

Please read the following before proceeding

1. The exam is divided into two parts.

Part A is Scantron scored (44 points)

- a. Bubble-in your GTID number correctly.
- b. Bubble-in the TEST FORM, located at the top of the page.

Part B is free response (64 points)

Exam 5 Total (108 points available)

2. Materials: Turn off cell phones and wireless PDA devices. Place all other materials on the floor. You will only need a pencil. Molecular models are optional.
2. Show your Buzz Card when you turn in your completed exam.
3. You must work alone.
4. This is a closed book exam. Give or take no assistance from other students. Recall the Georgia Tech Honor Code.

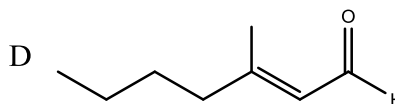
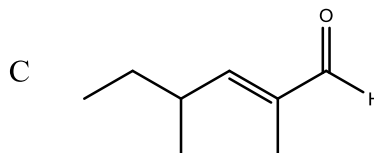
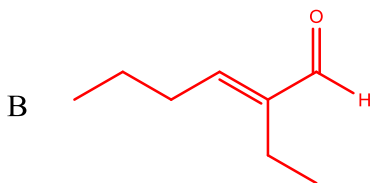
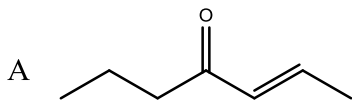
“I pledge my honor that I have not violated the Honor Code during this examination.”

Signed _____

PART A – Scantron Scored

(44 points, 4 points each) Bubble-in the correct answer on the Scantron card. There is only one correct answer. Also circle your answer below for later review with the answer key.

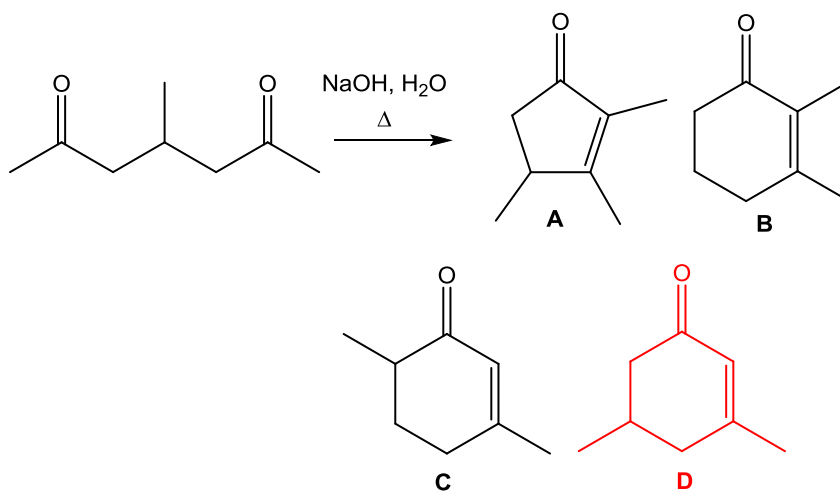
1. Of the following compounds, the one that forms a bright yellow precipitate upon treatment with iodine in aqueous sodium hydroxide
 - A. 2-hexanone
 - B. 3-pentanone
 - C. cyclohexanone
 - D. 2-butenal
2. Which of the following is **not** true about keto-enol interconversion of a ketone such as 2,4-pentanedione?
 - A) A proton is removed from the methylene carbon of the ketone.
 - B) An enolate ion is formed as an intermediate in the base-catalyzed reaction.
 - C) An enolate ion is formed as an intermediate in the acid-catalyzed reaction.
 - D) A proton is donated to the oxygen atom.
3. The product of the aldol condensation of butanal (C_4H_8O) in base with heat is the following.



