NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF APPLIED CHEMISTRY

END OF FIRST SEMESTER EXAMINATIONS – JANUARY 2011

POLYMER SCIENCE I – SCH 2107

TIME = THREE (3) HOURS

INSTRUCTIONS TO CANDIDATES:

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. MARKS ARE ALLOCATED AS INDICATED IN BRACKET.

2. START EACH QUESTION ON A NEW PAGE. (NOT EACH PART OF A QUESTION).

3. SHOW MECHANISM, CHEMICAL STEPS OR SYNTHESIS BY MEANS OF CURVED ARROWS.

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)   Illustrate the following **tacticity** structures using poly(vinylchloride) as an example:
           (i)   isotactic
           (ii)   syndiotactic
           (iii)   atactic
           (iv)   which of these structures has a greater percentage of crystallinity.

                                                      (4 marks)

    (b)   Suggest **four** ways by which free radical initiation reaction can be carried out.

                                                      (4 marks)

    (c)   Draw the repeating unit of each of the following polymers:
           (i)   polyvinyl acetate,
           (ii)   poly(methyl methacrylate),

                                                          (2 marks)

    (d)   How can Ziegler/Natta catalyst BE synthesised? Write chemical equation for it.

                                                      (5 marks)

    (e)   (i)   Define the concept *'degree of polymerisation'*.

                                                      (2 marks)

           (ii)   If the average weight of a given PMA sample is 6032 g/mol, what is the degree of polymerisation of the sample?   (4 marks)

    (f)   Give **five** factors that characterise step-growth polymerisation.

                                                         (5 marks)

    (g)   Draw a possible structure of ABS if it is described as……'a graft of styrene and acrylonitrile on a butadiene backbone.'

                                                      (4marks)

    (h)   Draw structures of Nomex and Kevlar polyamide. Indicate one use of each.

                                                      (4 marks)

    (i)   What properties distinguish a thermoplastic polymer from a thermosetting polymer?

                                                      (4 marks)

    (j)   What is the difference between polymer and a macromolecule?

                                                         (2 marks)

SECTION B:

2.   (a) Natural rubber is the cis-isomer of isoprene while gutta percha is the trans isomer. Write the repeating units of each of these polymers.

(4 marks)

   (b) Describe the art of latex tapping.

(8 marks)

   (c) What do you understand by vulcanisation of rubber?   (4 marks)

   (d) Explain with the aid of chemical equations why polyvinyl alcohol can not be synthesised from vinyl alcohol but it can be synthesised from polyvinyl acetate.

(4 marks)

3.   (a) Taking styrene as an example, write chemical equations for the initiation, propagation and termination steps involved in cationic polymerisation of this monomer.

(10 marks)

   (b) 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 it will produce.

(6 marks)

   (c) What do you understand by mercerisation?   (4 marks)

4.   (a) Describe how Tencel fibre is produced from wood pulp.   (3 marks)

   (b) Spandex is synthesised from toluene diisocyanate and adipate ester of 1,2-propanediol. Draw the structure of the spandex indicating urethane and ester linkage .

(6 marks)

   (c) Write synthetic steps with reaction conditions for the formation of carbon fibre from acrylonitrile.

(7 marks)

5.   (a) Write chemical equations for the following reactions in benzoyl peroxide initiated polymerisation of ethene.
      (i) initiation
      (ii) propagation
      (iii) termination.

(10 marks)

(b) Draw the labelled schematic diagram for emulsion polymerisation. State advantages and disadvantages of the polymerisation.

(6 marks)

(c) Draw the structure of Buna-s rubber.

(2 marks)

(j) What is the name used to describe the negatively charged counterion in cationic chain reaction polymerisation? Draw the structure of the ion.

(2 marks)

END OF QUESTION PAPER!!!!