UNIVERSITY OF SWAZILAND
FINAL EXAMINATION 2006

TITLE OF PAPER	:	Advanced Organic Chemistry
COURSE NUMBER	:	C403
TIME	:	Three Hours
INSTRUCTIONS	:	Answer any **FOUR Questions.** Each Question carries 25 Marks.

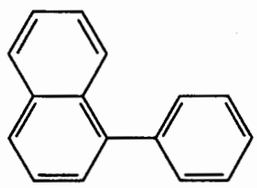
You must not open this paper until the Chief Invigilator so has granted permission to do.

SECTION A

POLYCYCLIC AROMATIC HYDROCARBONS

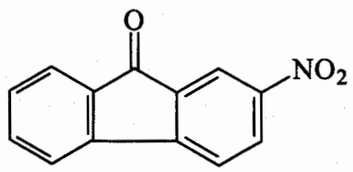
Question 1

(a) Write the sequence of reactions that correctly describe a rational synthesis of each of the following polycyclic aromatic hydrocarbons. In each case show all the reagents, reaction conditions and intermediate products. (16)



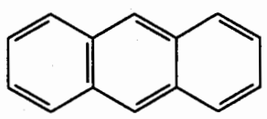
(i)

(4 marks)



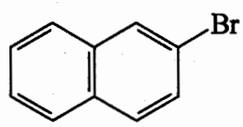
(ii)

(5 marks)



(iii)

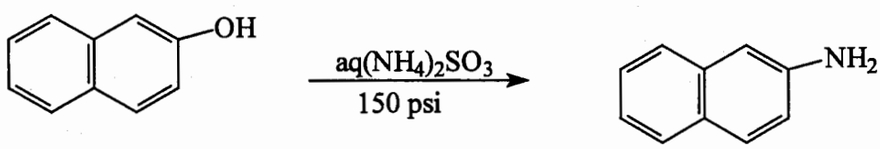
(3 marks)



(iv)

(4 marks)

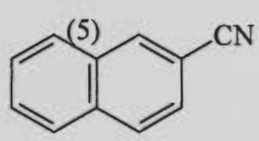
(b) Write out the mechanism for conversion of 2-naphthol to 2-amino naphthalene, showing every intermediate involved in the Bucherer reaction. (4)



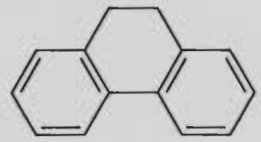
2-naphthol

2-Amino naphthalen

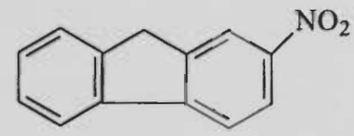
(c) Write the structure of the expected dominant product in the mono-nitration of each of the following compounds.(5 Marks)



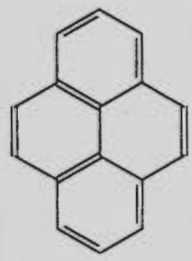
(i)



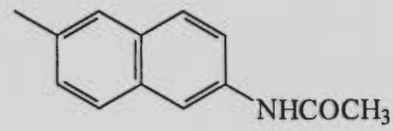
(ii)



(iii)



(iv)



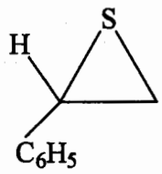
(v)

SECTION B

HETEROCYCLIC COMPOUNDS

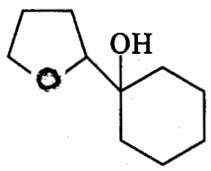
Question 2

(a) Outline a synthesis for each of the following compounds starting from non heterocyclic compounds or unsubstituted heterocyclic system (15)



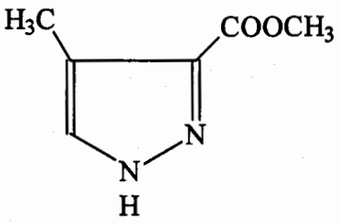
(i)

(3 marks)



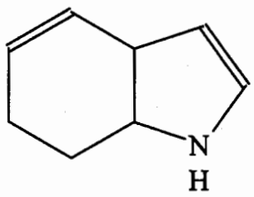
(ii)

(3 marks)



(iii)

(6 marks)

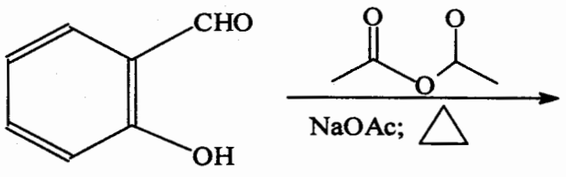


(iv)

