UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session 2007/2008

October/November 2007

EBP 200/3 - Polymeric Materials
[Bahan Polimer]

Duration : 3 hours
[Masa : 3 jam]

Please ensure that this examination paper contains EIGHT printed pages before you begin the examination.
[Sila pastikan bahawa kertas peperiksaan ini mengandungi LAPAN muka surat yang bercetak sebelum anda memulakan peperiksaan ini.]

This paper contains SEVEN questions.
[Kertas soalan ini mengandungi TUJUH soalan.]

Instructions: Answer any **FIVE** questions. If a candidate answers more than five questions, only the first five answers will be examined and awarded marks.
*[**Arahan:** Jawab **LIMA** soalan. Jika calon menjawab lebih daripada lima soalan hanya lima soalan pertama mengikut susunan dalam skrip jawapan akan diberi markah.]*

Answer to any question must start on a new page.
[Mulakan jawapan anda untuk setiap soalan pada muka surat yang baru.]

You may answer a question either in Bahasa Malaysia or in English.
[Anda dibenarkan menjawab soalan sama ada dalam Bahasa Malaysia atau Bahasa Inggeris.]

1. [a] The number average molecular weight of polypropylene is 1,000,000 g/mol. Calculate the number average degree of polymerization.

Purata berat molekul nombor suatu polipropilena ialah 1,000,000 g/mol. Kirakan purata nombor darjah pempolimeran.

(40 marks/*markah*)

[b] A polydisperse sample of polystyrene is prepared by mixing three mono disperse samples in the following proportions:

(i) 1g 10,000 molecular weight

(ii) 2g 50,000 molecular weight

(iii) 2g 100,000 molecular weight

Using the information, calculate the number average molecular weight, weight average molecular weight, and PDI of the mixture.

Suatu sampel penyerakan rawak polistierena dihasilkan dengan mencampurkan 3 sampel serakan sekata dengan pecahan seperti berikut:

(i) 1g 10,000 berat molekul

(ii) 2g 50,000 berat molekul

(iii) 2g 100,000 berat molekul

Menggunakan maklumat tersebut, kirakan berat purata molekul nombor, berat purata molekul berat dan PDI campuran tersebut.

(60 marks/*markah*)

2. [a] What is the difference between configuration and conformation in relation to polymer chains?

Apakah perbezaan di antara konfigurasi dan konformasi berhubung dengan rantai polimer?

(20 marks/*markah*)

[b] Sketch portions of a linear polystyrene molecule that are:

(i) Syndiotactic

(ii) Atactic

(iii) Isotactic

Lakarkan gambarajah polistirena linear yang bertaktisiti seperti berikut:

(i) Sindiotaktik

(ii) Ataktik

(iii) Isotaktik

(30 marks/*markah*)

[c] For a linear polymer molecule, the total chain length, L, depends on the bond length between the chain atoms, d, the total number of bonds in the molecule, N, and the angle between adjacent backbone chain atoms, θ, as follows:

$$L = Nd\sin\left(\frac{\theta}{2}\right)$$

Furthermore the average end to end distance for a series of polymer molecules, r, is equal to:

$$r = d\sqrt{N}$$

A linear polytetrafluoroethylene has a number average molecular weight of 500,000 g/mol; compute averages values of L and r for this material.

Untuk molekul polimer linear, jumlah panjang rantai, L, bergantung kepada panjang ikatan antara rantai atom, d, jumlah bilangan ikatan di dalam molekul, N, dan sudut antara rantai tulang belakang yang bersebelahan, θ, seperti berikut:

$$L = Nd\sin\left(\frac{\theta}{2}\right)$$

Purata jarak hujung ke hujung untuk suatu siri rantai polimer, r, adalah bersamaan dengan:

$$r = d\sqrt{N}$$

Politetrafloroetilena mempunyai purata berat molekul nombor 500,000 g/mol; kirakan nilai purata L dan r untuk bahan ini.

(50 marks/*markah*)

3. [a] Define and briefly explain the properties mentioned below for a polymeric material

(i) Tensile strength

(ii) Compressional strength

(iii) Elongation

(iv) Modulus

(v) Toughness

Berikan definisi dan jelaskan secara ringkas sifat-sifat yang dinyatakan di bawah untuk suatu bahan polimer.

