CHM 2120A
Midterm #1
October 7, 2015

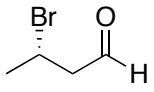
First Name: _____ Last Name: _____

Student Number: _____ Seat number: _____

Approximate total number of marks: 71
The marks are given as a guide and are subject to change.
You can write in pen or in pencil.
The use of molecular models is permitted but they cannot be shared.
The use of calculators or other electronic devices is not permitted.
There is a pK_a table on the last page.

1a	2a	3b	4b	5b	6b	7b	8		1b	2b	3a	4a	5a	6a	7a	0
1 H																2 He
3 Li	4 Be										5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg										13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	89 Ac	104 Rf	105 Ha	106 106												

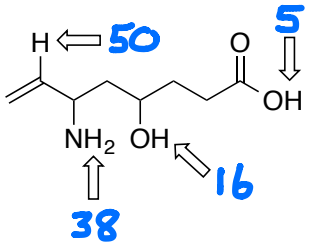
1. Name the following molecule. **(3 points)**



(s)-3-bromobutanal

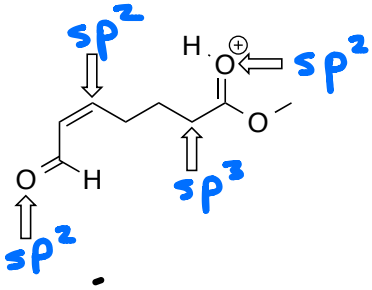
(1) (1) (1)

2. Estimate the pK_a value of each of the indicated protons. (**4** points)



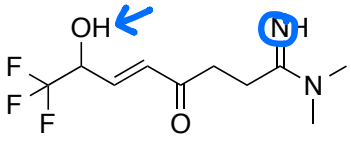
1 pt each

3. What is the hybridization of each of the indicated atoms? **(4 points)**



1 pt each

4. Point to the most acidic proton (→) and circle the most basic atom. **(2 points)**



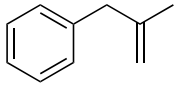
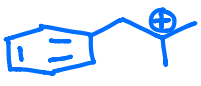
1 pt each

5. Protonate each of the molecules below. **(2 points)**

2/3

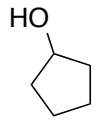
a) $\ominus NH_2$ NH_3 (1)

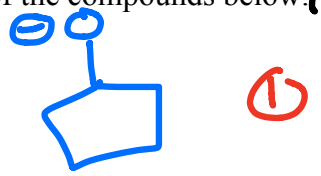
1 pt each

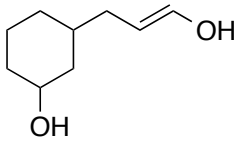
b)   1/2

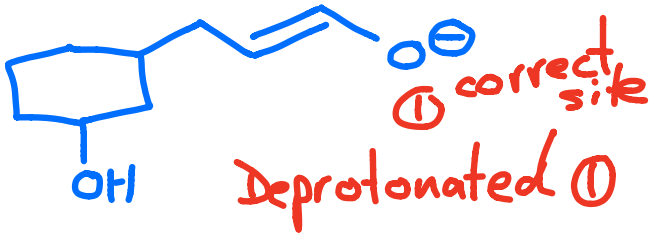
 1/2

6. Deprotonate each of the compounds below. **(3 points)**

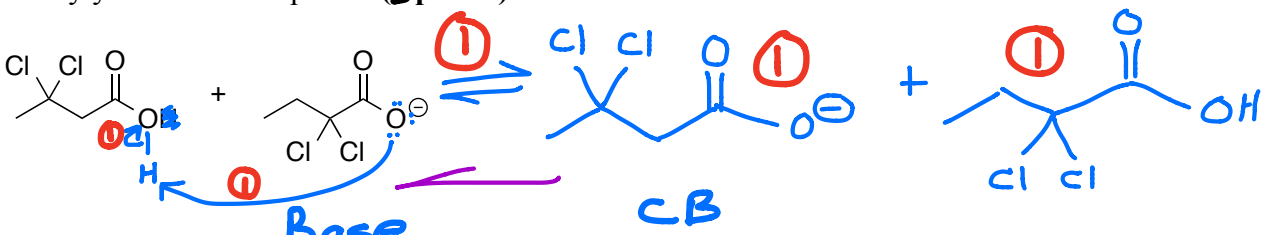
a) 



b) 

