National Exams May 2016

BS-12, Organic Chemistry

3 hours duration

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.
2. This is a CLOSED BOOK EXAM.
3. One Aid sheet 81/2 x 11 on both sides is permitted.
   A Casio or Sharp calculator is permitted.
4. TEN (10) questions constitute a complete exam paper.
   The first 10 questions as they appear in the answer book will be marked. Each question is of equal value.

Question 1:

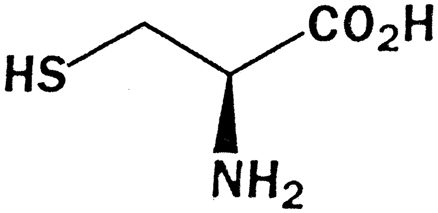
Four compounds have the molecular formula $C_4H_6O_2$ have the IR and ^{13}C NMR spectra given below. What are the structures of the 4 compounds?

a) IR: 1745 cm^{-1}; ^{13}C NMR: 214, 58 and 41 ppm
b) IR: 3300 (broad) cm^{-1}; ^{13}C NMR: 62 and 79 ppm
c) IR: 770 cm^{-1}; ^{13}C NMR: 178, 86, 40, 27 ppm
d) IR: 1720 cm^{-1} and 1650 cm^{-1} (strong); ^{13}C NMR: 165, 131, 133 and 54 ppm

Question 2:

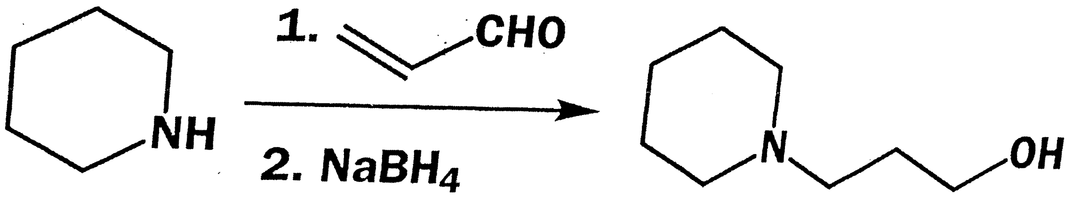
The pK_a values for the amino acid cysteine are 1.8, 8.3 and 10.8.

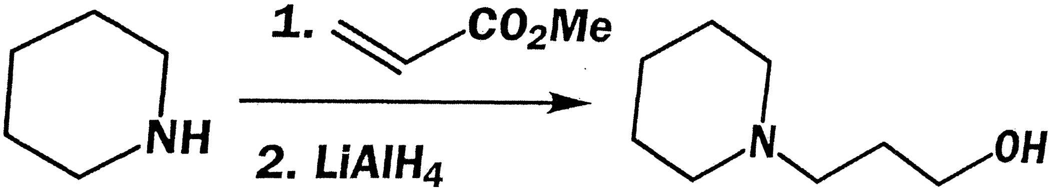
a) Assign these pK_a values to the functional groups in cysteine.
b) Draw the structure of the molecule in aqueous solution at the following pH values: 1, 5, 9 and 12.



Question 3:

Two routes are proposed for the preparation of the following amino alcohol. Which do you think is more likely to succeed and why? Show mechanisms where appropriate.