4. Which of the following are true about a Claisen condensation?

- A) The reactants are two molecules of an ester and an equivalent of a base.
- B) The base is the same as the leaving group of the ester.
- C) The products are a beta-keto ester and an alcohol.
- D) . Only a and c are correct.
- E) All of the above are correct

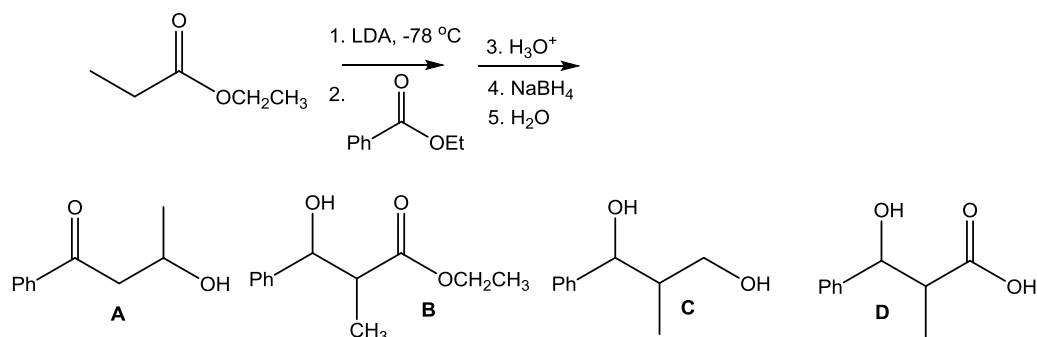
5. What is the major organic product obtained from the following reaction?



6. The pK_a of ethyl cyanoacetate is 9. Which of the following bases will give the most ethyl cyanoacetate enolate in solution (highest concentration)? The conjugate acid pK_a 's of the bases are given.

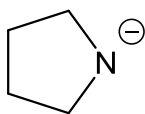
- A) Dimethyl amine ($(CH_3)_2NH$) [pK_a conjugate acid = 11]
- B) Acetate ($CH_3CO_2^-$) [pK_a conjugate acid = 5]
- C) *t*-Butoxide ($(CH_3)_3CO^-$) [pK_a conjugate acid = 18]
- D) Phenoxide (PhO^-) [pK_a conjugate acid = 10]
- E) Methane sulfonate ($CH_3SO_3^-$) [pK_a conjugate acid = -2]

7. What is the major organic product obtained from the following sequence of reactions?

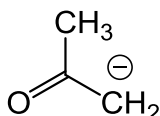


- A) A
B) B
C) C
D) D
8. Reaction of 6,6-dimethylcyclohex-2-en-1-one with a strong base, such as Lithium diisopropyl amide in tetrahydrofuran, followed by reaction with methyl iodide results in
- A) methyl isopropyl amine formation
B) amination at C4
C) methylation at C4
D) no reaction
9. What product is formed when 3-pentanone is dissolved in D_2O that contains some OD^- ?
- A) $\text{CD}_3\text{CD}_2\text{-C(=O)-CD}_2\text{CD}_3$
B) $\text{CH}_3\text{CHD-C(=O)-CHDCH}_3$
C) $\text{CH}_3\text{CD}_2\text{-C(=O)-CH}_2\text{CH}_3$
D) $\text{CH}_3\text{CHD-C(=O)-CH}_2\text{CH}_3$
E) $\text{CH}_3\text{CD}_2\text{-C(=O)-CD}_2\text{CH}_3$

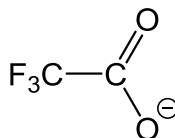
10. Which of the following bases is not strong enough to deprotonate CH_3SH ($\text{pK}_a = 11$)?



