JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY

SCHOOL OF BIOLOGICAL AND PHYSICAL SCIENCES

UNIVERSITY EXAMINATION FOR THE DEGREE OF BACHELOR OF EDUCATION (SCIENCE)

4TH YEAR 1ST SEMESTER 2013/2014 ACADEMIC YEAR

REGULAR

COURSE CODE: SCH 401

COURSE TITLE: HETEROCYCLIC CHEMISTRY

EXAM VENUE:LAB 4 **STREAM: (BSc. Science)**

DATE: 13/8/14 **EXAM SESSION: 9.00 – 11.00AM**

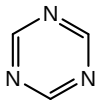
TIME: 2 HOURS

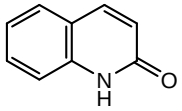
Instructions:

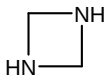
1. **Answer question 1 (compulsory) and any other 2 questions.**
2. **Candidates are advised not to write on the question paper.**
3. **Candidates must hand in their answer booklets to the invigilator while in the examination room.**

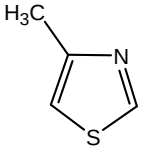
QUESTION 1 [30 marks]

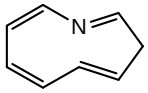
(a) Give IUPAC names for the following heterocyclic compounds. [8 marks]

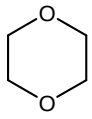
i. 

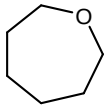
ii. 

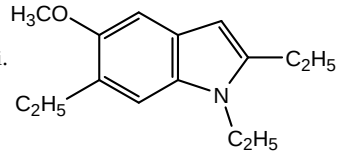
iii. 

iv. 

v. 

vi 

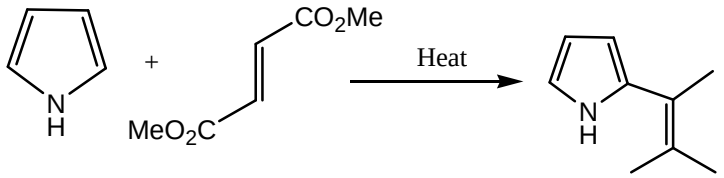
vii. 

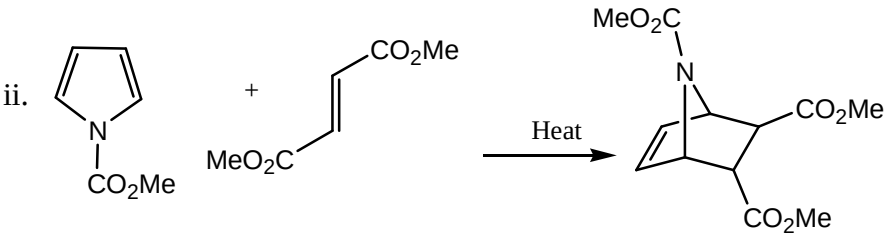
viii. 

(b) Electrophilic substitution reaction of the pyridine ring preferentially occurs at position three rather than the 2nd and 4th positions. Illustrate this observation using suitable resonance structures. [4 marks]

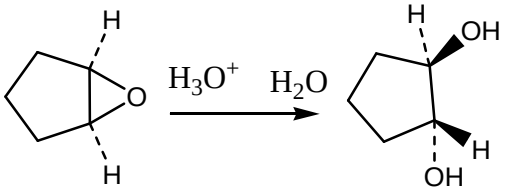
(c) Using suitable examples identify any three methods by which oxiranes may be synthesized. [6 marks]

(d) Explain the observations in the reactions below. [3 marks]

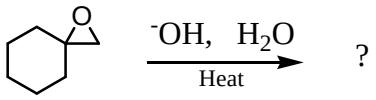
i. 

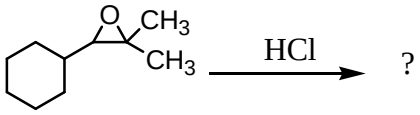
ii. 

