(University of Choice)

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

MAIN CAMPUS

THIRD/FOURTH YEAR FIRST SEMESTER EXAMINATIONS
SUPPLIMENTARY EXAMINATION

FOR THE DEGREE
OF
BACHELOR OF SCIENCE (INDUSTRIAL CHEMISTRY)

COURSE CODE: SCH 462

COURSE TITLE: POLYMER AND PETROLEUM CHEMISTRY

DATE: 28TH JULY 2022 **TIME:** 8.00 TO 10. 00 AM

INSTRUCTIONS TO CANDIDATES

1. Answer all questions

TIME: 2 Hours

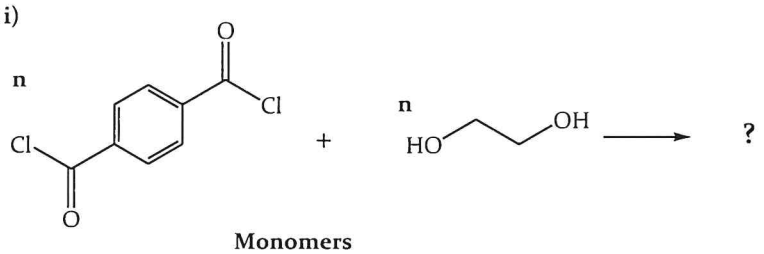
MMUST observes ZERO tolerance to examination cheating

This Paper Consists of 5 Printed Pages. Please Turn Over.

QUESTION 1 (17)

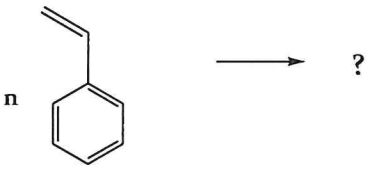
a) Suggest structures of the monomer or monomers used to synthesize each of the polymers given and indicate in each case whether it is a chain-growth polymer or a step-growth polymer **9 Marks**

i)



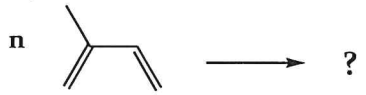
Monomers

ii)



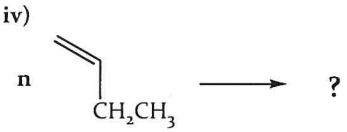
Monomer

iii)



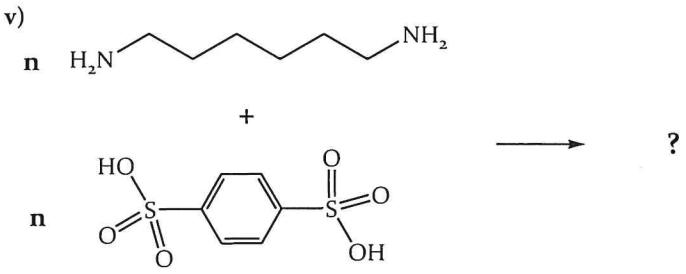
Monomer

iv)



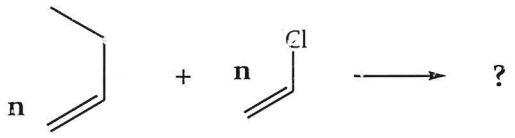
Monomer

v)



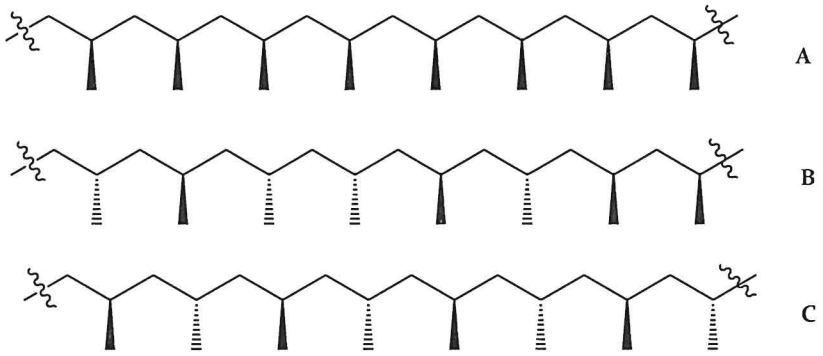
Monomers

vi)



b) Which of the polymers in question 1 a, above is polyester? Explain. **2 Marks**

c) Study the three segments **A**, **B**, and **C** of a well known polymer all produced from the same monomer.

