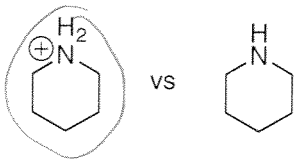
1. Circle the most stable (lowest energy) ion from among each of the following pairs. **(2 points)**

(1) a. (Br⁻) vs Cl^-

(1) b. FCH_2O^- vs (F_3CO^-)

2. Circle the strongest acid from among each of the following pairs. **(2 points)**

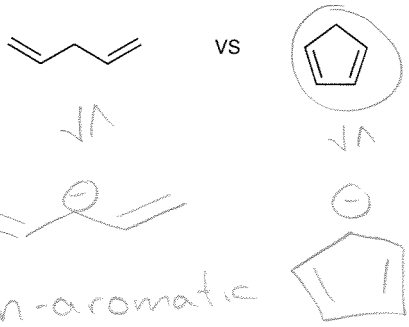
a.

(1) 

b.

(1) 

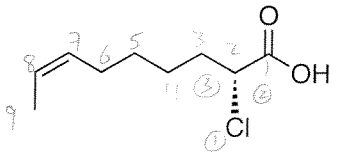
3. Circle the strongest acid **(1 point)** and justify your choice, using structures to support your answer **(5 points)**.



(1) (1) (1) non-aromatic

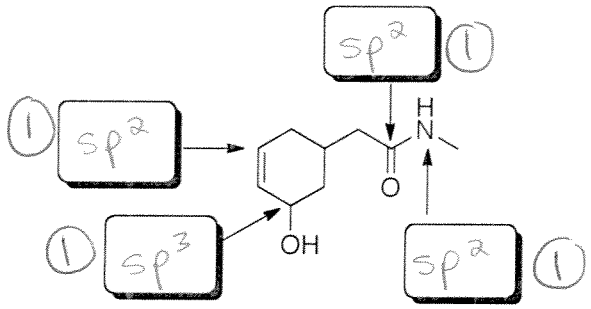
less stable (or stronger or higher E) ← (1) (one of 2 must be stated) → more stable (or weaker or lower E) aromatic (1)

4. Name the following compound. **(4 points)** 5



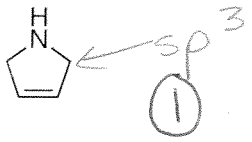
(1) (Z,R)- (1) 2-chloronon-7-enoic (1) acid

5. Identify the hybridization state for each of the atoms indicated with an arrow. **(4 points)**



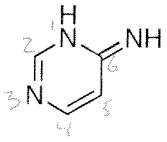
6. Decide whether each of the following compounds is aromatic, anti-aromatic, or non-aromatic and justify your choice (please support your answer with a drawing if you are discussing the position of electrons or orbitals in space). **(8 points)**

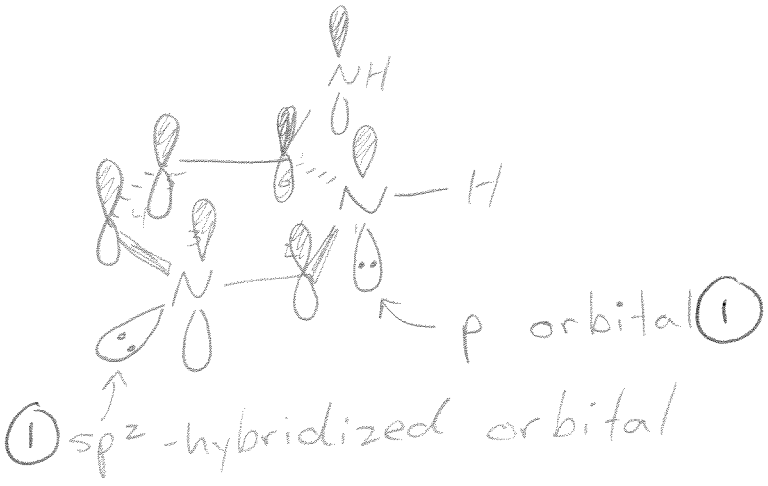
a.



non-aromatic

b.





