NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF SCIENCE AND TECHNOLOGY EDUCATION

DEPARTMENT OF SCIENCE, MATHEMATICS AND TECHNOLOGY EDUCATION

POLYMER AND POLYMERISATION (PST1143)

Main Examination Paper

November, 2024

This Examination Paper consists of 4 pages

Time Allowed: 3 hours

Total Marks: 100

Special Requirements: **Graph paper**

Internal Examiner: Mr L. Sibanda

External Examiner: Dr S Mpofu

INSTRUCTIONS

1. Answer all questions in section **A** and any **three** questions in section **B**

2. Show all your steps clearly in any calculation

MARK ALLOCATION

QUESTION	MARKS
1.	20
2.	20
3.	20
4.	20
5.	20
6.	20
TOTAL	100

SECTION A

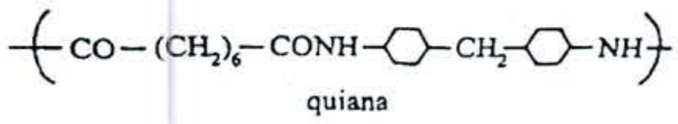
QUESTION ONE

(a). Give **one** repeating units of the following polymers:

i. Polystyrene
ii. Polymethylmethacrylate
iii. Polytetrafluoroethylene
iv. Nylon 6.
v. Nylon 6.6 **[5 MARKS]**

(b) Quiana is polymer that has a silk-like feel while polyacrylonitrile is a fabric which is stronger than wool. The structure of quiana is shown in fig 1.

Fig 1.



quiana

(i) Name the type of linkage that is present in quiana and draw two monomers of quina. **[3 MARKS]**

(ii) Describe the polymerisation that produces quiana. **[1 MARK]**

(ii1) Draw two repeat units of polyacrylonitrile given that the structure of acrylonitrile is CH_2=CH-CN. **[2 MARKS]**

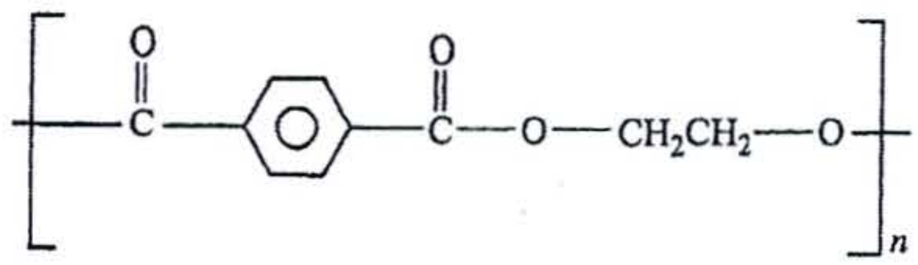
(c) Calculate the average number molecular weight (Mn) and average weight molecular weight (Mw) of a mixture of five molecules each having the following molecular weights:

i. $1,25 \times 10^6$
ii. $1,35 \times 10^6$
iii. $1,50 \times 10^6$
iv. $1,75 \times 10^6$
v. $2,00 \times 10^6$ **[9 MARKS]**

QUESTION TWO

(a) Fig 2.0 shows the formula of synthetic polymer **X**

Fig 2.0



i. Draw the structures of the monomers that react to form X. **[2]**

ii. Name the polymerisation that results in the formation of X. **[1]**

iii. With aid of a chemical equation explain why fabric made of X is weakened when placed in aqueous sodium hydroxide. **[3]**

(b) What is the degree of polymerisation of each of the following?

1. PE with molecular weight 16494 **[2 MARKS]**
2. PVC with molecular weight 23437 **[2 MARKS]**
3. PMA with molecular weight 6033 **[2 MARKS]**
4. PS with molecular weight 6030 **[2 MARKS]**

(c) Given the following pairs:

Compound	Q	e
Acrylonitrile	0,06	1,20
Butadiene	2,39	-1,05

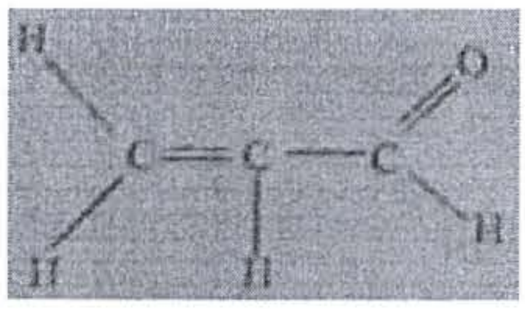
(i) Calculate r_1 , r_2 and state the type of polymer that will be produced. **[6 MARKS]**

SECTION B:

QUESTION THREE

(a) The displayed formula of acrotein is shown in **Fig 3.0**

Fig 3.0



(i) Draw two repeat units of a polymer produced when acrotein polymerises. **[2 MARKS]**

(ii) Explain why acrotein undergoes the type of polymerisation described in **[1MARKS]**

(iii) State the differences between thermoplastic polymer and thermosetting polymer.**[6 MARKS]**

(b) Write chemical equations for the following reactions in benzoyl peroxide initiated polymerisation of ethene.

i. Initiation **[3 MARKS]**
ii. Propagation **[3 MARKS]**
iii. Termination **[3 MARKS]**

(c) Suggest explanations for the following observations:

1. Hexanedioic acid and 1,6-diaminohexane are formed when sulphuric acid is added to a fabric made of nylon-66. **[2 MARKS]**
2. Terylene is a better absorber than nylon-66. **[2 MARKS]**

QUESTION FOUR

(a) Describe the factors affecting dissolution of polymer. **[5 MARKS]**

(b Discuss the synthesis of following monomers:

i. Styrene
ii. Vinyl chloride
iii. Vinyl acetate
iv. Tetrafluoroethene. **[8 MARKS]**

(ii) Describe the art of latex tapping. **[2 MARKS]**

(b) Describe emulsion polymerisation. **[5 MARKS]**

QUESTION 5

(a) Given the following information, calculate the solubility parameter of Poly(vinyl acetate). Density of Poly(vinyl acetate) is 0,932g/cm^3

GROUP	SMALL/HOY FACTOR$(J\text{-}M^3)^{1/2}$
$-CH_3$	303
$-CH_2$	269
>C<	65
-COO-	668
>CH<	176
>C=0	538
-O-	235
-CHO-	599

[10]

(b) How Tencel fibre is produced from wood pulp? **[4 MARKS]**

(c) Draw the structures of :

i. Nomex polymide
ii. Kelvar polymide

State one of each polymide. **[6 MARKS]**

QUESTION 6

(a) Describe the production natural rubber. **[14 MARKS]**

(b) Describe the following processes:

i. Limited swelling

ii. Incomplete swelling

iii. Negative swelling **[6 MARKS]**

END OF QUESTION PAPER