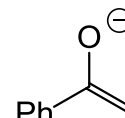
A

conjugate acid pK_a
36

B

conjugate acid pK_a
19

C

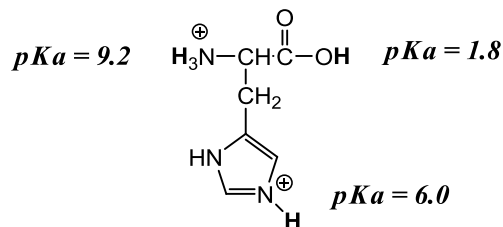
conjugate acid pK_a
0.18

D

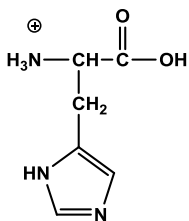
conjugate acid pK_a
16

- A) A
B) B
C) C
D) D
E) All are strong enough to deprotonate CH_3SH

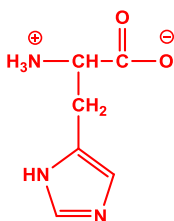
11. **Extra Credit:** Histidine is an amino acid. The fully protonated form has the pK_a values indicated below.



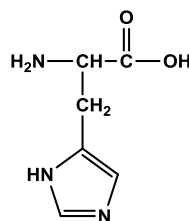
Which one of the following is the predominant structure at $\text{pH} = 7.6$?



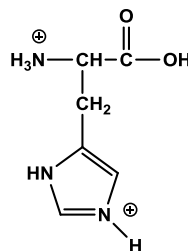
A



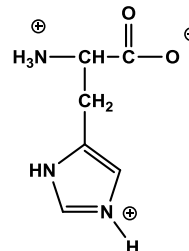
B



C



D

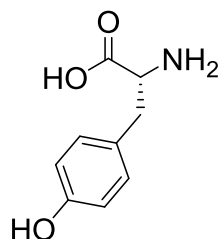


E

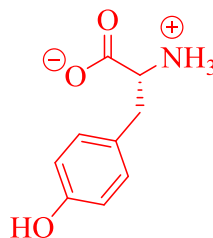
END of PART A – Scantron scored

BEGIN PART B – free response

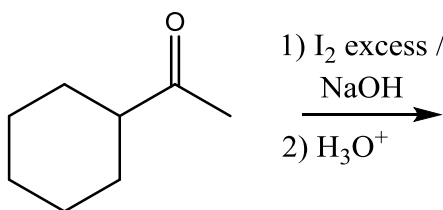
Extra Credit (4 points): The pKa of phenol, the side chain group of the amino acid tyrosine, is close to 10. The pKa of the COOH group is 2.2 and NH_3^+ is 9.1. In the box draw the species that will predominate at a pH = 7.6.



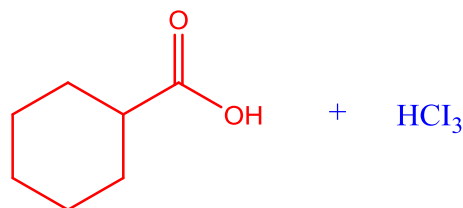
k)



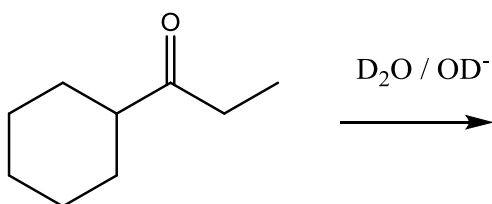
2. (40 points, 4 points each) Provide the structure(s) of the major organic product(s); Fill in the box for all questions.



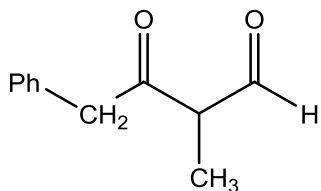
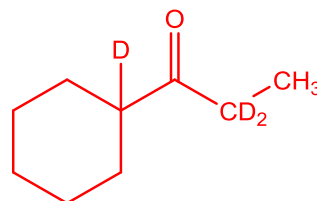
a.



major product only



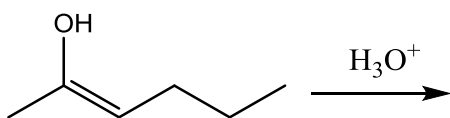
b.



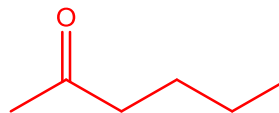
How many enolizable protons are there in the molecule on the left?

