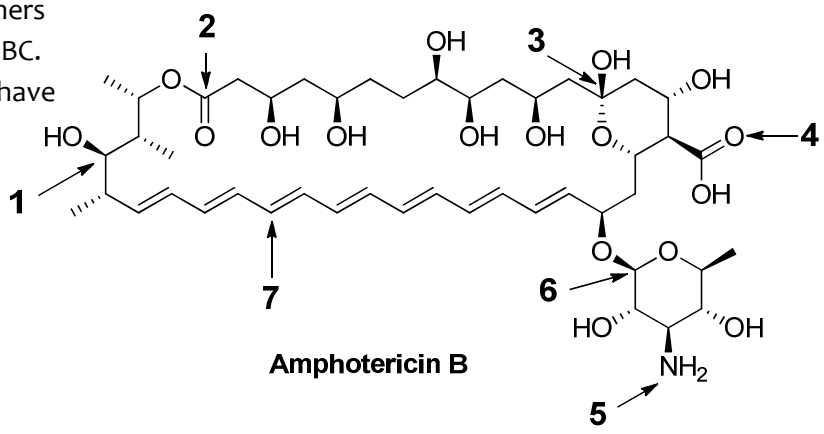
The following is a representative example of the type of questions that I may ask on the final exam. These are literally all the questions I have! The final exam will be 2.5 hours in length. This also represents all of the practice questions I have left.

It is not possible to match the actual exam length exactly, but this is a close attempt. The test contains items that sample from the learning objectives in the course, but does not test everything. The difficulty level is also similar to the actual final exam. However, since the questions sample from the course, the actual exam may feel more or less difficult to you, depending on how well you know the various topics.

I ABSOLUTELY GUARANTEE THAT NONE OF THE QUESTIONS ON THIS EXAM WILL APPEAR IN THE EXACT SAME FORMAT ON MY FINAL. DON'T STUDY THE SOLUTIONS KEY!!!!!

Multiple Choice. Questions 1 - 30 must be answered on the Scantron form by shading the appropriate circle with blue or black pen or pencil. Although responses on your Scantron sheet will be used to calculate your midterm grade, you can ensure that you receive all earned credit by indicating your answers on ***both*** the Scantron sheet and this examination paper. Note that ***more than one letter could*** be entered as an answer to a multiple choice question. In the case of a discrepancy between your examination paper and your Scantron, the Scantron shall be graded as the intended answer. Each correct response is worth one point.

Questions 1– 7. Amphotericin B is a potent antifungal and antiprotozoal compound that has been employed to effectively treat diseases such as malaria and African sleeping sickness. It is now being studied as a new treatment for HIV by researchers in the Neglected Global Diseases Initiative at UBC. Take note of the fact that specific atoms/sites have been labelled **1** through **7**.



Amphotericin B

1) What is the stereochemical configuration of the carbon labelled **1**?

(A) *R* **(B)** *S* **(C)** *E* **(D)** *Z* **(E)** *cis* **(F)** *trans* **(G)** D

2) To what functional group does the carbon atom labeled **2** belong?

(A) carboxylic acid **(B)** ester **(C)** ether **(D)** acetal **(E)** ketal **(F)** hemiacetal **(G)** hemiketal

3) To what functional group does the carbon atom labeled **3** belong?

(A) carboxylic acid **(B)** ester **(C)** ether **(D)** acetal **(E)** ketal **(F)** hemiacetal **(G)** hemiketal

4) What is the hybridization of the oxygen atom labelled **4**?

(A) s **(B)** p **(C)** sp **(D)** sp^2 **(E)** sp^3 **(F)** σ (sigma) **(G)** π (pi)

5) What term describes the substitution of the amine labelled **5**?

(A) primary **(B)** secondary **(C)** tertiary **(D)** quaternary **(E)** R **(F)** S **(G)** E

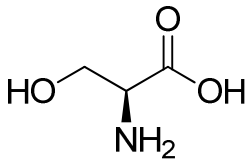
6) To what functional group does the carbon atom labeled **6** belong?

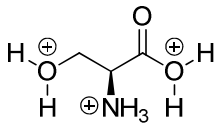
(A) carboxylic acid **(B)** ester **(C)** ether **(D)** acetal **(E)** ketal **(F)** hemiacetal **(G)** hemiketal

7) What is the hybridization of the carbon atom labelled **7**?