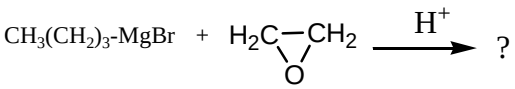
(e) Give the mechanism that leads to the following transformation: [3 marks]

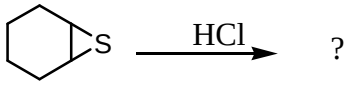


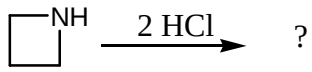
(f) Complete the following reactions by giving structures of the major product(s). [6 marks]

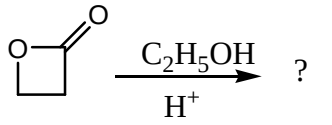
i. 

ii. 

iii. 

iv. 

v. 

vi. 

QUESTION 2 [20 marks]

(a) Oxiranes are usually more reactive than open chain ethers. Explain.

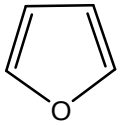
[2 marks]

(b) Using suitable equations, show how tetrahydrofuran may be synthesized from the following:

[5 marks]

i. Furan

ii. Acetylene and formaldehyde



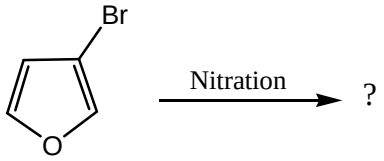
Furan

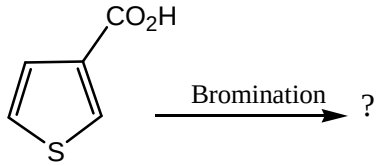
Acetylene

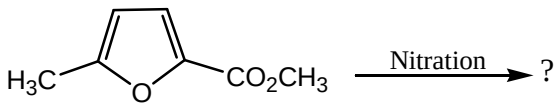
HCHO
Formaldehyde

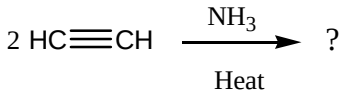
(c) Complete the following reactions by giving structures of the major product(s).

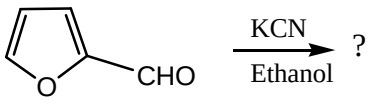
[7 marks]

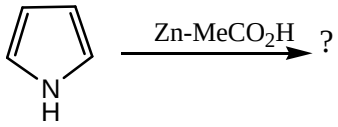
i. 

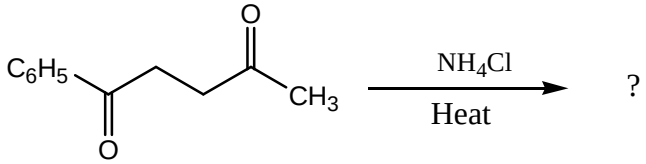
ii. 

iii. 

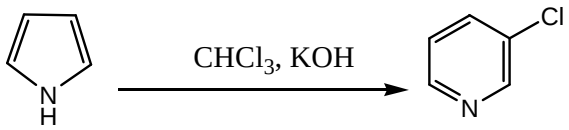
iv. 

v. 

vi 

vii. 

d) Pyrrole undergoes ring expansion to form 3-chloropyridine according to the equation below.



Suggest a mechanism for the reaction. [3 marks]

e) Show how pyridine may be synthesized using pentamethylene diamine, HCl and any other necessary reagent(s). [3 marks]

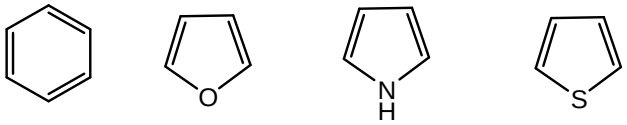
$HN_2(CH_2)_5NH_2$

Pentamethylene diamine

QUESTION 3 [20 marks]

(a) Furan undergoes electrophilic substitution reaction much more readily than benzene. However, most of the reactions of this type are of little practical importance. Explain. [2 marks]