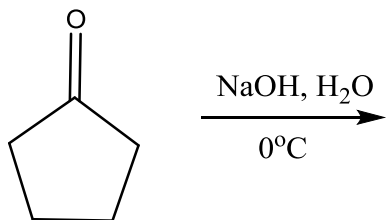
c.

3

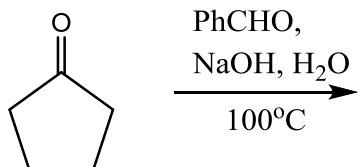
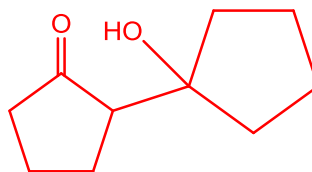


d.

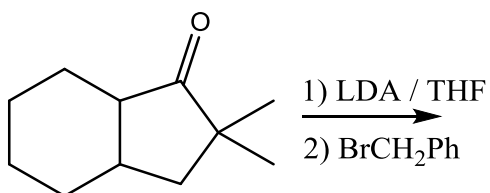
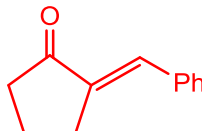




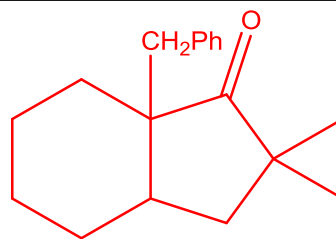
e.

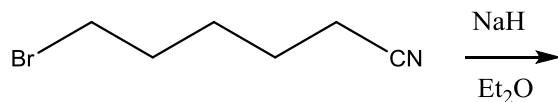


f.

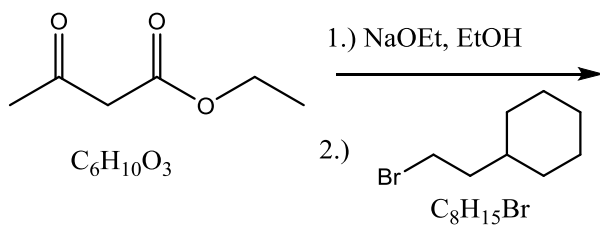


g.

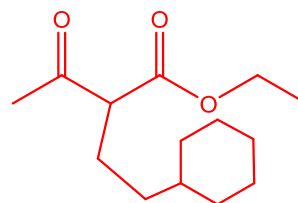
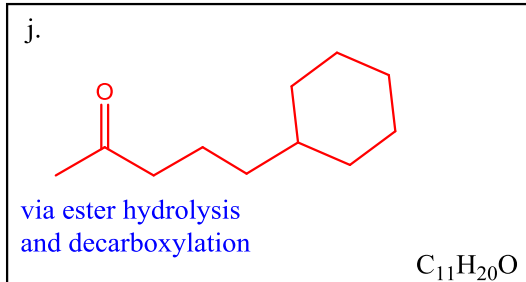




h.