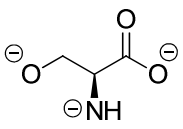
(A) s **(B)** p **(C)** sp **(D)** sp^2 **(E)** sp^3 **(F)** σ (sigma) **(G)** π (pi

To the right is a representation of the amino acid serine. Answer **questions 7 – 8** using this representation, and the structures below. Take note that for this question, incorrect answers will be subtracted from correct answers to a minimum grade of zero.

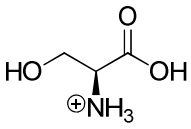




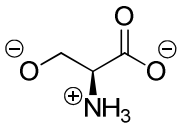
A



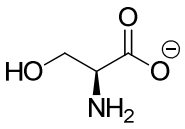
B



C



D



E

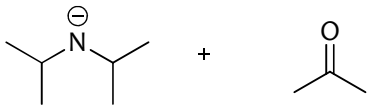
Question 7. Which structure(s) (**A** – **E**) best represents the structure of serine at a pH = 2?

Question 8. Which structure(s) (**A** – **E**) best represents the structures of serine at a pH = 5?

For **questions 9 – 18,** select the letter (**A, B, C** or **D**) that corresponds to the arrow(s) that best describe the relationship between the reactants and the products.

9)  ***products of proton transfer***

10)  ***products of proton transfer***

11)  ***products of proton transfer***

12)  ***products of proton transfer***

13)  *products of proton transfer*

14)  *products of proton transfer*

15) 

16) 

17) 

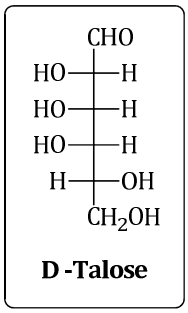
18) 

For **questions 19 – 27.** Indicate the statements as either:

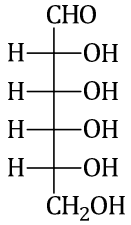
(A) True **(B)** False **(C)** Cannot be determined

19) A cyclic system with 8 pi electrons does not obey HÜckel's Rule.
20) Serine proteases carry out biological amine hydrolysis reactions.
21) The reaction rate of an E2 reaction is dependent on the concentration of both the substrate and the base.
22) Anomers of the same carbohydrate have the same melting point.
23) $NaBH_4$ is water soluble.
24) Propanoyl chloride undergoes a reaction with water at a faster rate than propyl proanoate reacts with water.
25) The C-5 epimer of D-glucose is L-glucose.
26) Carboxylic esters are more electrophilic than thioesters.
27) Protonation of carbonyl oxygen atoms makes them more electrophilic.

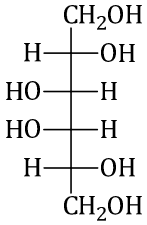
Consider the structure of D-talose and the structures (**A** – **E**) provided below when answering **questions 28** – **33**. Take note that for this question, incorrect answers will be subtracted from correct answers to a minimum grade of zero.