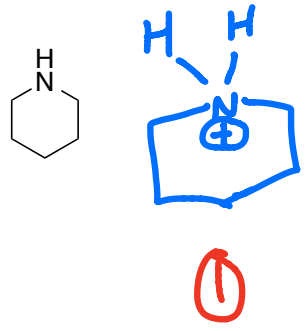


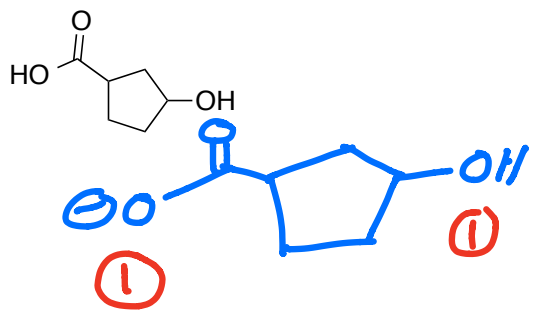
7. For the following reaction:
   a. Draw the mechanism and products. **(5 points)**
   b. Determine the direction of the equilibrium. **(1 point)**
   c. Justify your answer in part b. **(3 points)**



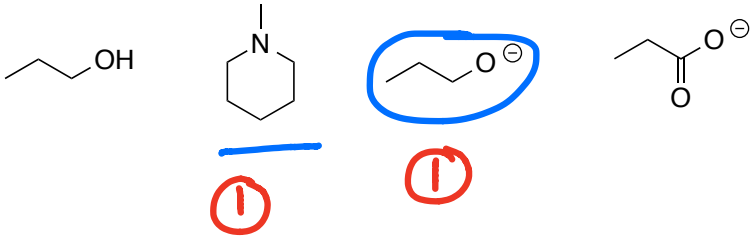
Base is better stabilized by the inductive effect than the CB (electronegative Cl's are closer in the base than the CB)

8. Draw the predominant form of each of the following compounds at pH 7. **(3 points)**

a) 

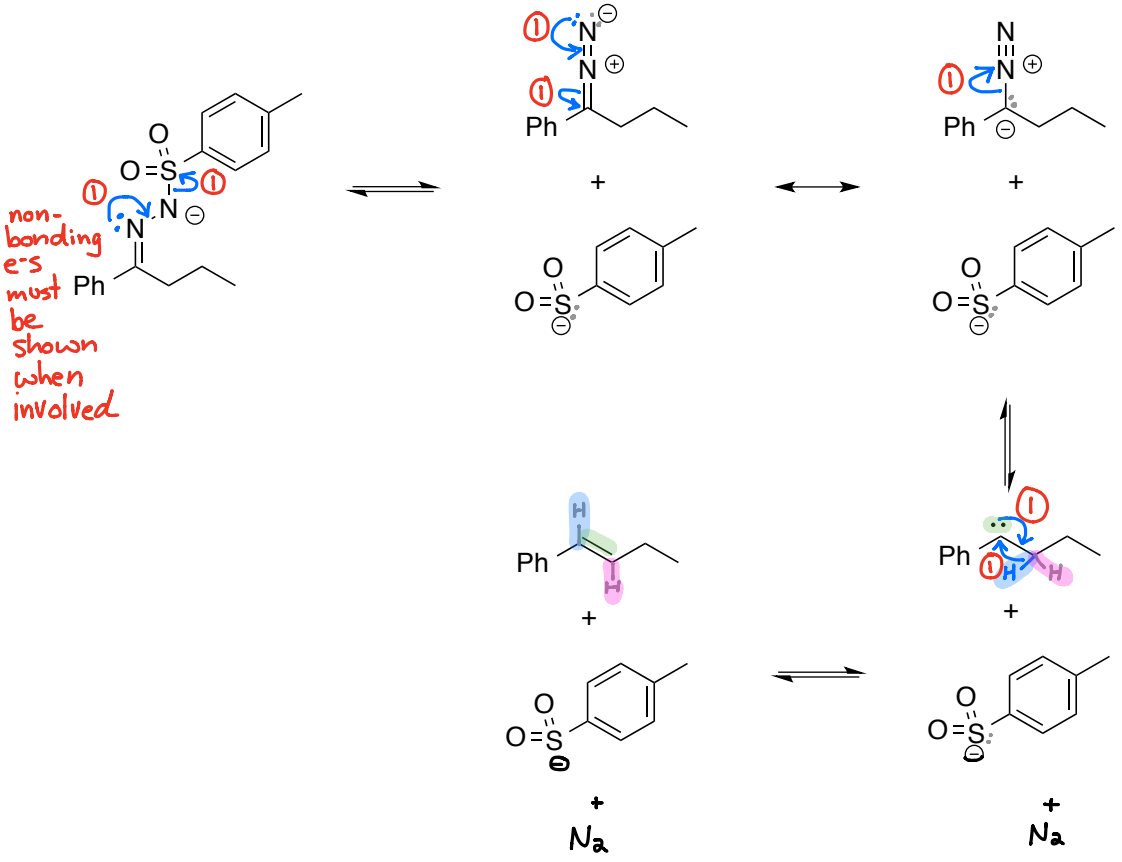
b) 