planar

all atoms sp^2-hybridized

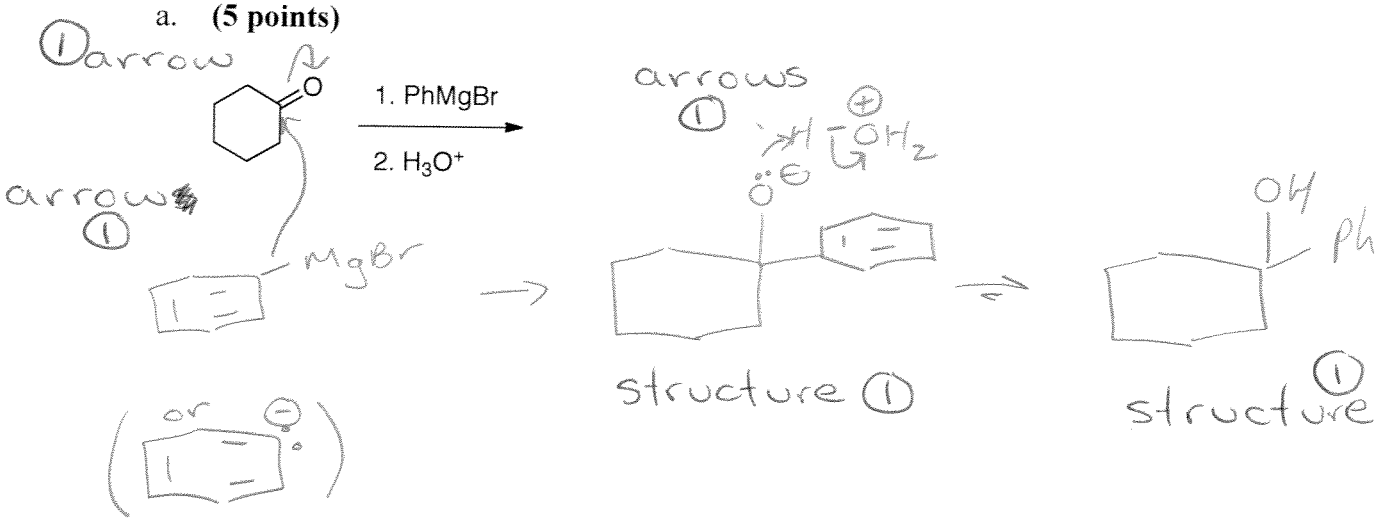
6 π e⁻s $= 4n + 2$

$n = 1$

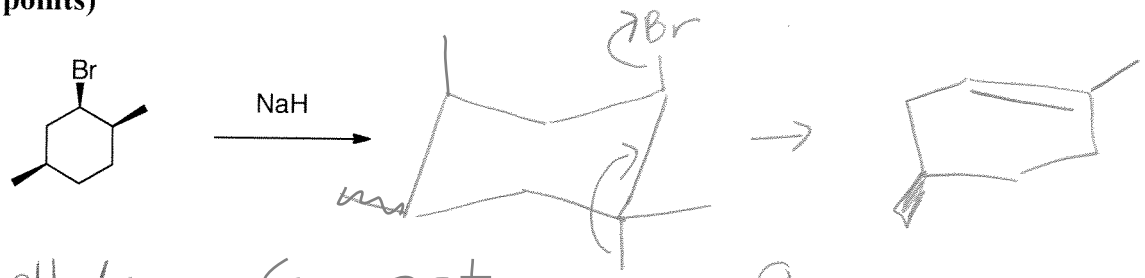
∴ Aromatic

7. Provide a mechanism and the major organic product of each of the following reactions.

a. **(5 points)**



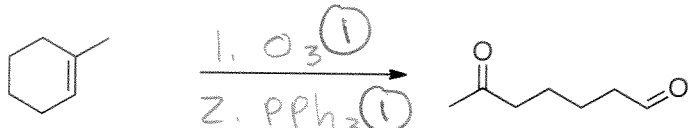
b. Please include the structure of the reactive conformation in 3D (chair). **(5 points)**



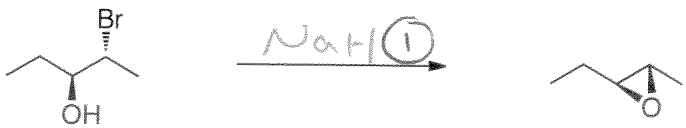
1 chair well drawn (correct molec.)
1 reactive conformation
1 regiochem (H on most subs'd C removed)
1 arrows 1 final structure

8. Draw the reagents required to accomplish each of the following transformations. **(3 points)**

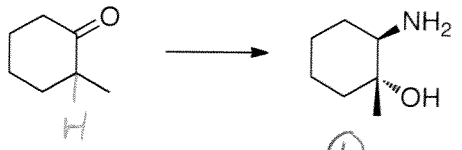
a.



b.



9. Propose a synthesis of the following diol from cyclohexanone. **(15 points)**



(1) (1) (1)

(1) Include an analysis (bonds broken, bonds formed, regiochemistry and stereochemistry) and brainstorming (ideas for reactions which aren't necessarily the final synthesis) in your answer. You do not have to provide a retrosynthesis.