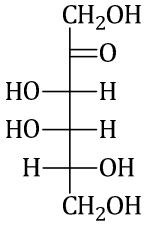
D -Talose



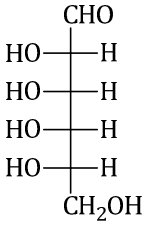
A



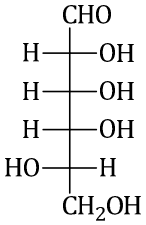
B



C



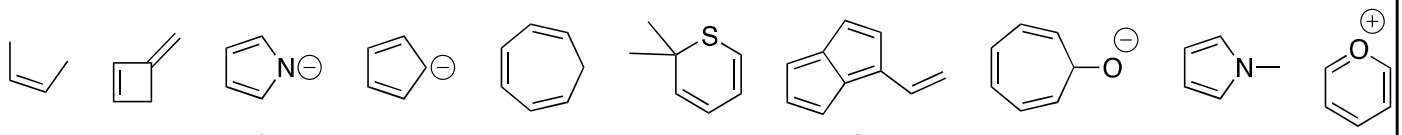
D



E

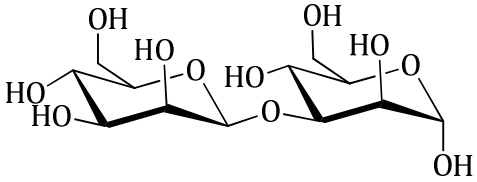
28) Which compound(s) (**A** – **E**) is/are diastereomers of D-Talose?
29) Which compound(s) (**A** – **E**) is/are meso compounds?
30) Which compound(s) (**A** – **E**) is/are enantiomers of D-Talose?
31) Which compound(s) (**A** – **E**) is/are constitutional isomers of D-Talose?
32) Which compound(s) (**A** – **E**) is/are epimers of D-Talose?
33) Which compound(s) (**A** – **E**) is/are L-carbohydrates?

Question 34. Consider the compounds (**A** – **J**) below. Select the structure(s) that is/are fully aromatic.



A **B** **C** **D** **E** **F** **G** **H** **I** **J**

Consider the disaccharide shown to the right for **questions 35 – 38.** Indicate true or false for each statement.

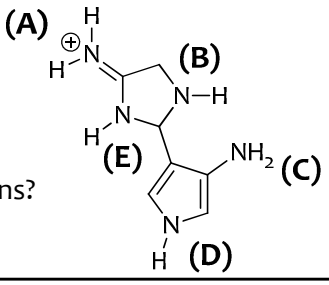


35) Contains a monosaccharide derived from an aldose. (A) True (B) False
36) Contains a β – 1, 2' glycosidic linkage. (A) True (B) False
37) Contains a monosaccharide derived from a pentose. (A) True (B) False
38) Contains an α-glycosidic bond. (A) True (B) False

Question 39. Which of the nitrogen atom(s) (**A** – **E**) is/are the most basic?

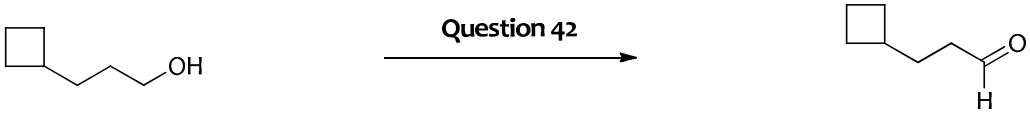
Question 40. Which of the nitrogen atom(s) (**A** – **E**) is/are the least basic

Question 41. Which of the nitrogen atom(s) (**A** – **E**) has a localized lone pair of electrons?



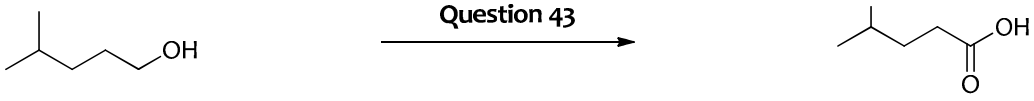
For **questions 42 - 46,** select the reagents and reaction conditions (A – E) that could BEST carry out the indicated transformations.

Question 42



(A)	(B)	(C)	(D)	(E)
H_2SO_4 (cat.) H_2O	H_2, Pd/C	CrO_3, H_2SO_4 H_2O	KOtBu, DMF	CrO_3, pyridine HCl

Question 43

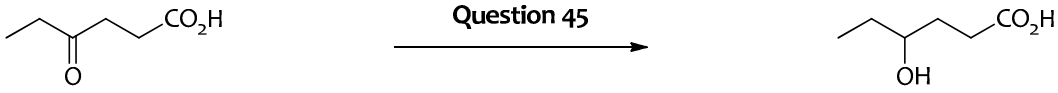


(A)	(B)	(C)	(D)	(E)
H_2SO_4 (cat.) H_2O	CrO_3, H_2SO_4 H_2O	KOH, THF	H_2, Pd/C	CrO_3, pyridine HCl

Question 44

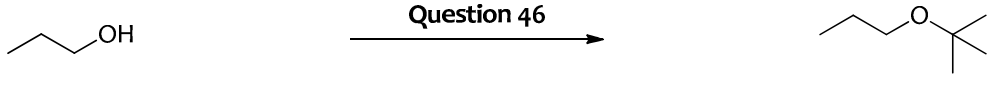
(A)	(B)	(C)	(D)	(E)
a) $LiN(i\text{-}C_3H_7)_2$ (LDA) b) CH_2=$CHCH_2CH_2Br$	a) $KOCH_3$ b) CH_2=$CHCH_2CH_2Br$	a) $LiN(i\text{-}C_3H_7)_2$ (LDA) b) CH_2=$CHCH_2CH_2Br$	CH_2=$CHCH_2CH_2OH$ H_2SO_4 (cat.) 189°C	a) $LiAlH_4$, *solvent* b) CH_2=$CHCH_2CH_2Br$