9. For the following compounds:
   a. Circle the strongest base for an E2 reaction. **(1 point)**
   b. Underline the bulkiest base for an E2 reaction. **(1 point)**

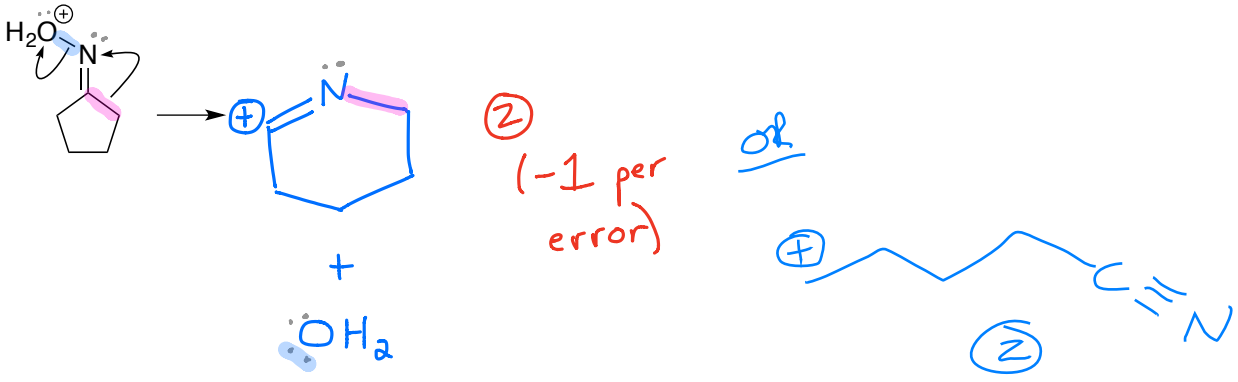


10. Add curved arrows to describe the mechanism for the following reaction (expand the structures as necessary). All reagents and intermediates have already been shown. **(7 points)**

blue: required components
grey: optional "