(3 marks)

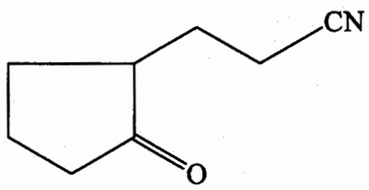
(b) What is the structure of the main product expected from the following reactions. (10)

(i)



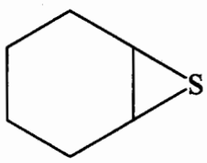
(2)

(ii)



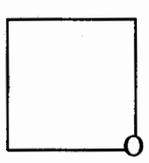
$\xrightarrow{H_2/Pd}$? (2)

(iii)

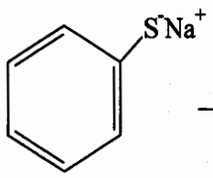


+ HCl ⟶ ? (2)

(iv)



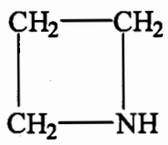
+



$\xrightarrow[100^{o}C;\,6h]{H_2O}$?

(2)

(v)



+ $\xrightarrow[\triangle]{\text{dil HCl}}$? (2)

Question 3

(a) Account for the following facts.

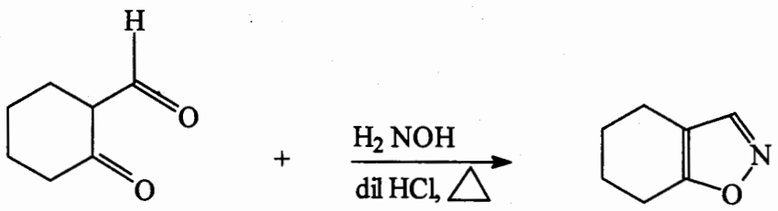
(i) Compared to other azoles, imidazole and pyrazole have relatively high boiling points and are the only solids at room temperature. (2)

(ii) For a compound with sp^2 hybridized nitrogen, imidazole is abnormally basic (pka = 7). (2)

(iii) Electrophilic substitution occurs predominantly at the α-position [C-2] in furan, pyrrole and thiophene. (2)

(iv) The most preferred orientation in electrophilic substitution reactions in indole is C-3. (2)

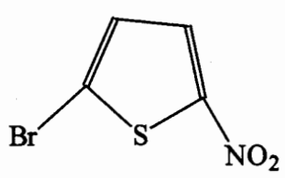
(b) (i) The isoxazole ring system A may be synthesized by the reaction of hydroxylamine with a 1,3-dicarbonyl compound or its equivalent as shown vide infra.



A

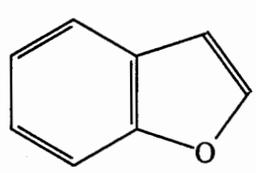
Write the mechanism for this reaction. (3)

(ii) Outline a synthesis for each of the following compounds starting from non-heterocyclic reagents.



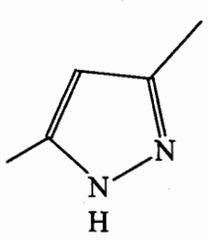
(ii)

(2 marks)



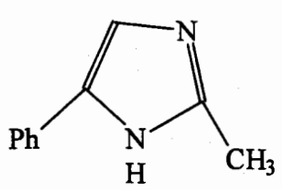
(iii)

(3 marks)



(iv)

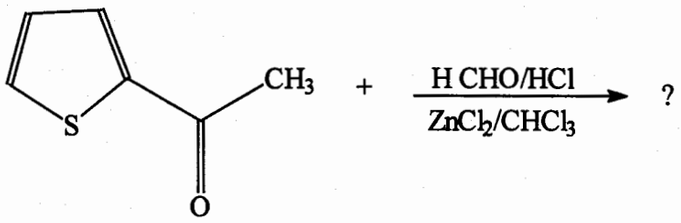
(2 marks)

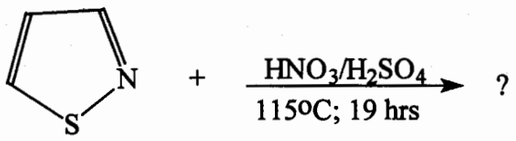


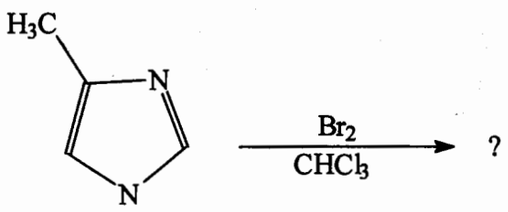
(v)