Question 45



(A)	(B)	(C)	(D)	(E)
1. $LiAlH_4$ 2. H_3O^+ - *workup*	CrO_3, H_2SO_4 H_2O	a) NaH b) H_3O^+ - *workup*	$NaBH_4$, EtOH	Na, NH_3, -33°C

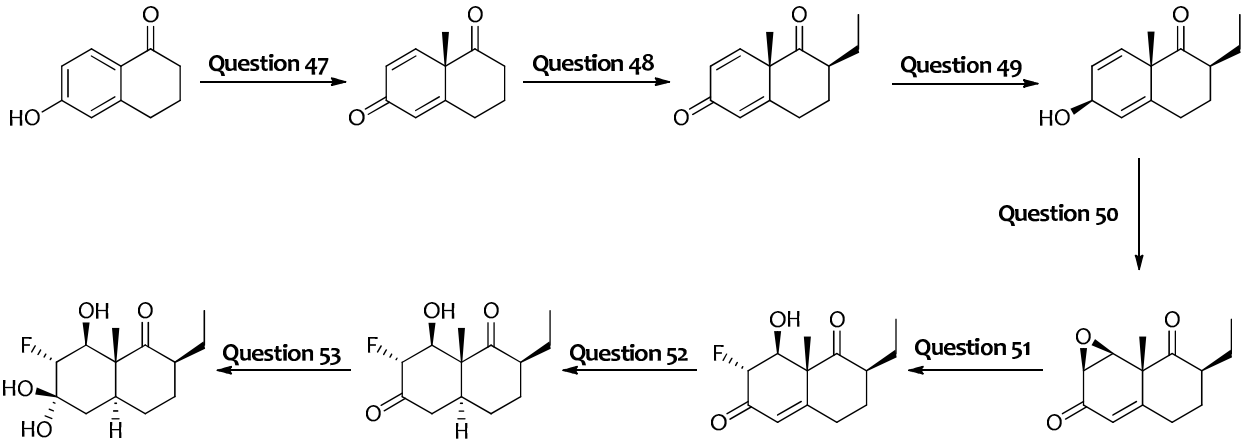
Question 46



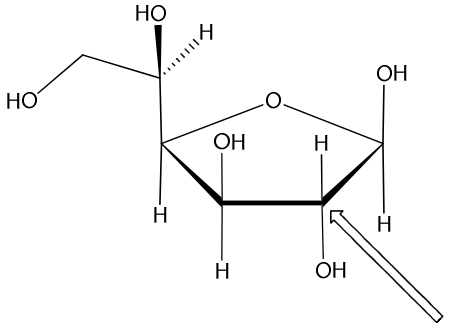
(A)	(B)	(C)	(D)	(E)
a) KOH b) $(CH_3)_3CBr$	2-methylpropene H_2SO_4 (cat.)	a) NaH b) $(CH_3)_3CBr$	a) NaH b) 2-propanone	1. a) NaH b) CH_3CH_2Br 2. a) LDA (2 equiv.) b) CH_3I (2 equiv.)

Consider the synthetic route outlined below when answering **questions 47 - 53.** Classify each reaction as a(n):

(A) Oxidation **(B)** Reduction **(C)** Not a redox reaction



Consider the monosaccharide below when answering **questions 54 – 55.**



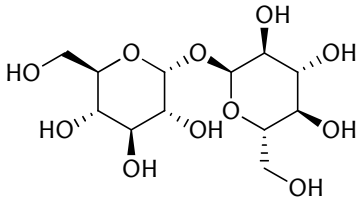
54) What is the absolute stereochemical configuration of the carbon indicated with an arrow in the monosaccharide above?