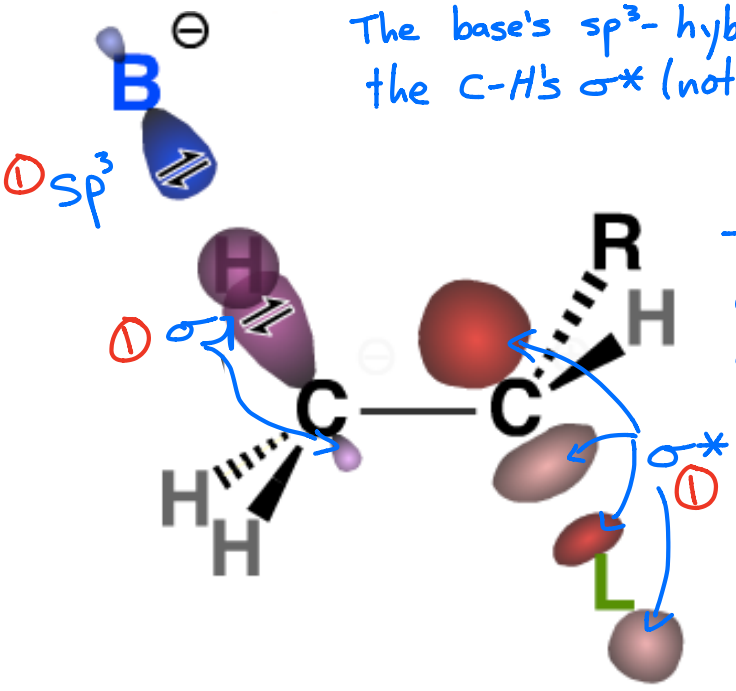


11. Draw the product of the reaction step shown below. **(2 points)**



12. The following images represent the orbitals involved in an E2 reaction. Label each orbital and describe how each orbital is involved in the reaction.

All reactants (B=base = $^{\ominus}OCH_3$)



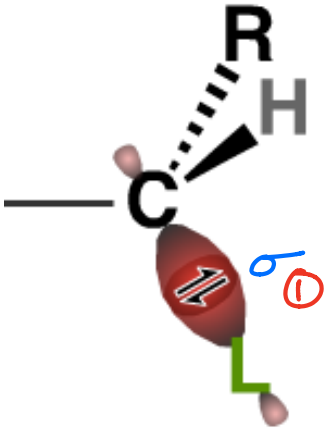
The base's sp^3- hybridized orbital overlaps with the C-H's σ* (not shown) to form an O-H σ (1)

(1) σ

the C-H's σ MO (bond) overlaps with the C-LG's σ* to form a new π (not shown) (1)

σ* (1)

Expansion of carbon–leaving group (L) bond:



σ (1)

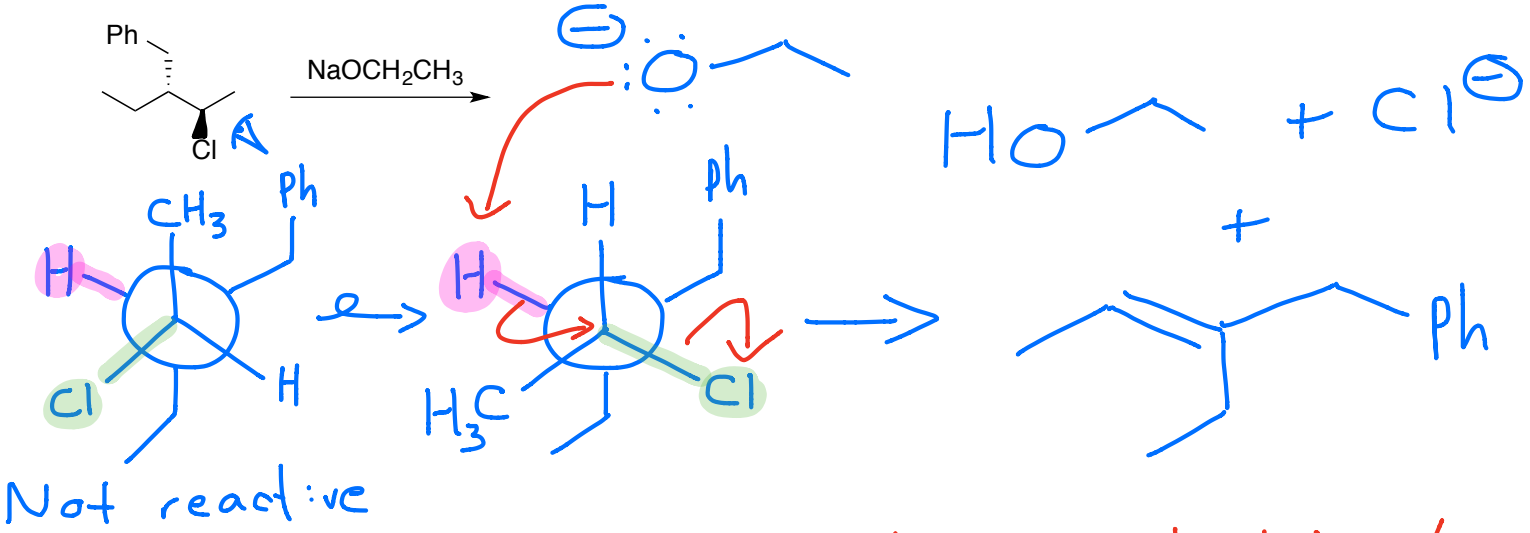
C-LG σ bond breaks & the more electronegative LG takes the e⁻s. (1)