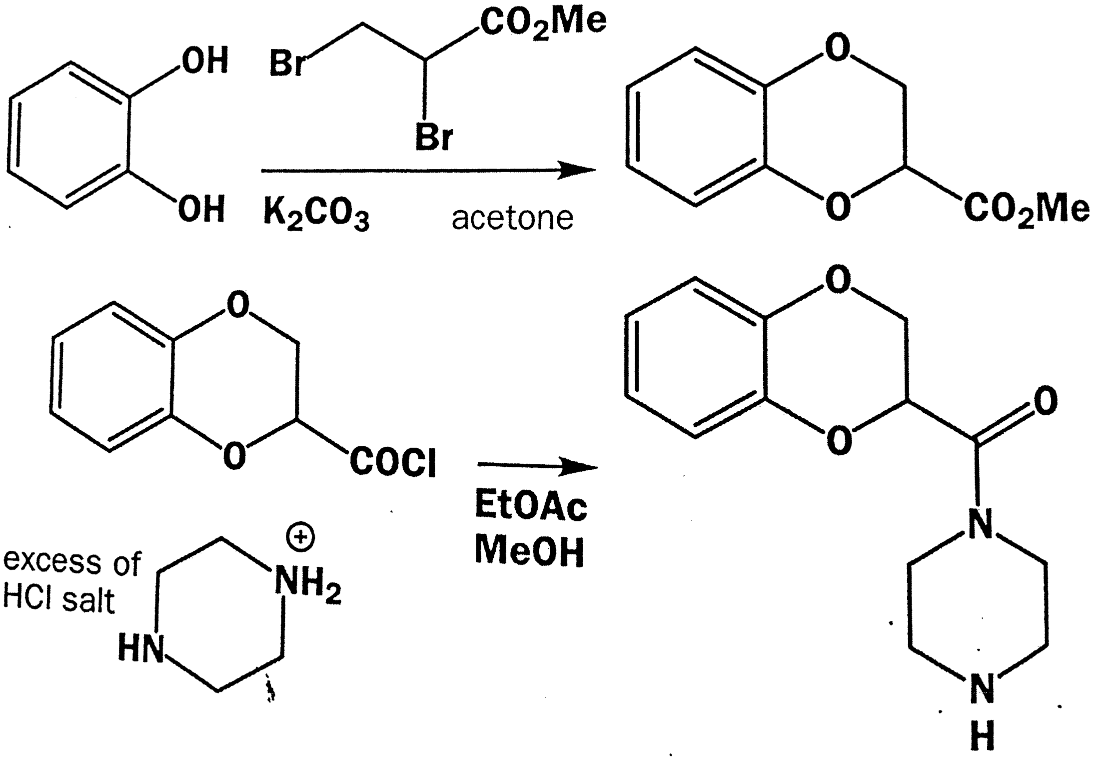
Question 4:

Below is a summary of part of the synthesis of Pfizer's heart drug Doxazosin (Cardura®).

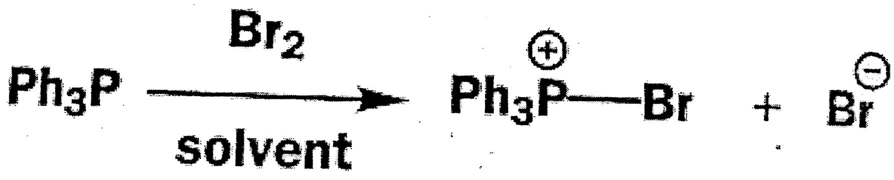
a) Suggest reagents for the conversion of the methyl ester into the acid chloride.

b) In the last step, good yields of the amide are achieved if the amine is added as its hydrochloride salt in excess. Why is this necessary?

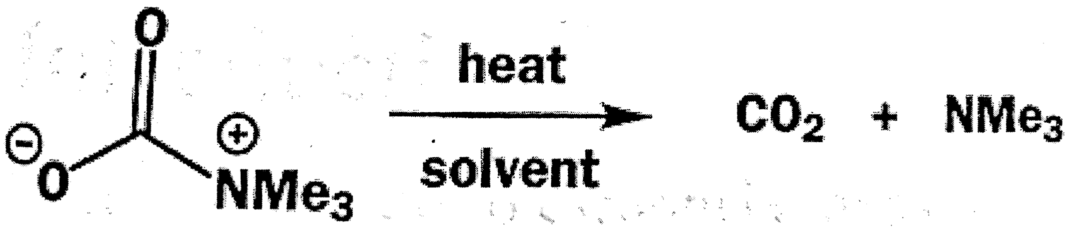
c) Comment on the bases used for the first step of the reaction.