(A) R
(B) S
(C) E
(D) Z
(E) *cis*
(F) *trans*
(G) meso
(H) carbon is achiral

55) The monosaccharide above is a(n):

(A) Ketopentose, beta
(B) Ketopentose, alpha
(C) Aldopentose, beta
(D) Aldopentose, alpha
(E) Aldohexose, beta

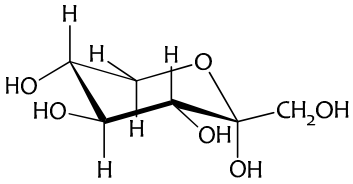
The following image is of trehalose, which is 45% as sweet as sucrose. Trehalose is the major carbohydrate energy storage molecule used by insects that fly. Consider the structure of trehalose when answering **questions 56 – 57.**

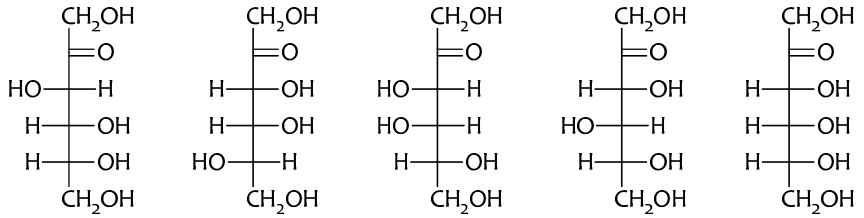


56) Is glucose a component of trehalose?
(A) Yes
(B) No

57) Can trehalose undergo mutarotation?
(A) Yes
(B) No

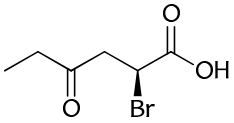
Question 58. Which of the following structures (**A** – **E**) is an accurate open-chain version of the cyclic monosaccharide on the left?





(A) **(B)** **(C)** **(D)** **(E)**

Question 59. Which of the following (**A** - **I**) is the correct IUPAC name for the structure below?

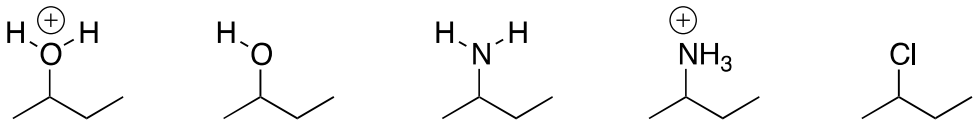


(A) 3-keto-4-bromo-5-hexanecarboxylic acid
(B) 3-keto-4R-bromo-5-hexanecarboxylic acid
(C) 4-oxo-2-bromohexanoic acid
(D) 4-oxo-2R-bromohexanoic acid
(E) 4-oxo-2S-bromohexanoic acid
(F) 2R-bromo-4-oxohexanoic acid
(G) 2S-bromo-4-oxohexanoic acid
(H) 5R-bromo-3-oxohexanoic acid
(I) 5S-bromo-3-oxoheanoic acid
(J) FINE! I'll go review IUPAC naming again Jay!

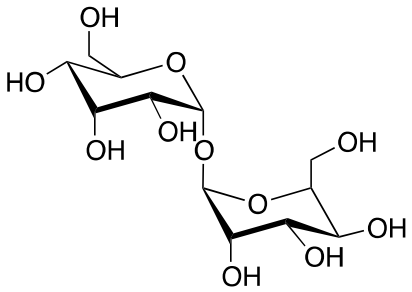
Question 60. Which of the following species has the HIGHEST pKa? (Read this question carefully, what is it asking?)

(A) CH_3CH_2SH
(B) CH_3CH_2OH
(C) CH_3COOH
(D) $CH_3CH_2NH_3^+$

Question 61. Which structure (**A** – **E**) below is the MOST nucleophilic?



Use the structure of the disaccharide below when answering **questions 62 – 64.**



62) What type of glycosidic linkage exists in the disaccharide above?
(A) 1,1'
(B) 1,2'
(C) 1,3'
(D) 1,4'
(E) 3,1'

63) The disaccharide below has both an alpha and beta linkage.

(A) True **(B)** False **(C)** Cannot be determined

64) The disaccharide above is a:

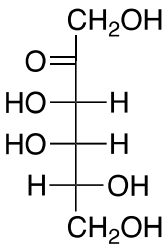
(A) Reducing sugar **(B)** Not a reducing sugar

This is the end of the multiple choice portion of this examination!!
Be sure you have correctly "bubbled-in" your name and student number (I.D. number)!!