13.

a. What is the major mechanism type for the reaction below? **(1 point)** E2

b. Draw the starting material in the Newman structure of its reactive conformation. **(3 points)**

c. Draw the mechanism and the major organic product. **(3 points)**



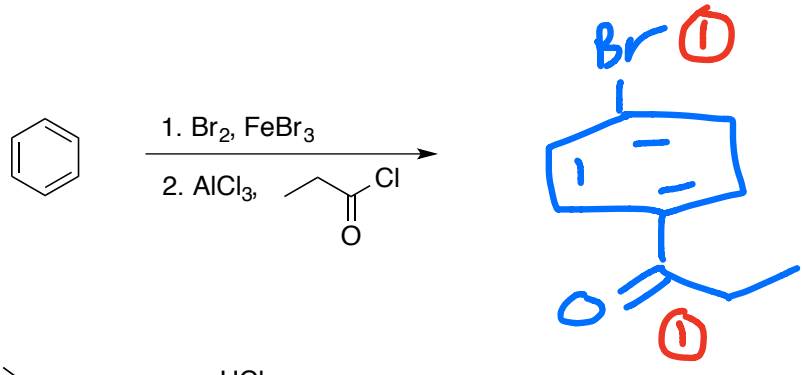
d. Explain the mechanism above. **(3 points)** ① pt per correct statement -1 per error

The strong base abstracts (removes) a proton anti-periplanar to the Cl leaving group, giving the most stable alkene product. BONUS: mention that the APP H + Cl is required so that the HC σ & C-LG σ* can overlap

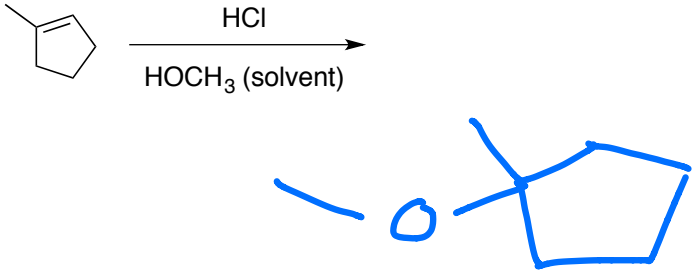
14. Draw the major organic product(s) for the following reactions. **(3 points each; total 9 points)**

a.

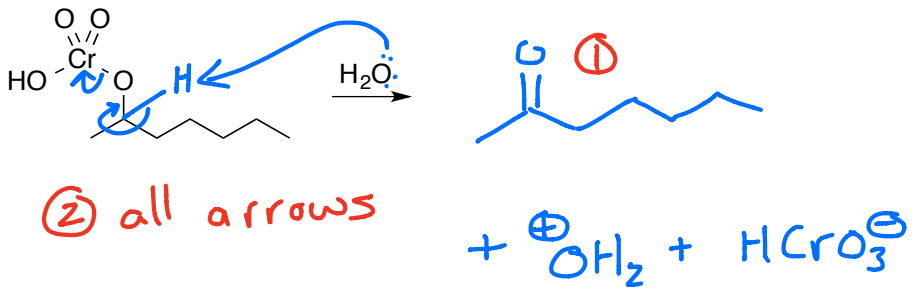
b.



c.