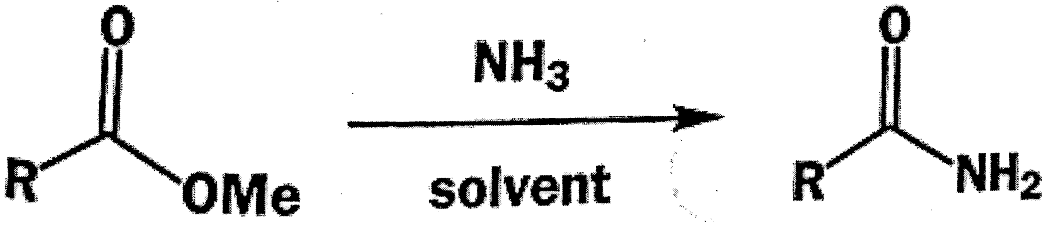


Question 5:
What would be the solvent effects of these three reactions? Would the reactions be accelerated or retarded by a change from a nonpolar to a polar solvent. Justify your responses.



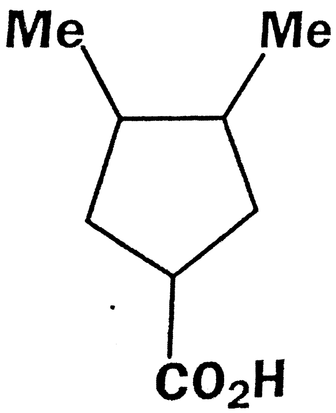
fast

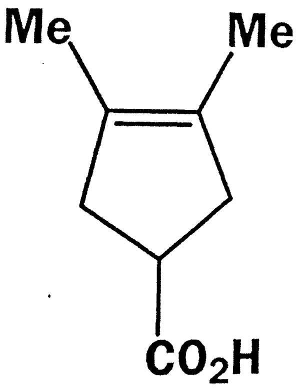




Question 6:
How many diastereoisomers of compound 1 are there? State clearly whether each diasteriomer is chiral or not. If you had made a random mixture of stereoisomers by chemical reaction, by what types of methods might they be separated? Which isomers would be expected from the hydrogenation of compound 2?

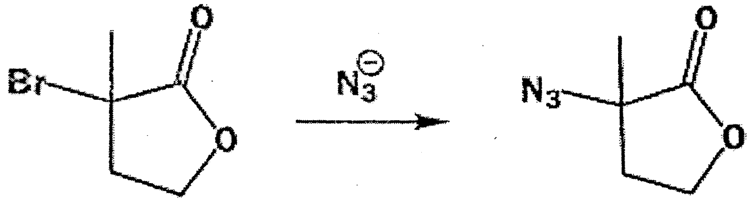
1



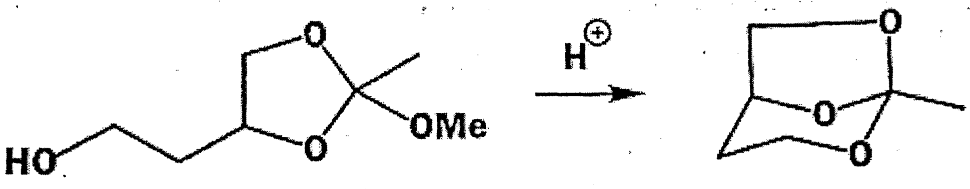


Question 7:
State, with reasons, whether these reactions will be S_N1 or S_N2

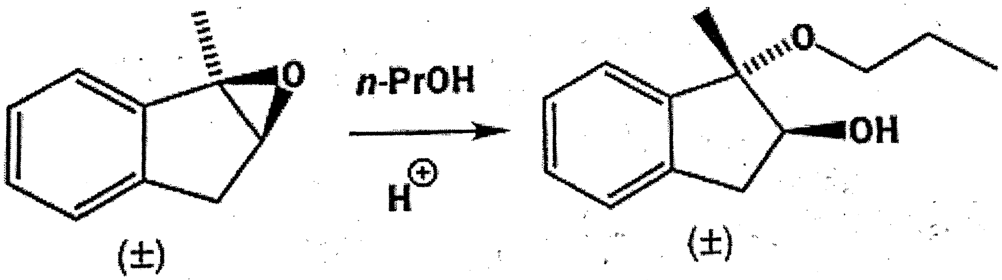
(a)