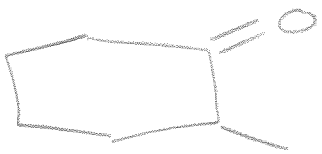
(2)*

bonds broken { C=O reduced → *NaBH4? ; H removed → A/B or elimination*? }

*can be incorrect rxns in this section

new grps/ bonds formed { NH2 + OH added: vicinal (adjacent C's) ; stereo → anti (trans) ; regio → NH2 on least-subs'd C ↳ epoxide*? }

Synthesis

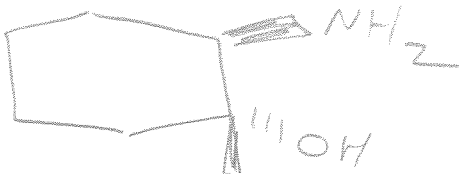


1. $NaBH_4$ (1)
2. H_3O^+ (1)

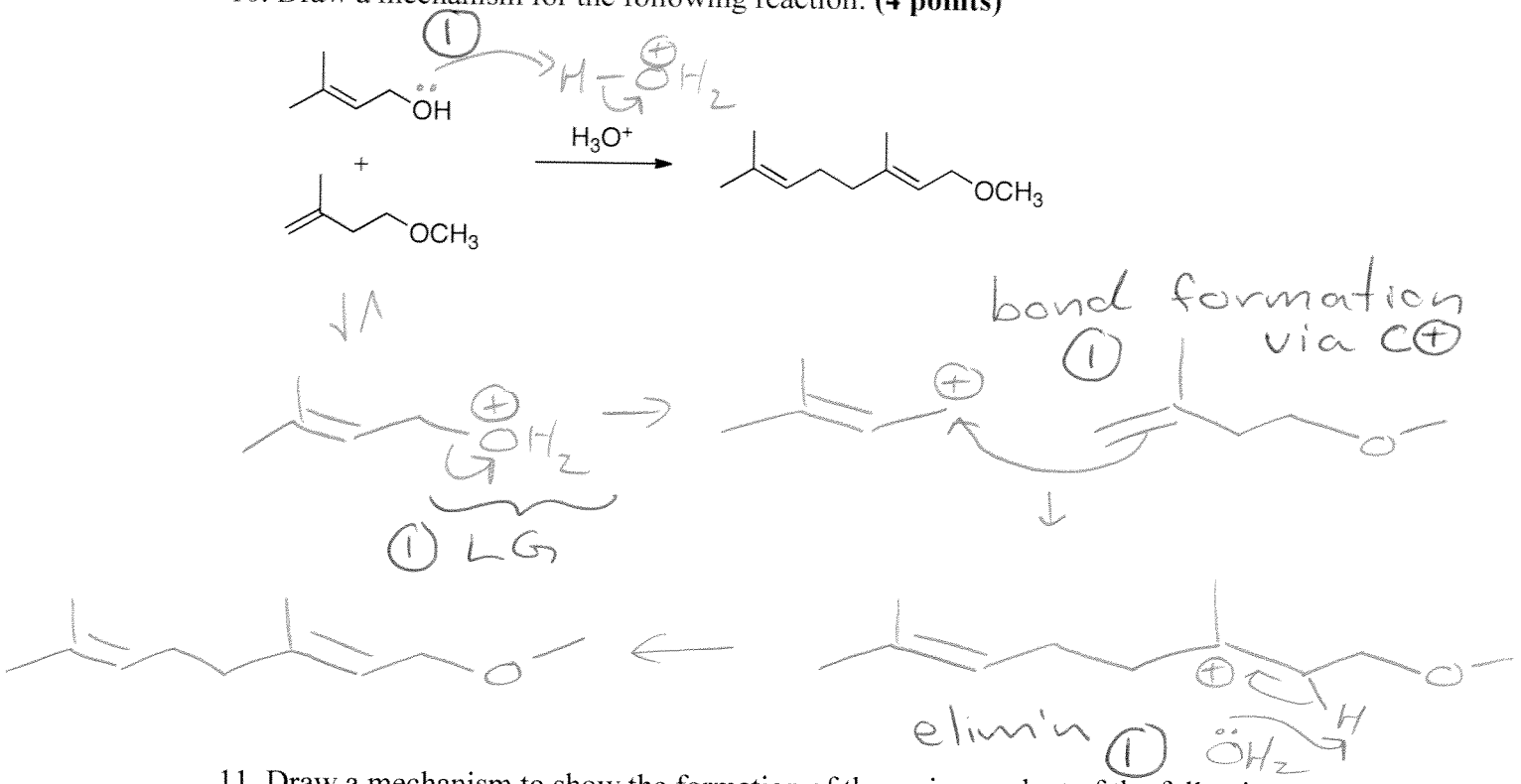
↓ H_3PO_4 (Δ) (1) or another strong acid