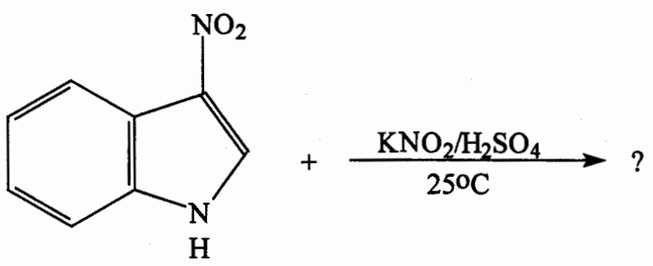
(3 marks)

(c) Write the structure of the main product expected from the following reactions (4)

(i) 

(ii) 

(iii) 

(iv) 

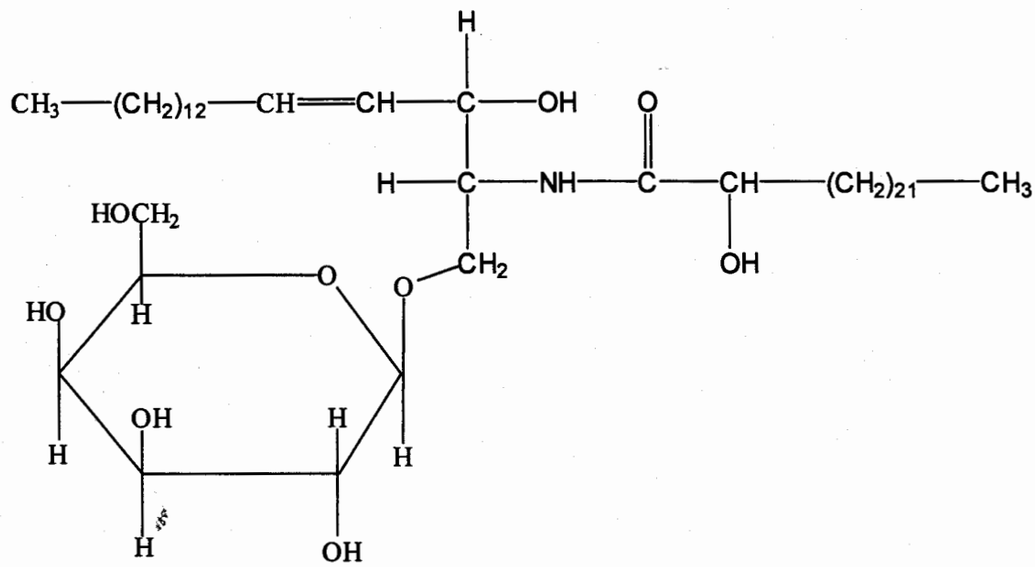
SECTION C

NATURAL PRODUCTS

Question 4

(a) Trimyristin is a while crystalline fat, mp 54 – 55^{O}C, obtainable from nutmeg, and is the principal constituent of nutmeg butter. Hydrolysis of trimyristin with hot aqueous sodium hydroxide gives an excellent yield of tetradecanoicacid (myristic acid) m.p. 52 – 53^{O}C, as the only fatty acid. What is the structure of trimyristin? (6)

(b) Cerebrosides are found in the brain and in myelin sheath of nerve tissue. The structure of the cerebroside phrenosine is as follows



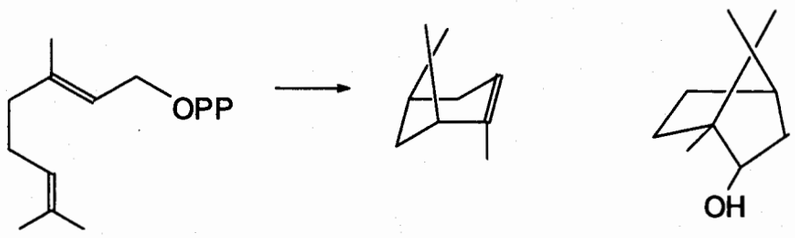
(i) Give the name of the hexose (sugar) formed on hydrolysis of the glycoside bond of phrenosine. (2)

(ii) Is phrenosine an α- or β- glycoside?

(iii) Hydrolysis of phrenosine gives in addition to the hexose in part (i), a fatty acid called cerebronic acid along with a third substance called sphingosine.

