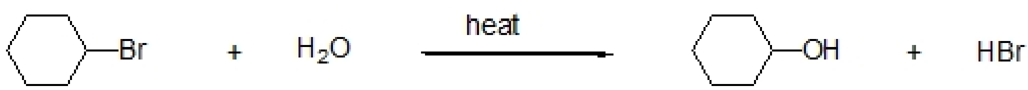
I. Theory

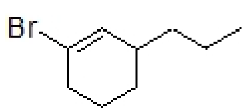
1. Provide an equation that shows the relationship between Gibb's free energy (ΔG°), enthalpy (ΔH°), and entropy (ΔS°). (3 points)

2. Use the bond dissociation energy table on the last page to calculate the enthalpy of the reaction below in Kcal/mol. State whether the reaction is endothermic or exothermic. (4 points)

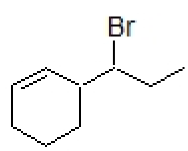


3. Provide a rate equation for the reaction above. (3 points)

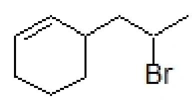
4. Which sequence ranks the following substrates in order of increasing reactivity in an S_N2 reaction? (3 points)



1



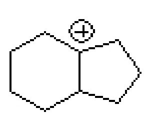
2



3

a) 1<2<3 b) 2<3<1 c) 3<1<2 d) 3<2<1 e) 2<1<3 f) 1<3<2

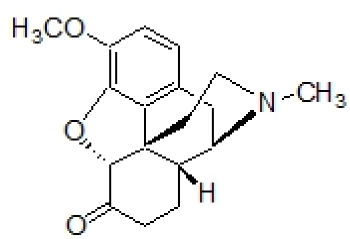
5. Provide the structure of 4 constitutional isomers ($C_9H_{15}Br$) that undergo a structural rearrangement to produce the following carbocation. (8 points)



6. The benzylic carbon-hydrogen bond of toluene, shown below, has a low bond dissociation energy (85 kcal /mol) due to the stability of the intermediate resulting from homolytic bond dissociation. Draw a structure for this intermediate and all contributing resonance structures. (5 points)

II. Stereochemistry

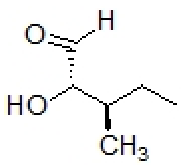
1. Hydrocodone is a powerful pain reliever and when combined with the acetaminophen make up the #1 best selling prescription medication in the U.S.. Assign each chiral center as having R or S configuration. (8 points)



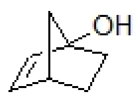
2. How does relative stereochemistry differ from absolute stereochemistry? (2 points)

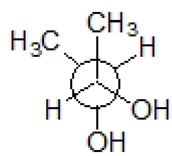
3. Compounds that rotate plane polarized light are said to be ___________________ active. (2 points)

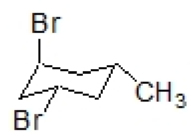
4. Translate the following structure to a Fischer projection **and** then draw its enantiomer in its most stable Newman projection siting down the C2-C3 bond. (10 points)



5. Circle all chiral structures below. Indicate any meso structures. (6 points)





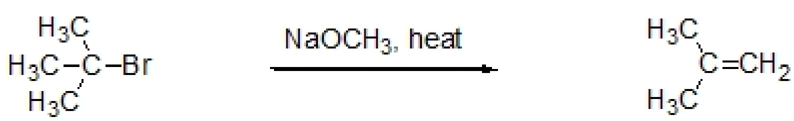


6. A reaction produced a nonracemic mixture of two enantiomeric compounds, A and A'. The chiral mixture had a specific rotation of +25º. It was found that pure enantiomer A, had an specific rotation of -65º. Calculate the optical purity of this mixture and then state the percent abundance of each enantiomer in the reaction mixture. Show all of your work for full credit. (4 points)