(b) Arrange the following heterocycles in order of decreasing reactivity towards electrophilic substitution reactions. Explain your answer. [4 marks]

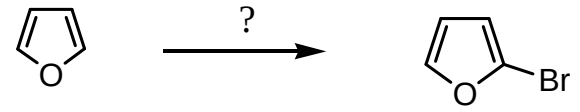


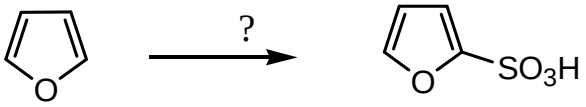
(c) Using suitable equations show how furfural may be obtained from agricultural waste products containing large quantities of pentose polysaccharide. [3 marks]

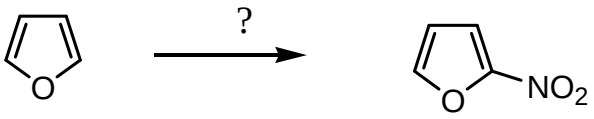
$(C_5H_8O_4)n$

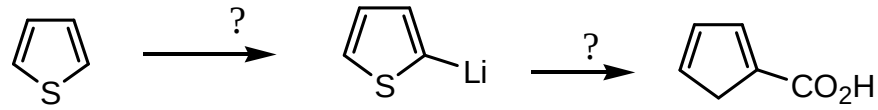
Pentoses polysaccharide

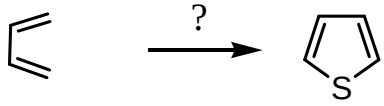
(d) Complete the following reactions by giving the reagents required for the transformations. [6 marks]

i. 

ii. 

iii. 

iv. 

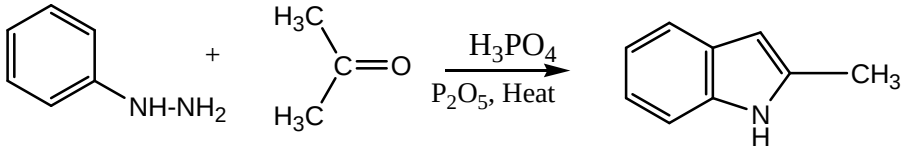
v. 

(e) Draw the structures for the following named compounds. [5 marks]

i. Azetidine
ii. Oxepane
iii. Benzo[c]pyridine
iv. 6H-1,2,4-Thiadiazine
v. 7-Chloro-5-nitroisoquinoline.

QUESTION 4 [20 marks]

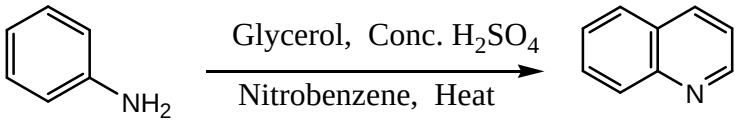
(a) Consider Fischer Indole synthesis reaction below.



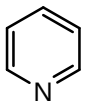
Give the mechanism for the reaction. [4 marks]

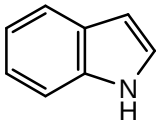
(b) Give the mechanism for the transformation below (Skrup quinoline synthesis).

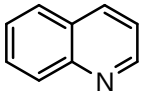
[4 marks]

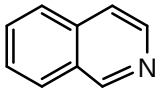


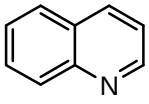
(c) Give products for the following reactions: [6 marks]

i.  $\xrightarrow{NaNH_2}$?

ii.  $\xrightarrow[CCl_4]{\text{N-Bromosuccinimide}}$?

iii.  $\xrightarrow[H_2SO_4]{HNO_3}$?

iv.  $\xrightarrow[NH_{3\ (L)}]{NaNH_2}$?

v.  $\xrightarrow[NH_{3\ (L)}]{NaNH_2}$?

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

(e) Electrophilic substitution of the aromatic 5-membered heterocyclic compounds preferentially occurs at 2-position as opposed to the 3-position. Explain this observation using suitable resonance structures. [3 marks]