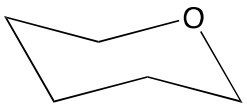
Part 2: Short Answer Questions. Write your answers in the designated space. *Please note that in some cases it may be better for you to work out your answer on scrap paper and copy a neat version to the examination paper. You may write in pencil or pen. Clearly cross-out or erase any work you do not want graded!* Clearly indicate stereochemistry where applicable. Using a squiggly bond (∿) will be interpreted as meaning both stereoisomers are present, and will be graded accordingly.

Messy and/or incoherent answers that are difficult to read or interpret may receive reduced or zero credit*

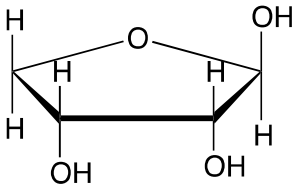
Question 65. Provide the requested structures below.



A



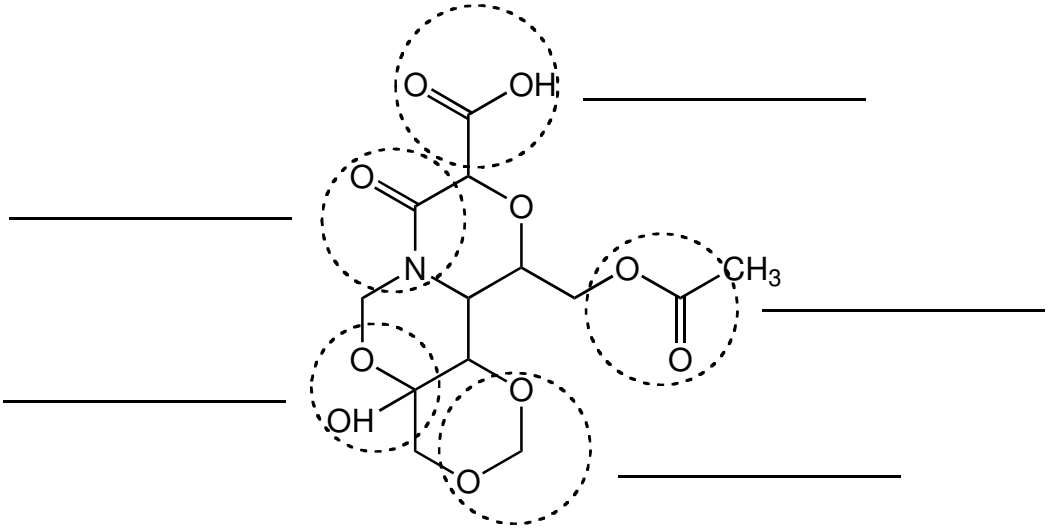
α-pyranose of A



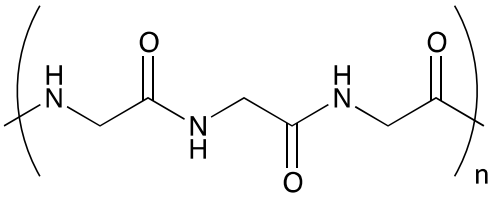
B

Fischer projection of B

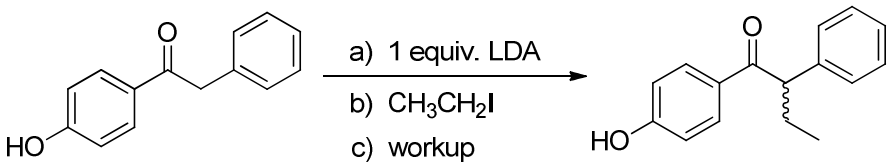
Question 66. Write the name of the indicated functional groups on the corresponding line.



Question 67. Draw the monomer that can react to form the polymer shown below.



Question 68. A key part of the synthesis of tamoxifen (an anti-cancer drug) is the alkylation shown below. A CHEM 233 student decided to do this reaction using the reagents shown below. This reaction did not work.

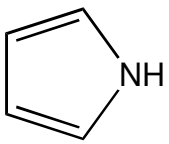


a) Why would the product shown not be formed?

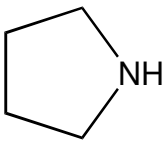
b) What product would be formed instead?