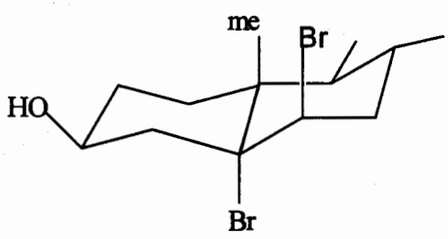
Write the structural formulae for both cerebronic acid and sphingosine. (4)

(c) Outline the biosynthesis of α-pinene and borneol from (E)-geranyl pyrophosphate. (6)

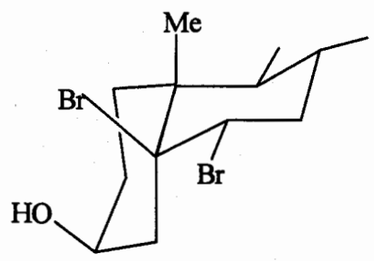


(E)-GPP α-pinene borneol

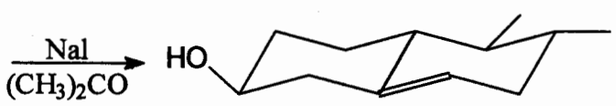
(d) Both compounds II and I are debrominated by sodium iodide in acetone to compound III, but compound I react much faster than compound II. Why? Explain your reasoning clearly. (5)



I



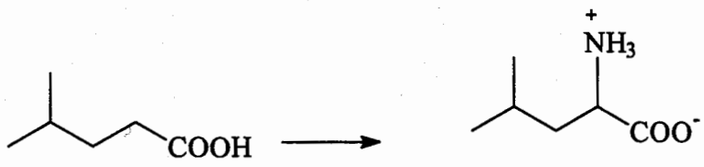
II



III

Question 5 Amino acids, Proteins and Peptides

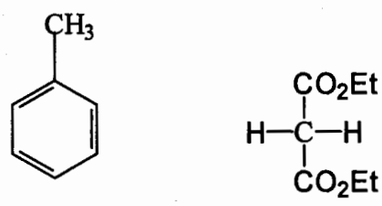
(a) Outline a synthesis of Leucine from 4-methyl pentanoic acid. (4)



4-methylpentanoic acid Leucine

(b) Starting from toluene (1), diethylmalonate (2) and any needed aliphatic and inorganic reagents, outline the main steps in the synthesis of the amino acid phenylalanine (3) by the following methods. (6)

(i) Malonic ester synthesis
(ii) Strecker synthesis



1 2 3

(c) Using diethylacetamidomalonate and any other appropriate reagents, outline a synthesis for histidine. (7)

histidine Diethylacetamidomalonate

(d) Glycine undergoes acid catalysed esterification more slowly than does propionic acid. Explain. (4)

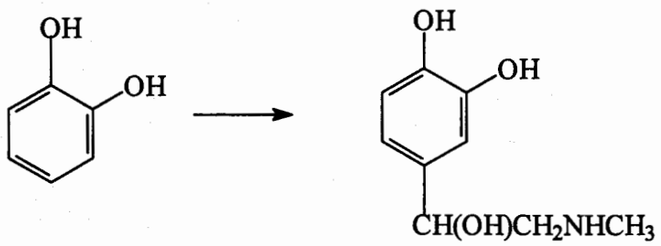
(e) Write the structural formula of the Glycylalanine (Gly-ala) dipeptide showing:

(i) the constitution and
(ii) The stereochemistry at the α-carbon atom. (4)

Question 6

(a) Write a brief note on alkaloids, emphasizing their structural features, methods of classification and isolation, and importance in human health management. (6)

(b) Show in detail, the sequence of steps and reagents required in the synthesis of adrenaline from catechol.

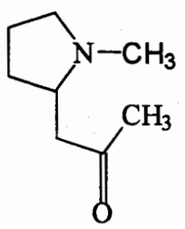


Catechol

Adrenaline

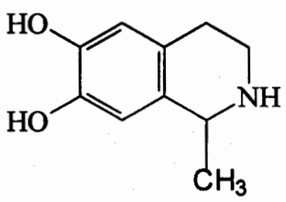
Explain why this synthesis produces a racemic mixture. (6)

(c) Outline a biosynthesis for each of the following alkaloids from the corresponding amino acids.



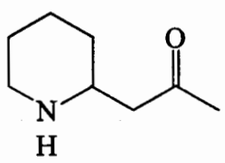
Hygrine

(i) (5 marks)



Pellotine

(ii) (4 marks)



Pelletierine

(iii) (4 marks)