NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF APPLIED CHEMISTRY

BACHELOR OF SCIENCE HONOURS DEGREE

END OF SECOND SEMESTER EXAMINATIONS – JUNE 2010

POLYMER SCIENCE II – SCH 2207

TIME: THREE (3) HOURS

INSTRUCTIONS TO STUDENTS

1. **ANSWER *ALL* QUESTIONS FROM SECTION A AND *ANY THREE* FROM SECTION B. SECTION A CARRIES 40 MARKS AND EACH QUESTION IN SECTION B CARRIES 20 MARKS.**

2. **START EACH QUESTION ON A NEW PAGE.**

3. **GRAPH PAPER WILL BE PROVIDED ON REQUEST**.

TOTAL MARKS = 100

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

SECTION A:

1. (a) Explain briefly "The degree of crystallinity". (3 marks)

   (b) Indicate four characteristics of crystallisable polymers. (4 marks)

   (c) Differentiate between good and poor solvent. (2 marks)

   (d) Name five factors that affect the dissolution of polymers. (4 marks)

   (e) Describe the influence of temperature on viscosity. (4 marks)

   (f) What do you understand by:
   (i) long range order
   (ii) short range order
   (4 Marks)

   (g) (i) What is Tg? (3 marks)
   (ii) List the factors affecting Tg. (3 marks)

   (h) What do you understand by:
   (i) limited swelling (2 marks)
   (ii) Incomplete swelling (2 marks)

   (i) What is negative swelling? (2 marks)

   (j) What do you understand by the term 'morphology'? (2 marks)

   (k) How does a polymer solution differ from a micromolecule solution? (2 marks)

   (l) What are the characteristics of a true polymer solution? (3 marks)

SECTION B:

2. (a) In a solution viscosity experiment the efflux time for the pure solvent was 9.0 sec. The efflux time for the solution of different concentrations is given in the data below:

Concentration kg/M^3	10	20	30	40	50
Efflux time in sec.	10	11	13	15	17

Find the viscosity average molecular weight (Mv) of the polymer if:

$K = 1.04 \times 10^{-3}$ dl/kg $a = 1.75$

(15 marks)

(b) Sketch a graph of relaxation modulus vs temperature and indicate all distinguishable stages which are within the amorphous range.

(5 marks)

3. (a) Given the following information, calculate the solubility parameter (δ) of Poly(methylmethacrylate) (PMMA). Density of PMMA is 1.188g/cm^3.

GROUP	SMALL/HOY FACTOR [(J-CM^3)^{½}]
-CH3	303
-CH2	269
>C<	65
-COO-	668
>CH<	176
>C=O	538

(10 marks)

(b) With the aid of a block diagram describe the DTA technique of polymers analysis.

(10 marks)

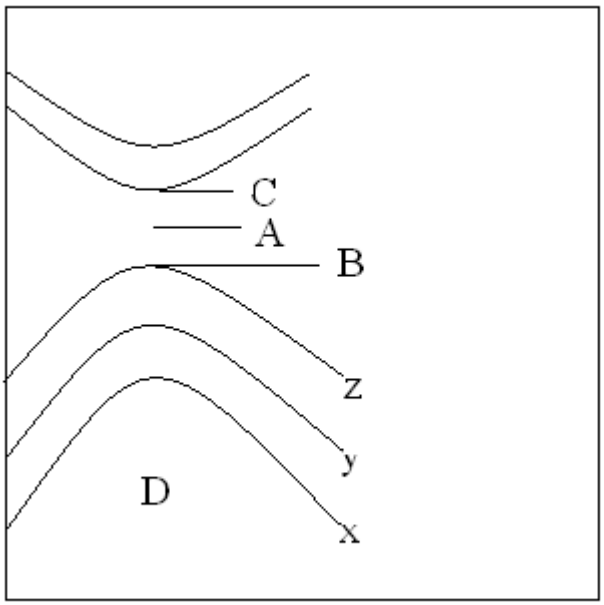
4. (a) Outline the mechanism of polymer crystallisation with special emphasis on:

(i) Nucleation and

(ii) Rate of growth of crystallites. (kinetic equations not required).

(10 marks)

(b) From the labelled diagram below:



(i) Identify B and C (1 mark)
(ii) Comment on position A and D (1 mark)
(iii) Comment on x, y and z (2 mark)
(iv) What does the curve on the diagram indicate? (1 mark)

(c) Write Avrami Equation for kinetics of crystallisation and identify the parameters involved.

(5 Marks)

5. (a) (i) Techniques for fractionating polymers can be preparative and analytical. Name three preparative methods of fractionations.

(ii) With the aid of diagram describe one of the methods of fractionations.

(3+7 marks)

(b) Suppose in a polymer sample there are 100 polymer molecules of molecular mass 103, 200 molecules of molecular mass 104 and 200 molecules of molecular mass 105. Calculate:

(i) Mn
(ii) Mw
(iii) Mw/Mn
(iv) Is the polymer monodispersed or polydispersed?

(10 marks)

**********End of question Paper**********