(i) Kekuatan tensil

(ii) Kekuatan mampatan

(iii) Pemanjangan

(iv) Modulus

(v) Keliatan

(50 marks/*markah*)

[b] The tensile strength and number average molecular weight for two polymethyl methacrylate materials are as follows:

Kekuatan tensil dan purata berat molekul nombor untuk 2 bahan polimetil metakrilat adalah seperti berikut:

Tensile strength (MPa) *Kekuatan Tensil (MPa)*	Number Average Molecular Weight (g/mol) *Purata Berat Molekul Nombor (g/mol)*
107	40,000
170	60,000

Estimate the tensile strength at a number average molecular weight of 30,000 g/mol

Anggarkan kekuatan tensil pada purata berat molekul nombor 30,000g/mol

(50 marks/*markah*)

4. [a] Briefly describe the three ways (below) in which polymers will act differently from monomers.

(i) Chain entanglement.

(ii) Summation of intermolecular forces.

Secara ringkas perihalkan tiga cara (di bawah) bagaimana polimer akan bertindak berlainan dengan monomer;

(i) Kekusutan rantai.

(ii) Jumlah daya antara molekul.

(50 marks/*markah*)

[b] There are a few types of failures in polymeric materials. Based on your understanding, discuss two mechanical failures in polymers and how these failures can be described as brittle, ductile or crazing deformation.

Terdapat pelbagai jenis kegagalan bagi bahan polimer. Berdasarkan kefahaman anda, bincangkan dua kegagalan mekanikal dan bagaimanakah kegagalan ini boleh menerangkan kelakuan kegagalan rapuh, mulur atau retak halus?

(50 marks/*markah*)

5. [a] Compare thermoplastics, thermosets, elastomers and thermoplastic elastomers in terms of their deformation properties in the solid state.

Bandingkan termoplastik, termoset, elastomer dan termoplastik elastomer dari segi sifat-sifat deformasi dalam keadaan pepejal.

(40 marks/*markah*)

[b] Discuss the role of various types of additives in polymer compounding.

Bincangkan fungsi pelbagai jenis bahan tambah dalam penyebatian polimer.

(30 marks/*markah*)

[c] Most polymers melt exhibit pseudoplastic characteristics under shear conditions. How these differ from those of Newtonian fluids

Kebanyakkan polimer lebur mempamerkan ciri-ciri pseudoplastik pada keadaan ricih. Bagaimana ianya berbeza daripada cecair Newtonian.

(30 marks/*markah*)

6. [a] There are a number of ways in which polymeric materials may degrade over a period of time. Explain two of any of polymer degradation below:

(i) Oxidative degradation

(ii) Radiation degradation

(iii) Mechanical degradation

(iv) Microbiological degradation

Terdapat pelbagai cara bagaimana suatu bahan polimer boleh terdegradasi dalam jangkamasa penggunaannya. Jelaskan dua daripada degradasi polimer di bawah:

(i) Degradasi oksidatif

(ii) Degradasi radiasi

(iii) Degradasi mekanikal

(iv) Degradasi mikrobiologi

(30 marks/*markah*)

[b] Creep phenomenon is a common behaviour for visco-elastic polymer. The creep data can be presented as isochronous curves, isometric curve and creep modulus. Using the data from creep curves in tension from Figure 1, sketch the curves for representation of creep data and how it can be used to predict life time of polymers.

Fenomena krip/rayapan merupakan kelakuan umum bagi bahan polimer yang bersifat likat-kenyal. Data rayapan boleh ditunjukkan semula dengan lengkungan isokronos, lengkungan isometrik dan lengkungan modulus rayapan. Menggunakan data daripada lengkungan rayapan dalam tegangan berdasarkan Rajah 1, lakarkan lengkungan untuk persembahan semula data rayapan dan bagaimanakah ia boleh digunakan untuk menentukan jangka hayat sesuatu bahan polimer.

