing **all the reagents** and special conditions needed to obtain the product. If more than one step is required label the steps 1) then 2), etc.

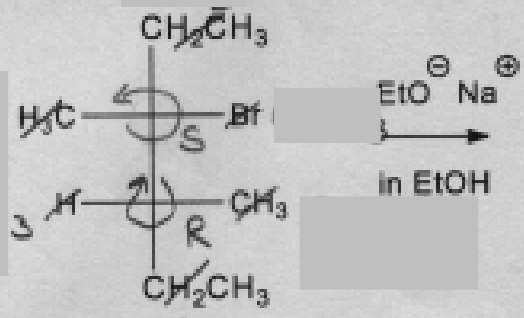








5. (12Points) (a) Show a clear **stereochemical** structure for the major alkene product obtained in the reaction below. Also show both sawhorse and Newman projections of **the reactive conformation** involved in this elimination reaction.



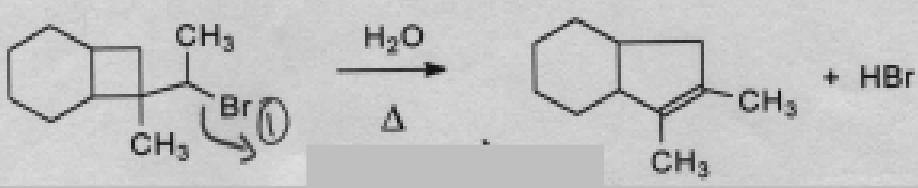
Product

sawhorse

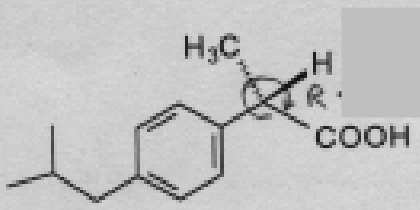
Newman

(b) Show how you would make diethyl ether $CH_3CH_2OCH_2CH_3$ from bromoethane. You may use any other reagent you need **but all the C atoms of the product must originate from bromoethane.** Be sure to show all steps, reagents and reaction conditions. No mechanisms needed.

6. (14 points). (a) Write a step-by step mechanism (include arrows) accounting for the formation of **both** products in the reaction below:



(b) A commercial synthesis of **Ibuprofen** gives the enantiomer shown in 97% enantiomeric excess. Is this isomer R or S? (*Note: do not guess!! wrong answers will incur a point deduction*)



Answer:

What is the percentage of the major isomer in the mixture above? Show the **details** of your work.

Answer: %

$CH_3CH_2CH_3$ CH_3

7. (12 points). (a) Using only propane and methane as the **sole source** of carbon atoms, propose a synthesis of the compound below. You may use any other reagent you require. Show **all the steps** of the synthesis and **all the reagents** or special conditions used. No mechanisms are required.

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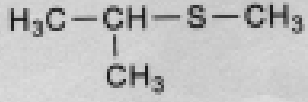

(b) The optical rotation of a solution of 0.4g of a steroid dissolved in 10.0mL of alcohol measured in a tube 5.0 cm in length at 25°C using the D line of a sodium lamp is +2.18°. Calculate the specific rotation of the steroid. Show the **formula** you use and the **details** of your calculations .

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Answer:

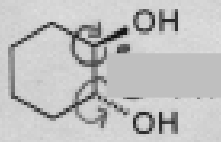
8. (10 Points) **For all multiple choice questions circle the number of the correct answer (one only)**

(a) CH_3Cl is: (1) a liquid at 0°C (2) a good haloalkane for E2 eliminations

(3) a chemical found in Kelp (4) a good nucleophile for SN2 reactions

(5) A haloalkane that reacts rapidly with hot water to form methanol CH_3OH

(b) What is the most appropriate name for the molecule shown below



(1) meso-1,2-cyclohexanediol

(2) (1R,2R)-1,2-cyclohexanediol

(3) (1S,2S)-1,2-cyclohexanediol

(4) (1R,2S)-1,2-cyclohexanediol

(5) (1S,2R)-1,2-cyclohexanediol

(c) Doubling the concentration of KOH in the reaction

(1) Changes the mechanism to elimination (2) Has no effect on reaction rate

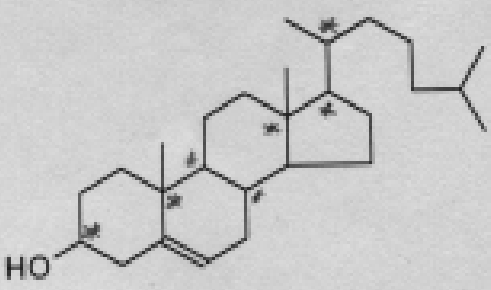
(3) Halves the rate of reaction (4) Doubles the rate of reaction

(5) Changes the order of the reaction (6) Changes the regiochemistry

(d) The discovery of the interaction of optically active substances with plane polarized light is credited to:

(1) Biot (2) Pauling (3) Saytzev (4) Pasteur (5) Kekule

(e) How many stereocenters are present in the molecule of cholesterol ? **(circle one number)**



1 2 3 4

5 6 7 8

9 10 11 12

Note: **There are no questions to be answered on this page,** it only contains data that may be of use in solving the questions contained in this exam. Not all of the data given is needed.

Value of gas constant: R = 2.0 cal deg^{-1} mol^{-1}

Value of e (base for natural logarithms) e = 2.718

Value of absolute zero (kelvin) = -273°C

Partial periodic table of the elements

GROUP	I A	II A	III B	IV B	V B	VI B	VII B	0
VALENCES	+1	+2	+3	−4 +4	−3 +5	−2 +6	−1 +7	0
PERIOD 1	1 H 1.008							2 He 4.003
2	3 Li 6.941	4 Be 9.012	5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
3	11 Na 22.99	12 Mg 24.31	13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95
4	19 K 39.10	20 Ca 40.08	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
5	37 Rb 85.47	38 Sr 87.62	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3