Question 69. Both pyrrole (A) and pyrrolidine (B) can act as acids in the presence of a strong enough base.

a) Rank the pKa values of these compounds by circling the correct statement.



A



B

pKa (pyrrole) > pKa (pyrrolidine)

pKa (pyrrole) = pKa (pyrrolidine)

pKa (pyrrole) < pKa (pyrrolidine)

b) Both pyrrole (A) and pyrrolidine (B) can also act as bases. Show the conjugate acid, C, of pyrrole and the conjugate acid , D, of pyrrolidine. Rank the pKa values of these compounds by circling the correct statement.

C

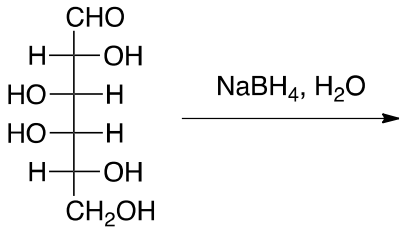
D

pKa (C) > pKa (D)

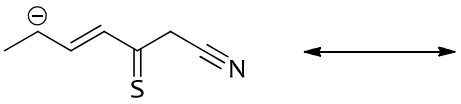
pKa (C) = pKa (D)

pKa (C) < pKa (D)

Question 70. D-galactose, shown below, is an optically active compound. Reduction with sodium borohydride yields an optically inactive product. Show the reaction product and explain why the optical activity is lost.

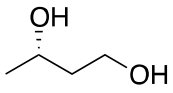


Question 71. Provide the major contributing resonance structure(s) for the following compound. Include all non-zero formal charges. Including incorrect structures may reduce your total score for this question.



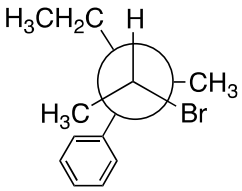
Question 72. Provide the requested information for the reaction schemes below. Only the major organic product(s) should be provided. Please review the rules outlined at the beginning of the written part of this exam.

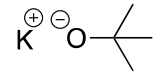
a)



a) CrO_3, H_2SO_4, H_2O
b) workup

b)



a) 

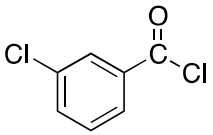
, solvent

b) workup

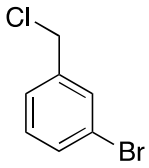
c)

a) $SOCl_2$, *solvent*

b) workup



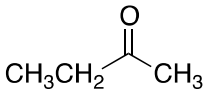
d)



a) NaCCH, solvent

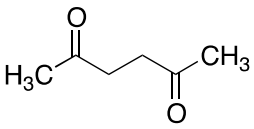
b) workup

e)

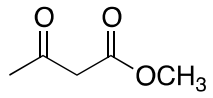


excess CH_3OH, HCl (cat.)

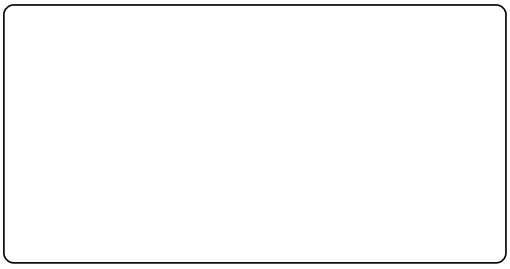
f)

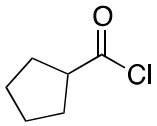


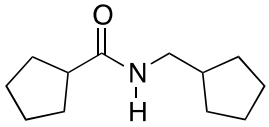
a) NaOH, H_2O
b) workup

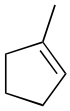
g) 

a) $NaOCH_3$
b) CH_3Br
c) workup

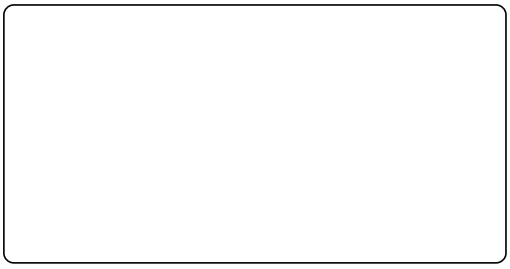


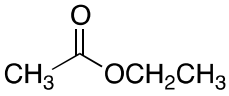
h) 