O
Br
O
$N_3^{\ominus}$
O
N_3
O

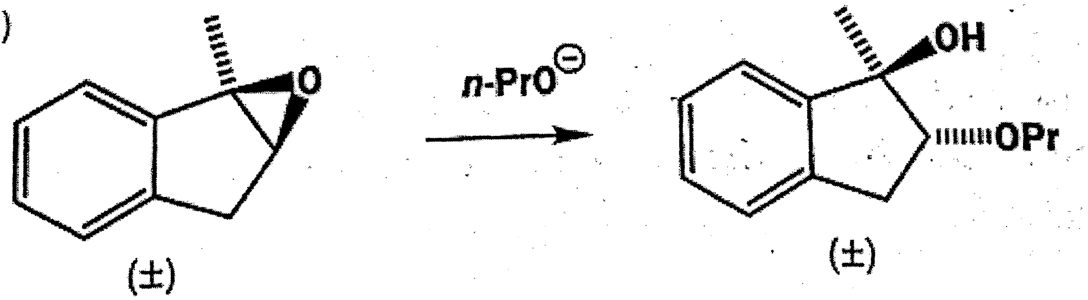
(b)


O
OMe
O
HO
$H^{\oplus}$
O
O
O

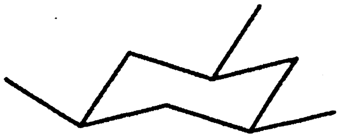
(c)

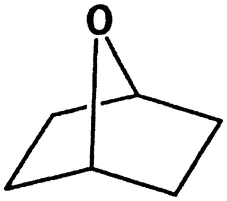

O
(±)
n-PrOH
$H^{\oplus}$
O
OH
(±)

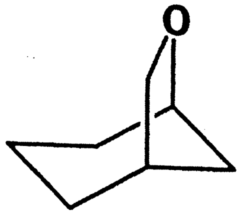
(d)

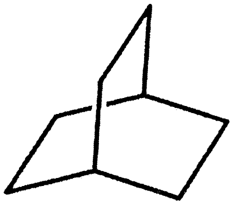

O
(±)
$n\text{-PrO}^{\ominus}$
OH
OPr
(±)

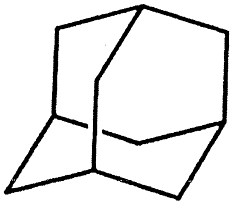
Question 8:
Identify the chair or boat six membered rings in the following structures and say why that particular shape is adopted.

