
UNIVERSITI SAINS MALAYSIA

First Semester Examination
2014/2015 Academic Session

December 2014 / January 2015

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 consists of SEVEN questions. ONE question in PART A, THREE questions in PART B and THREE questions in PART C.

[Kertas soalan ini mengandungi TUJUH soalan. SATU soalan di BAHAGIAN A, TIGA soalan di BAHAGIAN B dan TIGA soalan di BAHAGIAN C.]

Instruction: Answer FIVE questions. Answer ALL questions from PART A, TWO questions from PART B and TWO questions from PART C. If a candidate answers more than five questions only the first five questions answered in the answer script would be examined.

[Arahan: Jawab LIMA soalan. Jawab SEMUA soalan dari BAHAGIAN A, DUA soalan dari BAHAGIAN B dan DUA soalan dari BAHAGIAN C. Jika calon menjawab lebih daripada lima soalan hanya lima soalan pertama mengikut susunan dalam skrip jawapan akan diberi markah.]

The answers to all questions must start on a new page.

[Mulakan jawapan anda untuk semua 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.]

In the event of any discrepancies in the examination questions, the English version shall be used.

[Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah digunapakai.]

PART A / BAHAGIAN A

1. [a] Explain the following observations:
- (i) Polyvinyl chloride (PVC) requires incorporation of thermal stabilizers and antioxidants but not flame retardants.
 - (ii) Ultra high molecular weight polyethylene (UHMWPE) cannot be processed via conventional processing routes such as injection moulding but normally processed by compression moulding or ram extrusion.

Terangkan pemerhatian berikut:

- (i) *Polivinil klorida (PVC) memerlukan penambahan penstabil haba dan antioksidan tetapi tidak memerlukan perencat api.*
- (ii) *Polietilena Berberat Molekul Ultra Tinggi (UHMWPE) tidak boleh diproses menggunakan pemprosesan konvensional seperti acuan suntikan tetapi biasanya diproses menggunakan pengacuan mampatan atau pengeksrudan ram.*

(50 marks/markah)

- [b] Make comparisons of thermoplastic and thermosetting polymers on the basis of
- (i) Possible molecular structure arrangement upon drawing.
 - (ii) Mechanical characteristics upon chosen application.

Buat perbandingan polimer termoplastik dan termoset berasaskan

- (i) *Susunan struktur molekul yang mungkin apabila dikenakan terikan.*
- (ii) *Ciri-ciri mekanikal terhadap aplikasi yang dipilih.*

(50 marks/markah)

PART B / BAHAGIAN B

2. [a] Vulcanization is one of the important processes in producing natural rubber product.
- (i) With the help of a suitable diagram, explain what is vulcanization process and how does vulcanization change the properties of natural rubber?
 - (ii) What are the differences between an elastomer and a thermoset?

Pemvulkanan adalah salah satu proses penting dalam menghasilkan produk getah asli.

- (i) *Dengan bantuan gambarajah yang sesuai, terangkan apakah proses pemvulkanan dan bagaimana pemvulkanan menukar sifat getah asli?*
- (ii) *Apakah perbezaan-perbezaan antara elastomer dan termoset?*

(60 marks/markah)

- [b] There are a number of ways in which polymeric materials may degrade over a period of time. Explain polymer degradation below;
- (i) Photo degradation
 - (ii) Oxidative degradation

Terdapat pelbagai cara bagaimana bahan polimer boleh terdegradasi dalam jangkamasa tertentu. Jelaskan degradasi polimer di bawah;

- (i) *Degradasi foto*
- (ii) *Degradasi oksidatif*

(40 marks/markah)

3. [a] Briefly explain the mechanical failures for polymeric materials below and explain how these failures can be described as brittle, ductile or crazing deformation.
- (i) Creep rupture
 - (ii) Impact failure

Terangkan secara ringkas kegagalan mekanikal untuk bahan polimer di bawah dan terangkan bagaimana kegagalan ini boleh digambarkan sebagai ubah bentuk rapuh, mulur atau keretakan halus.

- (i) Pecah krip*
- (ii) Kegagalan hentaman*

(40 marks/markah)

- [b] The front and rear bumper beams on a car was made from polypropylene/fiberglass composite. Based on the information given, estimates the longitudinal modulus and transverse modulus these beams assuming a fiberglass (E-glass) composition of 40 wt % (weight percent).