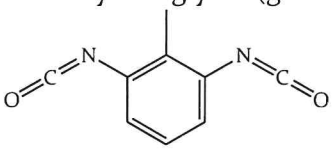


i) Determine the stereochemistry in each case **1.5 Marks**

ii) What are the possible differences in the physical properties of the three polymers? Explain. **4.5 Marks**

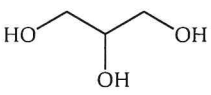
QUESTION 2 (17)

a) A type of polyutherane can be formed the reaction mixture of toluene-2,6-diisocyanate and ethylene glycol (given below).



toluene-2,6-diisocyanate

Ethylene glycol



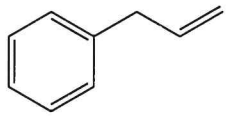
glycerol

i) Show the mechanism leading to the urethane functional group that joins the monomers of given **3 Marks**

ii) Draw the structure of the polyurethane produced above **2 Marks**

iii) If a small amount of glycerol is added to the reaction mixture of during the synthesis of polyurethane foam, a much stiffer foam is obtained. Explain using diagrams. **3 Marks**

a) 1-allylbenzene, structure provided, is said to form a random copolymer rather than a homopolymer, following cationic polymetization.



1-allylbenzene

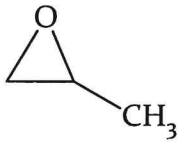
i) What is a copolymer? **1 Mark**

ii) Give two examples of initiators used in cationic polymerization process. **2 Marks**

iii) Using appropriate equations explain why 1-allylbenzene forms a random copolymer instead of homopolymer. **6 Marks**

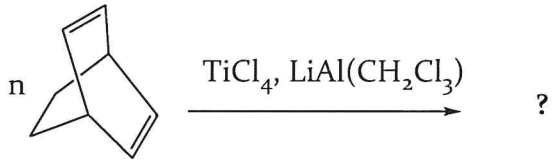
QUESTION 3 (15)

a) Explain why when propylene oxide undergoes anionic polymerization, nucleophilic attack occurs at the less substituted carbon of the epoxide, but when it undergoes cationic polymerization, nucleophilic attack occurs at the more substituted carbon. **4 Marks**

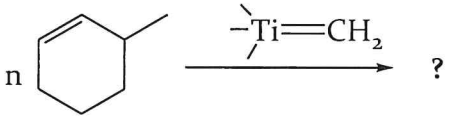


b) Give products for the following polymerization reactions. NB "**n**" is a very large number. **3 Marks**

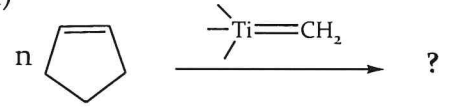
i)



ii)

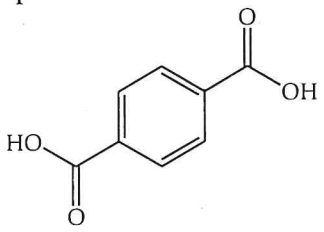


iii)

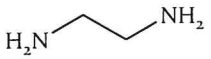


c) Show mechanism for polymerization process in question 3, a, iii) above. **4 Marks**

d) A particularly strong and rigid polyamide whose trade name is Eurigal, used fire fighter jackets, is made from terephthalic acid and ethane-1,2-diamine whose structures are given below.



terephthalic acid



ethane-1,2-diamine

i) Give the structure of this polymer. **2 Marks**

ii) What in your understanding makes the polymer so strong? Show using diagrams where applicable. **2 Marks**

QUESTION 4 (20)

a) What is natural gas and how is it formed? **2 Marks**

b) One of the key uses of natural gas is production of hydrogen gas through a process known as steam reforming. How is this done? (Show using equations) **2 Marks**

c) The nitrogen content in most crude oil is very low and does not exceed 0.1 weight per cent.

i) Give structures that represent both the basic (2) and non-basic (3) categories. **4 Marks**

ii) Why should nitrogen be removed despite being in trace amounts? **1 Mark**

iii) How can these nitrogen containing compounds be separated from crude oil? **1 Mark**

iv) How is this nitrogen removed? Show using equations **2 Marks**

d) Natural gas and crude oil are the basic raw materials for the manufacture of petrochemicals. Complete the following reactions used to manufacture petrochemicals. **3 Marks**

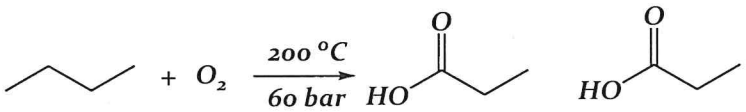
i)

$$2CH_4 + 2NH_3 + 3O_2 \longrightarrow 2HCN + H_2O$$

ii)

$$CH_4 + NH_3 \longrightarrow 2HCN + 3H_2$$

iii)



e) Define or explain using equations the following terms used in petroleum refinery process

(i) Visbreaking **3 Marks**

(ii) Thermal reforming **3 Marks**