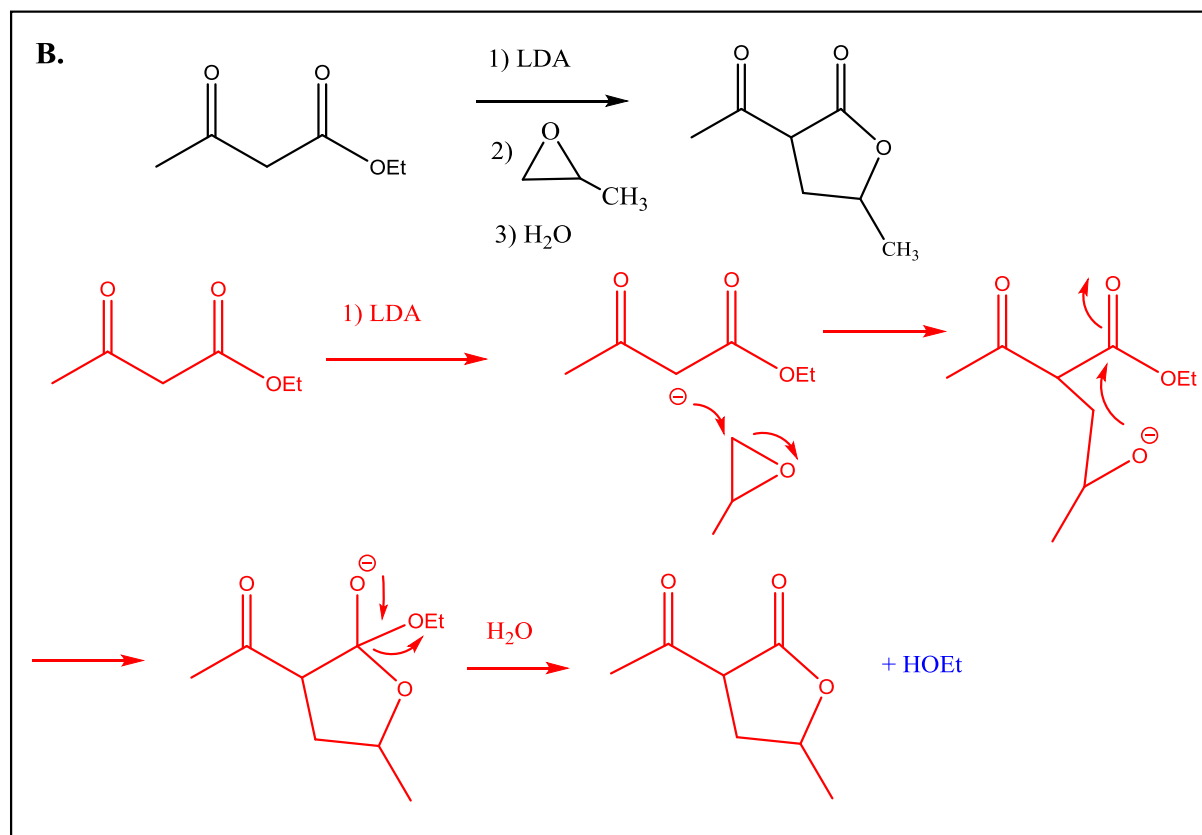
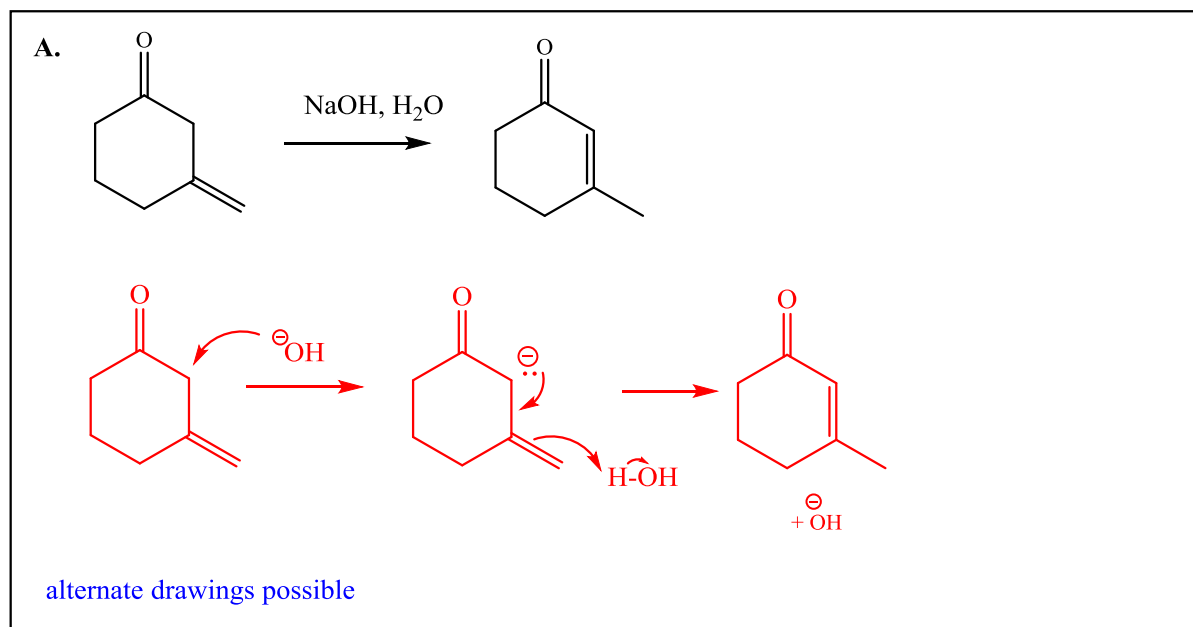
i.