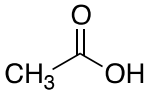
i) 

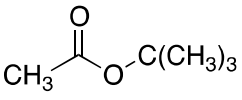
a) H_2O solvent, HCl
b) workup

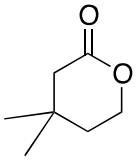


j) 

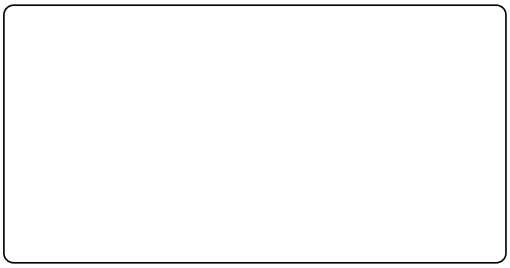
CH_3CH_2OH

k) 

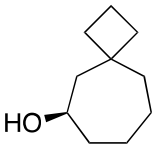


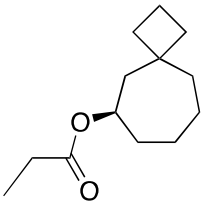
l) 

a) $LiAlD_4$, solvent
b) H_3O^+ workup

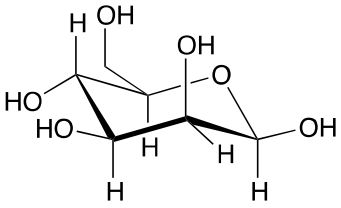


m)



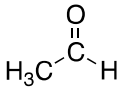


n)



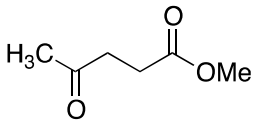
CH_3CH_2OH, H_2SO_4 (cat.)

o)



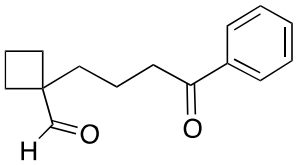
a) H_2NOH, H_2SO_4
b) workup

p)



a) $NaBH_4$, MeOH
b) workup

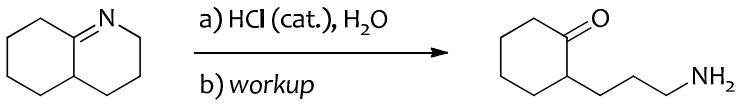
q)



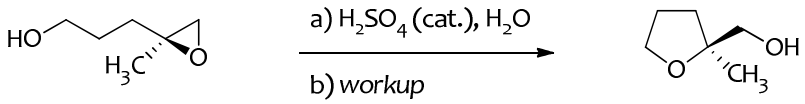
NaOH, H_2O, Δ

then workup

Question 73. ***Mechanism – Easy***. Using arrows to represent electron movement, draw a mechanistic rationale for the following transformation. Include relevant lone pairs of electrons, and intermediates. All non-zero formal charges must be included. DO NOT INCLUDE MINOR CONTRIBUTING RESONANCE STRUCTURES.

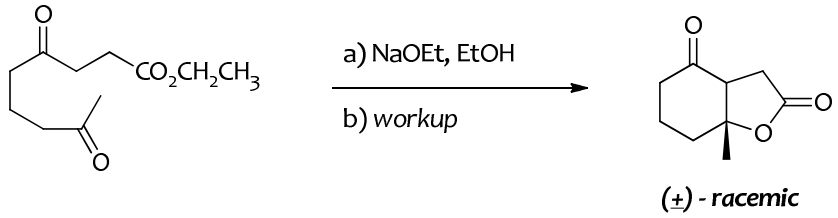


Question 74. ***Mechanism – Medium***. Using arrows to represent electron movement, draw a mechanistic rationale for the following transformation. Include relevant lone pairs of electrons, and intermediates. All non-zero formal charges must be included. DO NOT INCLUDE MINOR CONTRIBUTING RESONANCE STRUCTURES.



(this enantiomer) ***(±) - racemic***

Question 75. ***Mechanism – HARD.*** Using arrows to represent electron movement, draw a mechanistic rationale for the following transformation. Include relevant lone pairs of electrons, and intermediates. All non-zero formal charges must be included. DO NOT INCLUDE MINOR CONTRIBUTING RESONANCE STRUCTURES.



(±) - racemic