



**NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY**

**DEPARTMENT OF APPLIED CHEMISTRY**

**FIRST SEMESTER EXAMINATIONS – APRIL/MAY 2009**

**POLYMER SCIENCE I – SCH 2107**

**TIME : THREE (3) HOURS**

**INSTRUCTION TO CANDIDATES:**

**ANSWER ALL QUESTIONS IN SECTION A AND ANY THREE QUESTIONS FROM THE SECTION B.**

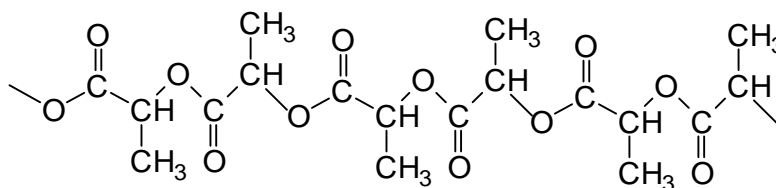
**SECTION A CARRIES 40 MARKS AND IN SECTION B EACH QUESTION CARRIES 20 MARKS. MARKS ARE INDICATED IN BRACKET.**

**THIS QUESTION PAPER CONSISTS OF THREE PRINTED PAGES (ON ONE SIDE ONLY) INCLUDING THE TOP PAGE WITH THE INSTRUCTIONS.**

## **SECTION A:**

1. (a) What is the degree of polymerisation of each of the following?  
(i) PE with molecular weight 16492  
(ii) PVC with molecular weight 23436  
(iii) PMA with molecular weight 6032  
(6 Marks)
- (b) Polyvinyl alcohol can not be synthesised from vinyl alcohol but it can be from polyvinyl acetate. Explain with the aid of chemical equations.  
(4 Marks)
- (c) What do you understand by vulcanisation of rubber?  
(4 Marks)
- (d) Give the repeating unit of the following polymers.  
(i) polyvinyl acetate  
(ii) poly tetrafluoroethylene  
(iii) polystyrene  
(3 Marks)
- (e) What function do the following ingredients fulfill in a SBR polymerisation system?  
(i) emulsifier  
(ii) modifier  
(iii) mercaptan  
(iv) EDTA  
(4 Marks)
- (f) What properties distinguish a thermoplastic polymer from a thermosetting polymer? Give one example of each.  
(5 Marks)
- (g) Draw the structures for the following polymers.  
(i) urea formaldehyde  
(ii) nylon 6,6  
(5 Marks)
- (h) Natural rubber is the cis-isomer of isoprene while gutta percha is the trans isomer. Write the structures of the repeating units of each of these polymer.  
(4 Marks)
- (i) Draw the structure of cotton [ poly(1,4- $\beta$ -anhydroglucopyranose)] fibre.  
(2 Marks)
- (j) What is the name used to describe the negatively charged counterion in cationic chain reaction polymerisation?  
(1 Mark)

- (k) One form of biodegradable polymer, used for 'plastic bags' has the following structure:



- (i) What could be the structure /s of monomer/s for this polymer?  
 (ii) Classify the polymer.

(2 Marks)

### **SECTION B:**

2. (a) Emulsion polymerisation is the preferred technique for elastomer production. With the aid of a diagram, describe how polymerisation takes place. (10 Marks)
- (b) Differentiate between step-growth polymerisation and addition polymerisation. Give one example of each. (6 Marks)
- (c) Write final kinetic equations for step-growth polymerisation  
 (i) presence of a catalyst in the reaction and  
 (ii) absence of a catalyst in the reaction. (4 Marks)
3. (a) On polymerisation, chloroprene forms many different types of structures. Draw as many structures as possible and also indicate the type of polymerisation which has taken place. (15 Marks)
- (b) Synthesise melamine from calcium cyanamide. (no reaction mechanism required). (5 Marks)
4. (a) Write chemical equations for the following reactions in benzoyl peroxide initiated polymerisation of ethane.  
 (i) initiation  
 (ii) propagation  
 (iii) termination by chain transfer and not by combination or by disproportionation. (8 Marks)
- (b) Draw the structures of (i) Nomex polyamide and (ii) Kevlar polyamide. Indicate one use of each polyamide. (4 Marks)
- (c) Given the following pairs:

Compound	Q	E
Styrene	1.00	-0.80
Vinyl acetate	0.03	-0.22

Calculate  $r_1$  and  $r_2$  and suggest the type of polymer will produce.

(5 Marks)

- (d) How Tencel fibre is produced from wood pulp?

(3 Marks)

5. (a) Draw a possible structure of ABS if it is described as “... Graft of styrene and acrylonitrile on butadiene backbone.”  
(5 Marks)
- (b) Taking styrene as an example, write chemical equations for the initiation, propagation and termination steps involved in cationic polymerisation of this monomer.  
(8 Marks)
- (c) Write synthetic steps with reaction conditions for the formation of carbon fibre from acrylonitrile.  
(7 Marks)

**END OF QUESTION PAPER!!!**