 $C_{14}H_{24}O_3$ 3.) H_3O^+

4.) Heat

End Part B**Begin Part C (next page)**

3. (20 points; 10 points each)) **Mechanistic Understanding:** Provide a step wise mechanism for **BOTH (A and B)** of the following. Use curved arrows to show the electron movement and show all intermediates.



END OF PART C

Write your class roll number on
(1) the top of the first page and
(2) in the box on the bottom of this page.

	Acid	Approximate pK_a	Conjugate Base	
Strongest acid	HSbF ₆	< -12	SbF ₆ ⁻	Weakest base
	HI	-10	I ⁻	
	H ₂ SO ₄	-9	HSO ₄ ⁻	
	HBr	-9	Br ⁻	
	HCl	-7	Cl ⁻	
	C ₆ H ₅ SO ₃ H	-6.5	C ₆ H ₅ SO ₃ ⁻	
	(CH ₃) ₂ OH ⁺	-3.8	(CH ₃) ₂ O	
	(CH ₃) ₂ C=OH ⁺	-2.9	(CH ₃) ₂ C=O	
	CH ₃ OH ₂ ⁺	-2.5	CH ₃ OH	
	H ₃ O ⁺	-1.74	H ₂ O	
	HNO ₃	-1.4	NO ₃ ⁻	
	CF ₃ CO ₂ H	0.18	CF ₃ CO ₂ ⁻	
	HF	3.2	F ⁻	
	CH ₃ CO ₂ H	4.75	CH ₃ CO ₂ ⁻	
	H ₂ CO ₃	6.35	HCO ₃ ⁻	
	CH ₃ COCH ₂ COCH ₃	9.0	CH ₃ COCH ⁻ COCH ₃	
	NH ₄ ⁺	9.2	NH ₃	
	C ₆ H ₅ OH	9.9	C ₆ H ₅ O ⁻	
	HCO ₃ ⁻	10.2	CO ₃ ²⁻	
	CH ₃ NH ₃ ⁺	10.6	CH ₃ NH ₂	
	H ₂ O	15.7	OH ⁻	
	CH ₃ CH ₂ OH	16	CH ₃ CH ₂ O ⁻	
	(CH ₃) ₃ COH	18	(CH ₃) ₃ CO ⁻	
	CH ₃ COCH ₃	19.2	⁻ CH ₂ COCH ₃	
	HC≡CH	25	HC≡C ⁻	
	H ₂	35	H ⁻	
	NH ₃	38	NH ₂ ⁻	
	CH ₂ =CH ₂	44	CH ₂ =CH ⁻	
Weakest acid	CH ₃ CH ₃	50	CH ₃ CH ₂ ⁻	Strongest base

Note : write your Roll Number in the box

Write your class roll number on (1) the top of the first page and (2) below.

Class Roll number _____

Part A Scantron scored (44 points)

Page 6 (20) _____

Page 7 (12) _____

Page 8 (12) _____

Page 9 (20) _____

Part B only_ _____ (64)