III. Mechanisms

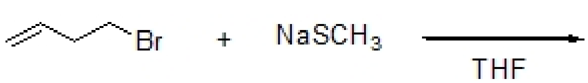
1. Provide an arrow pushing mechanism that accounts for the two products. Include all intermediates and formal charges. (10 points)

2. Provide a structure for the transition state of the following reaction. (4 points)

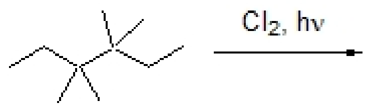


IV. Reactions

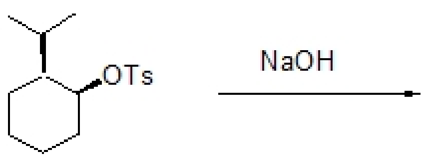
1. Predict the product of the following reaction. (3 points)



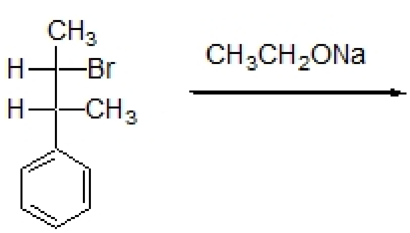
2. Draw the monochlorination products resulting from the following reaction. Use the relative reactivity of each type of hydrogen to determine the percent abundance of each product. (8 points)



3. Provide the major elimination product of the following reaction. Include all relevant stereochemistry. (3 points)



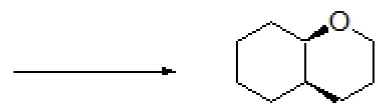
4. Provide a Fischer projection for the major substitution product and draw the major elimination product in a line-angle structure. (6 points)



5. Provide the starting materials for two possible intramolecular S_N2 reactions that produce the following product. Circle the better of the two routes. (8 points)

Route 1

Route 2



V. **Extra Credit** (5 points)

1. Using the reaction below, show how a polar protic solvent is able to stabilize the transition state of this reaction.

$$CH_3CH_2Br \xrightarrow{CH_3OH} CH_3CH_2OCH_3$$

You received __________ points out of 100 points possible. To check your overall performance in lecture see http://vista.weber.edu/.

Bond	Bond-Dissociation Energy kcal/mol	kJ/mol	Bond	Bond-Dissociation Energy kcal/mol	kJ/mol
H—X bonds and bonds			Bonds to secondary carbons		
H—H	104	435	$(CH_3)_2CH$ H	95	397
D—D	106	444	$(CH_3)_2CH$—F	106	444
F F	38	159	$(CH_3)_2CH$—Cl	80	335
Cl—Cl	58	242	$(CH_3)_2CH$—Br	68	285
Br—Br	46	192	$(CH_3)_2CH$—I	53	222
I—I	36	151	$(CH_3)_2CH$—OH	91	381
H F	136	569	Bonds to tertiary carbons		
H—Cl	103	431	$(CH_3)_3C$—H	91	381
H—Br	88	368	$(CH_3)_3C$—F	106	444
H I	71	297	$(CH_3)_3C$ Cl	79	331
HO—H	119	498	$(CH_3)_3C$—Br	65	272
HO—OH	51	213	$(CH_3)_3C$—I	50	209
Methyl bonds			$(CH_3)_3C$ OH	91	381
CH_3 H	104	435	Other C—H bonds		
CH_3—F	109	456	$PhCH_2$—H (benzylic)	85	356
CH_3—Cl	84	351	CH_2=$CHCH_2$ H (allylic)	87	364
CH_3—Br	70	293	CH_2=CH—H (vinyl)	108	452
CH_3—I	56	234	Ph—H (aromatic)	110	460
CH_3—OH	91	381	C—C bonds		

IIIA	IVA	VA	VIA	VIIA	He 4.003
5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
49 In 114.82	50 Sn 118.71	51 Sb 121.75	52 Te 127.60	53 I 126.90	54 Xe 131.29
81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po (209)	85 At (210)	86 Rn (222)
	114 - (289)		116 - (289)		118 - (293)