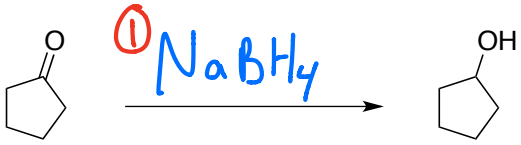


15. Draw the mechanism and products of the reaction below. **(3 points)**

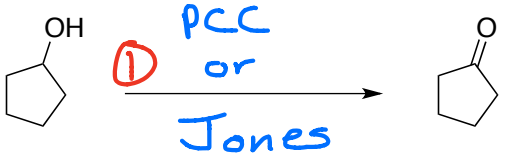


16. Add the appropriate reagents to effect the following transformations: **(2 points)**

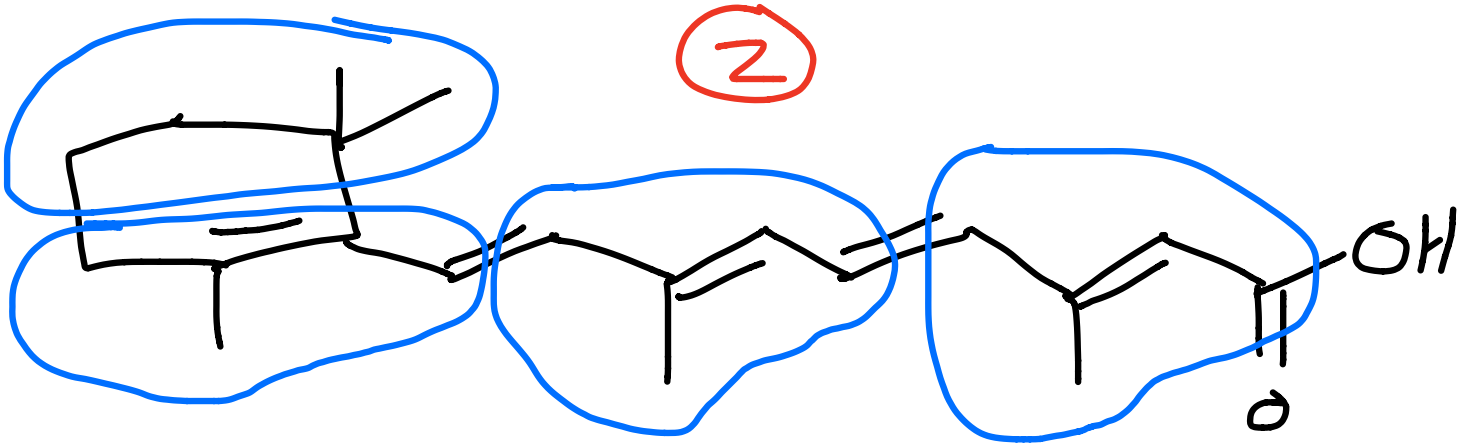
a.

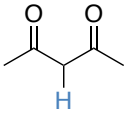
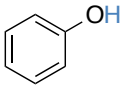
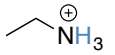
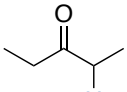
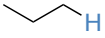


b.



BONUS a) 4 ①



Acid	pK_a value (H_2O solvent)	Acid	pK_a value (H_2O solvent)
HI	-10		9
H_2SO_4	-3		9.9
HBr	-9		10.6
HNO_3	-1.3	H_2O	15.7
HCl	-8		17
HF	3.17		20
	-3.8		24
	-2.6	H_2	36
	-6.2	NH_3	38
H_3O^+	-1.7		50
$CH_3OH_2^+$	-2.2		51
	4.76		