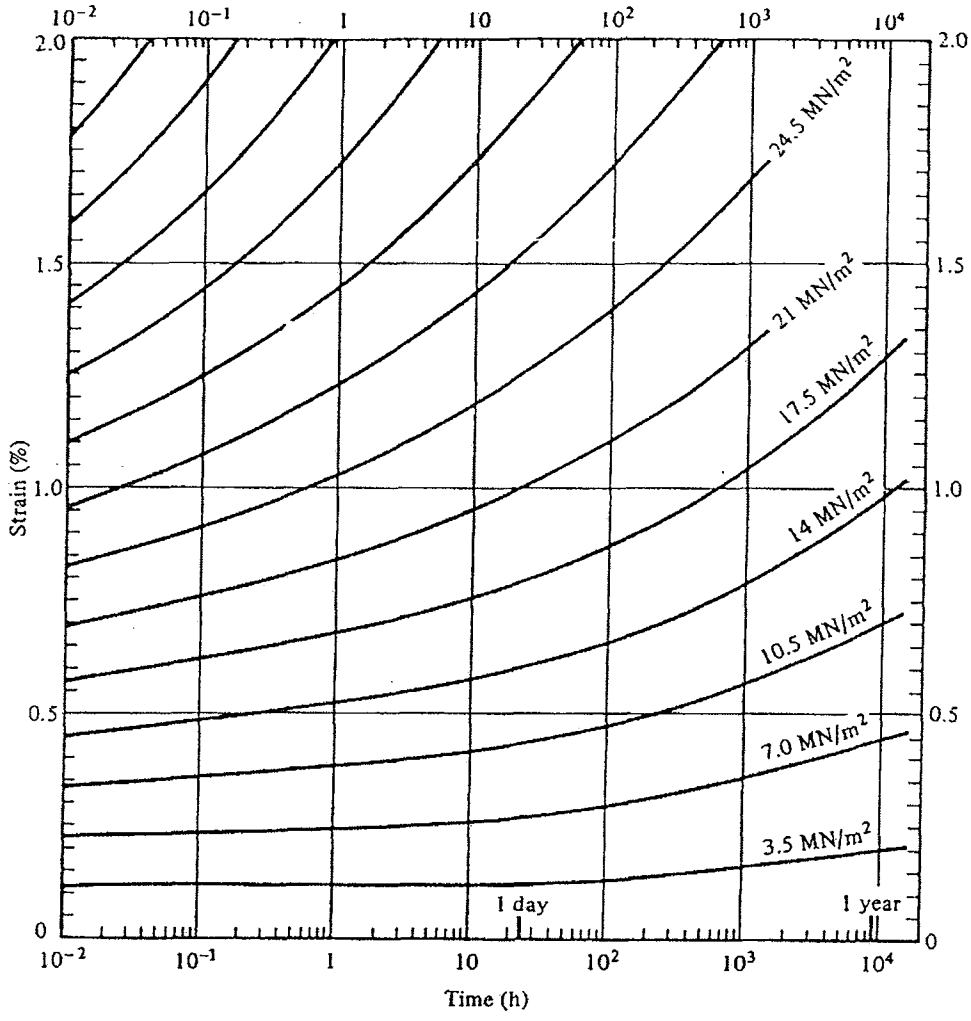

Figure 1 - Creep curves in tension: 20°C, 65% relative humidity, cast acrylic sheet

Rajah 1 - Lengkung rayapan dalam tegangan: 20°C, 65% kelembapan relatif kepingan akrilik tuangan

(70 marks/*markah*)

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7. [a] Polymer products can be produced using variety of polymer processing methods. Discuss the processing methods below:

(i) Blow moulding

(ii) Screw extrusion

(iii) Calendaring

Polimer boleh dihasilkan melalui pelbagai kaedah pemprosesan. Bincangkan kaedah-kaedah pemprosesan di bawah:

(i) Pengacuanan tiupan

(ii) Pengekstrudan skru

(iii) Perkalendaran

(60 marks/*markah*)

[b] A continuous and aligned fibre reinforced composite consists of 30% of aramic fibres having a modulus of elasticity of 131 GPa and 70% of a polycarbonate matric that displays a modulus of 2.4 GPa. With information given, calculate:

(i) Longitudinal modulus of composite

(ii) Transverse modulus of composite

Suatu polimer komposit bergentian kaca secara berterusan dan tersusun mengandungi 30% gentian aramik dengan modulus keelastikan 131 GPa dan 70% matrik polikarbonat yang mempamerkan modulus 2.4 GPa. Dengan maklumat yang diberi, kirakan

(i) Modulus membujur komposit

(ii) Modulus melintang komposit

(40 marks/*markah*)

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