(1) (or other eg) mCPBA

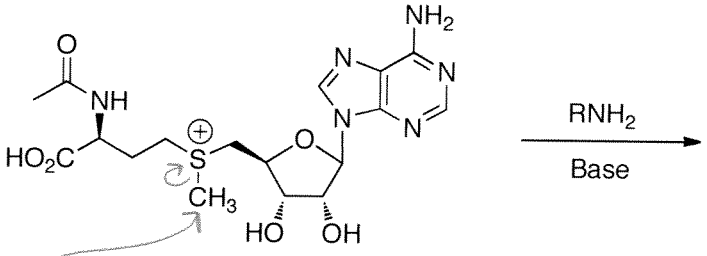
↓ 1. $NaNH_2$ (1)
2. H_3O^+ (1)



10. Draw a mechanism for the following reaction: **(4 points)**



11. Draw a mechanism to show the formation of the major product of the following reaction. You can simplify the structure by defining R groups if you wish. **(5 points)**

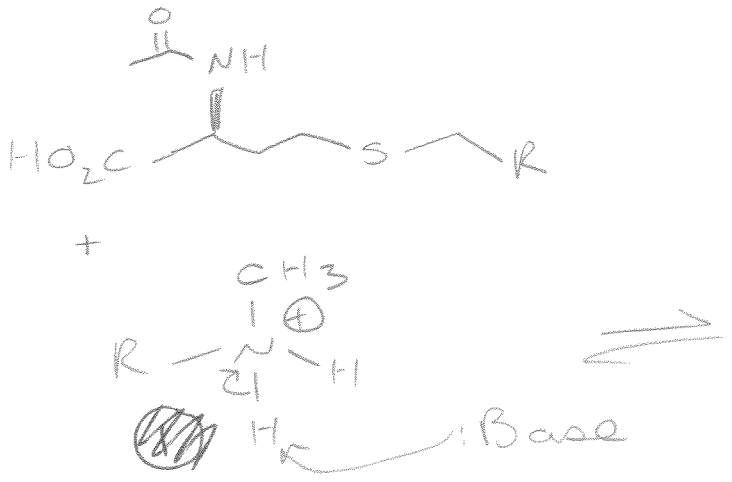


① correct Nu used

① correct α C chosen (CH_3)

① S_N2 arrows

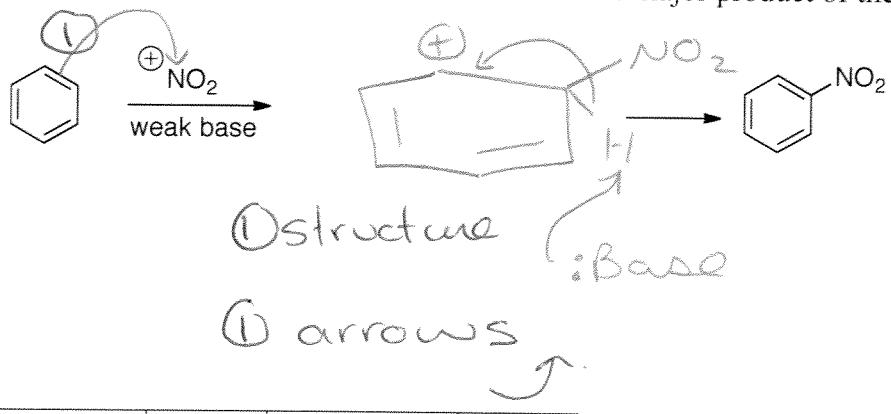
① deprotonation



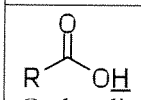
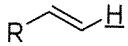
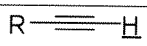
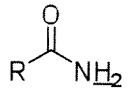
① final structure

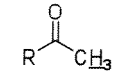
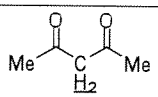
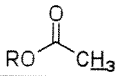
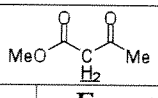
Bonus! **(3 points)**

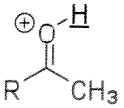
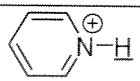
Draw a mechanism to show the formation of the major product of the following reaction:



Acid	pKa	Acid	pKa
HBr	-9	H_2SO_4	-3
HCl	-7	HNO_3	-1.4
HF	3		

Functional group	pKa	Functional group	pKa
ROH Alcohol	17	H_2	35
H_2O	15.7	R_3CH alkane	50
 Carboxlic acid	5	 Alkene	45
R_2NH Amine	40	 alkyne	25
 Amide	15		

Functional group	pKa	Functional group	pKa
	20		9
	25		11

Functional group	pKa	Functional group	pKa
H_3O^+	-1.7	NH_4^+ Ammonium	9
R-OH_2^+ Protonated alcohol	-2	R_3NH^+ Protonated amine	10
 Protonated ketone	-6	 Protonated pyridine	5