



KIBABII UNIVERSITY

**UNIVERSITY EXAMINATIONS
2020/2021 ACADEMIC YEAR**

**THIRD YEAR SECOND SEMESTER
SPECIAL/SUPPLEMENTARY EXAMINATIONS**

FOR THE DEGREE OF BSC (CHEMISTRY)

COURSE CODE: SCH 324

COURSE TITLE: ALICYCLIC AND HETEROCYCLIC CHEMISTRY


DURATION: 2 HOURS

DATE: 18/1/2022

TIME: 2-4PM

INSTRUCTIONS TO CANDIDATES

- Answer **QUESTION ONE** (Compulsory) and any other two (2) Questions.
- Indicate **answered questions** on the front cover.
- Start every question on a new page and make sure question's number is written on each page.

This paper consists of 5 printed pages. Please Turn Over 

KIBU observes ZERO tolerance to examination cheating

Question one (30 marks)

a) Draw the structure of the following heterocyclic compounds

[3 marks]

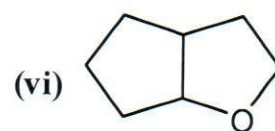
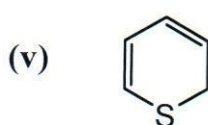
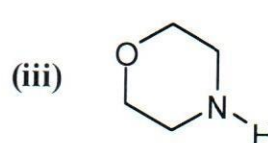
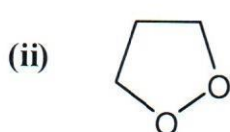
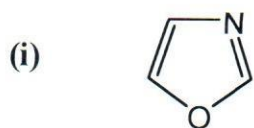
i). 1,3-Diazetidine

ii). 6H-1,2,5-Thiadiazine

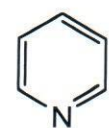
iii). 1,2,6-triethyl-5-methoxy-2,3-dihydroindole

b) Give IUPAC names for the following heterocyclic compounds.

[6 marks]



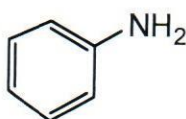
c) Study the following heterocyclic molecules and answer the questions below



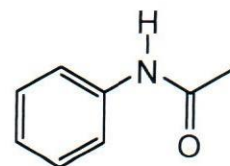
pyridine



pyrrole



aniline



acetanilide

i). Identify the molecules with basic characteristics

[2 marks]

ii). Explain the basic characteristics of the two mentioned compounds in c (i) above

[2 marks]

iii). Explain why the other two non-basic compounds cannot react with acids

[4 marks]

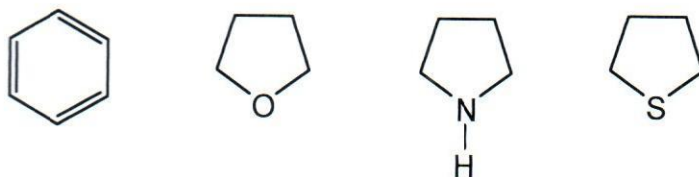
d) Furan undergoes electrophilic substitution reaction much more readily than benzene. However, most of the reactions of this type are of little practical importance. Give three reasons why the reactions are of little importance.

[3 marks]

e) Electrophilic substitution reaction of the pyridine ring preferentially occurs at position three rather than the 2nd and 3rd positions. Illustrate this observation using suitable resonance structures.

[4 marks]

- f) Arrange the following heterocycles in order of decreasing reactivity towards electrophilic substitution reactions. Explain your answer. [3 marks]



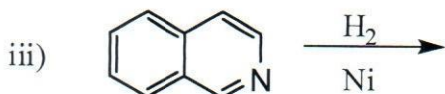
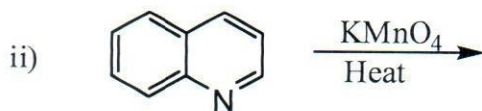
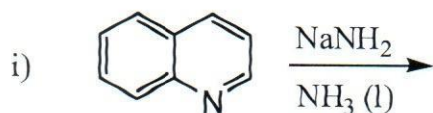
- g) Using suitable examples identify any two methods by which four – membered heterocycles may be synthesized. [3 marks]

Question TWO (20 marks)

- a) Arrange the following heterocyclic compounds in order of increasing basicity; thiophene, pyrrole, pyridine and furan. Explain. [6 marks]
- b) Explain why epoxides are more reactive than open chain ethers [2 marks]
- c) Compare the basicity of pyrrole with that of dimethyl amine. Explain [2 marks]
- d) There is preference for electrophilic substitution at the 2-position of the aromatic five membered heterocyclic compounds as opposed to the 3-position. Illustrate this concept using suitable resonance structures. [5 marks]
- e) Treatment of 1,2-epoxycyclohexane with a dilute aqueous acid (H_3O^+) gives 1,2-cyclohexanediol. Suggest a mechanism for this reaction [5 marks]