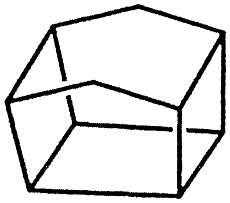




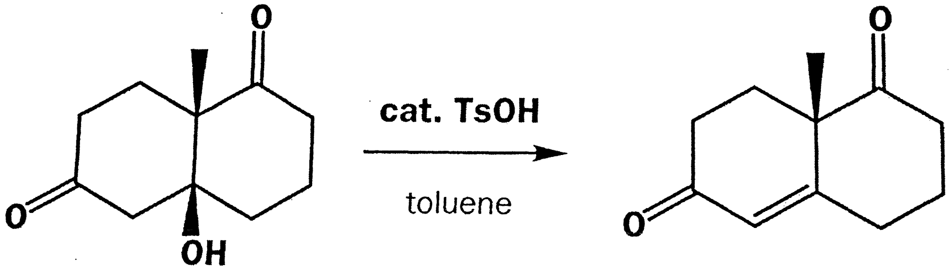


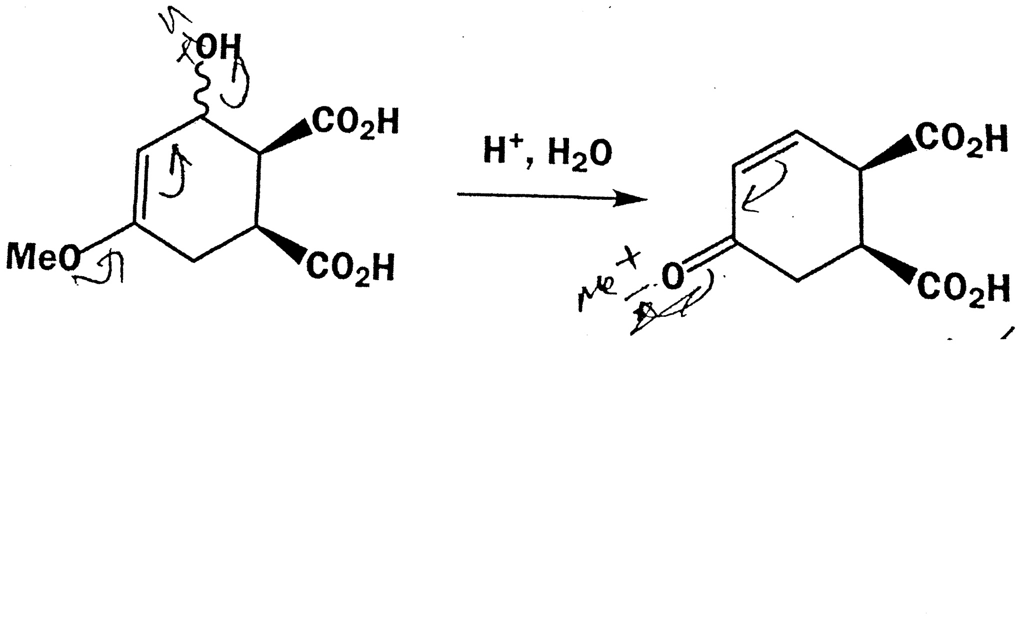




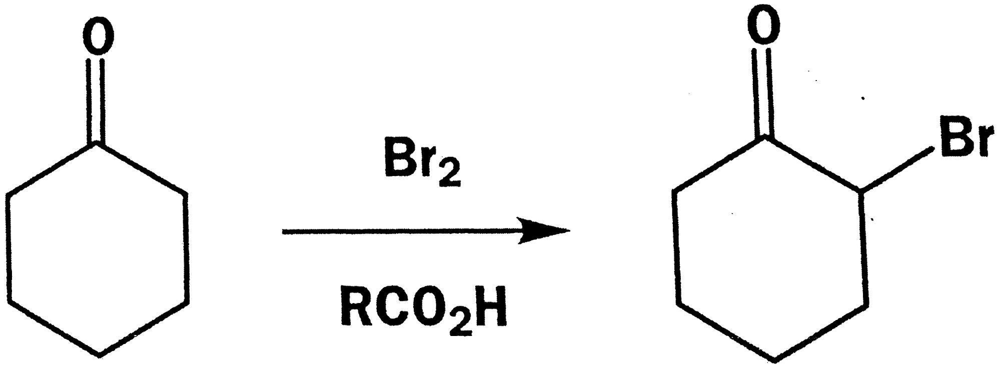


Question 9:
Explain the position of the double bond in the products of these reactions. The starting materials are enantiomerically pure. Are the products enantiomerically pure?

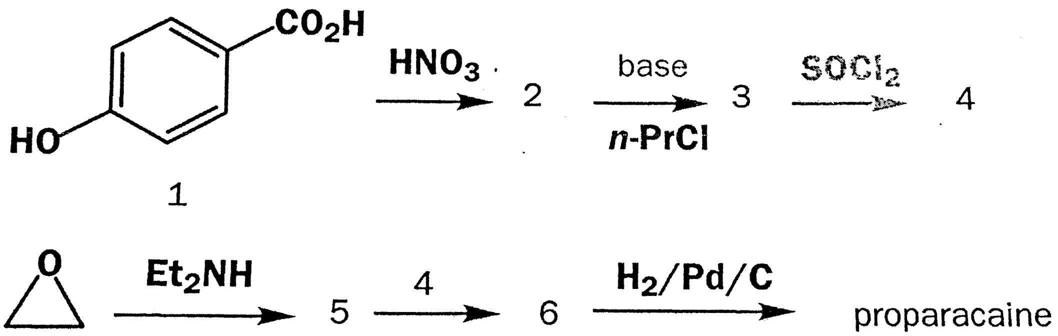


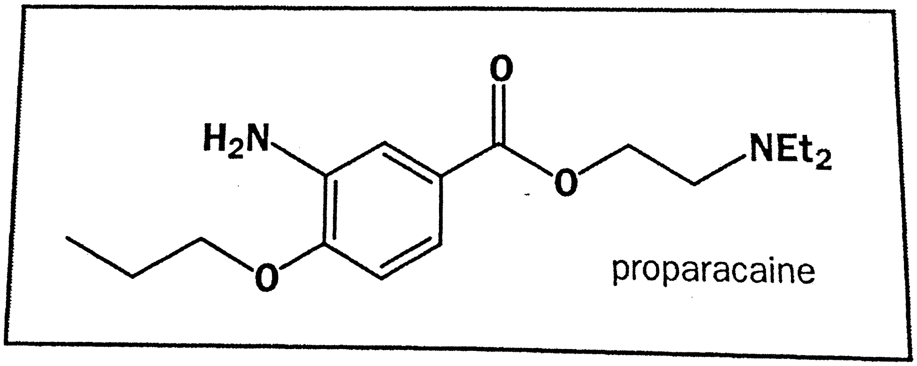


Question 10:
Bromination of ketone can be carried out with molecular bromine in a carboxylic acid solution. Give a mechanism for the reaction. The rate of the reaction is not proportional to the concentration of bromine. Suggest an explanation. Why is bromination of ketones carried out in acidic rather than basic solution?

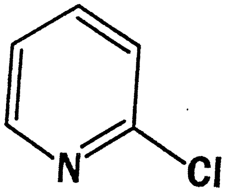


Question 11:
The local anaesthetic proparacaine is made by this sequence of reactions. Deduce a structure for each product and show a mechanism for each step to explain why it gives that particular product.

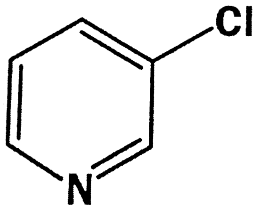




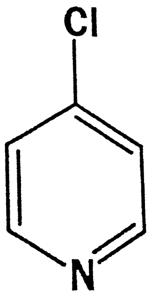
Question 12:
Pyridine is a six electron aromatic system like benzene. Why do 2- and 4-chloropyridines react with nucleophiles but 3-chloropyridine does not?



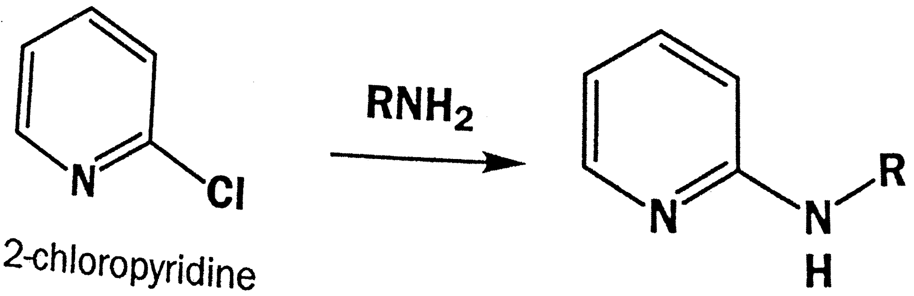
2-chloropyridine



3-chloropyridine



4-chloropyridine



Question 13:
Suggest how these amines might be synthesized.