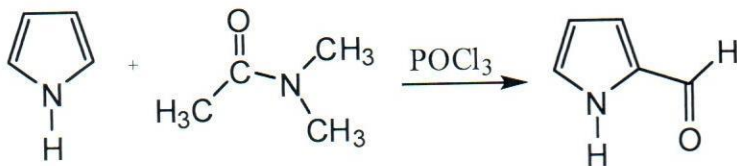
Question THREE (20 marks)

- a) The following reactions are known to give heterocyclic compounds. Predict the products in each case [6 marks]

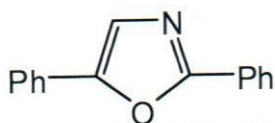
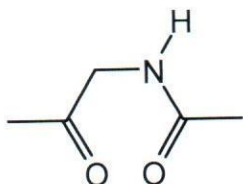


b) Give the mechanism for the reaction shown below

[4 marks]

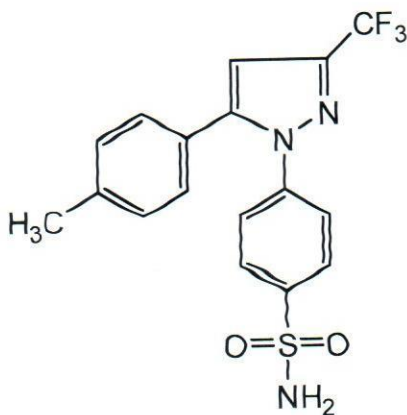


c) Show how the compound shown below can be converted to oxazole shown below through a cyclodehydration process. [4 marks]



2,5-diphenyl-1,3-oxazole

d) Celecoxib is a non-steroidal anti-inflammatory drug (NSAID) used in the treatment of osteoarthritis, rheumatoid arthritis, acute pain, painful menstruation and menstrual symptoms. The structure of Celecoxib is shown below.



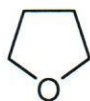
i). Identify the structures of the reactants used in the synthesis of celecoxib [4 marks]

ii). Identify the structure of the other product formed when the reactants used above are used [2 marks]

Question FOUR (20 marks)

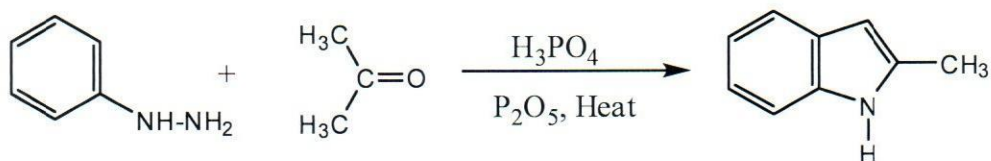
a) Nucleophilic substitution reaction of pyridine ring preferentially occurs at 2-position as opposed to the fourth position yet both C-2 and C-4 are electron deficient. Illustrate this observation using suitable structures. [4 marks]

- b) Describe two methods which may be used to prepare tetrahydrofuran in the laboratory. Write equations for the reactions involved. [6 marks]



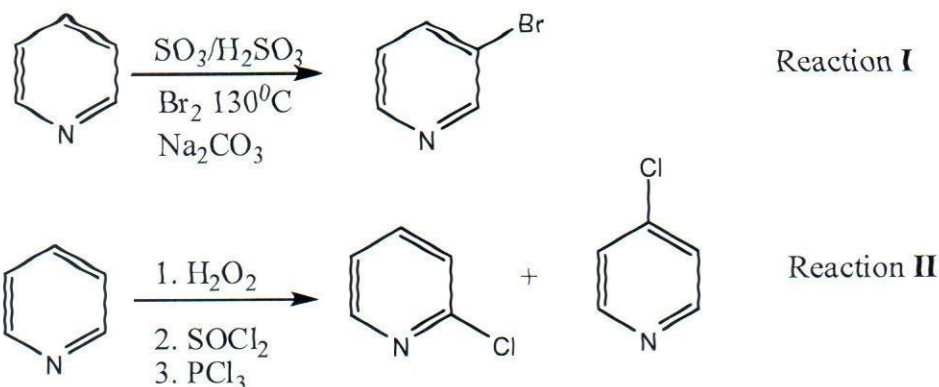
Tetrahydrofuran

- c) Draw resonance structures of quinoline [4 marks]
- d) Fischer indole synthesis involves heating the phenylhydrazone of aldehyde or ketone with a strong acid under non-hydrolytic condition. Suggest a mechanism that may convert reagents **A** and **B** to product **C**. [6 marks]



Question FOUR (20 marks)

- a) Bromopyridine can only be formed when pyridine is reacted with bromine in the presence of oleum at 130°C. Whereas reaction of pyrrole with bromine leads to multiple substitutions without the use of Lewis acid catalyst. Explain the difference in these observations. [8 marks]
- b) Study the two sets of reaction schemes for electrophilic aromatic substitution leading to halogenation of pyridine and answer the questions that follow.



- i). Briefly explain the difference in the choice of reaction conditions and reagents. [6 marks]
- ii). Provide an explanation towards the improved reactivity of pyridine in reaction II. [6 marks]