Given:

Modulus of PP = 1380 MPa

Modulus of fiberglass = 72.4 GPa

Density of fiberglass = 2.55 g/cm³

Density of PP = 0.905 g/cm³

Rasuk penampian depan dan belakang pada sebuah kereta diperbuat daripada komposit polipropilena/gentian kaca. Berdasarkan maklumat yang diberikan, anggarkan modulus membujur dan modulus melintang rasuk ini dengan mengandaikan gentian kaca (E-kaca) berkomposisi 40 wt% (peratus berat).

(60 marks/markah)

4. [a] Fluids especially polymer melts act differently under the application of stress.
- (i) With the help of suitable diagrams, discuss the differences between dilatant and pseudoplastic fluids.
 - (ii) Explain the importance of pseudoplastic flow in polymer processing.

Cecair terutamanya leburan polimer mempunyai tindakbalas yang berbeza terhadap tegasan.

- (i) *Dengan bantuan gambarajah yang sesuai, bincangkan perbezaan antara cecair dilatan dan pseudoplastik.*
- (ii) *Terangkan kepentingan aliran pseudoplastik dalam pemprosesan polimer.*

(60 marks/markah)

- [b] Polymer products can be produced using variety of polymer processing methods. By using schematic diagrams, describe similarities and differences between injection moulding and screw extrusion.

Produk Polimer boleh dihasilkan dengan menggunakan pelbagai kaedah pemprosesan polimer. Dengan menggunakan gambarajah skematik, terangkan persamaan dan perbezaan antara pengacuanan suntikan dan pengestrudan skru.

(40 marks/markah)

PART C / BAHAGIAN C

5. [a] How do fundamental characteristics of polymers determine their applications?

Bagaimanakah ciri-ciri asas polimer boleh menentukan aplikasi mereka?

(50 marks/markah)

- [b] In general, glass transition temperature (T_g) depends on the molecular structure of the polymer, and there are several factors influencing the transition. Explain briefly how chain length and side group affect the T_g of polymer.

Secara umum suhu peralihan kaca (T_g) bergantung kepada struktur polimer, dan terdapat beberapa faktor yang mempengaruhi peralihan tersebut. Jelaskan secara ringkas bagaimana panjang rantai dan kumpulan sisi mempengaruhi T_g polimer.

(50 marks/markah)

6. [a] Explain how chain entanglement and time scale of motion affect the rheological properties of a polymeric material.

Jelaskan bagaimana kekusutan rantai dan pergerakan skala masa mempengaruhi sifat-sifat reologi suatu bahan polimer.

(30 marks/markah)

- [b] How does a 5 mm thickness nonpolar polymer such as Ultra High Molecular Weight polyethylene (UHMWPE) able to stop a bullet traveling at the speed of 1777 feet per second?

Bagaimana polimer tidak berkutub seperti Polietilena Berberat Molekul Ultra Tinggi (UHMWPE) yang berketebalan 5 mm mampu menghentikan peluru bergerak pada kelajuan 1777 kaki sesaat?

(30 marks/markah)

- [c] A linear polyethylene polymer has a molecular weight (MW) of 400,000. If this refers to the number average molecular weight, calculate the degree of polymerization, average total chain length and the average chain end to end distance. [Assuming that for single carbon-carbon bond, $d = 0.154 \text{ nm}$ and $\theta = 109^\circ$].

Satu polimer polietilena linear mempunyai berat molekul (MW) 400,000. Jika ini merujuk kepada berat molekul purata nombor, kirakan darjah pempolimeran, purata jumlah panjang rantai dan purata jarak hujung ke hujung rantai. [Dengan menganggap bahawa untuk ikatan karbon-karbon tunggal, $d = 0.154 \text{ nm}$ and $\theta = 109^\circ$].

(40 marks/markah)

7. [a] Describe the stages of plastic deformation for a semicrystalline polymer referring to the amorphous and crystalline region.

Huraikan peringkat perubahan rupabentuk plastik suatu polimer semi hablur yang merujuk kepada kawasan amorfus dan berhablur.

(30 marks/markah)

- [b] Explain briefly how molecular weight and degree of crystallinity influence the toughness property for semicrystalline polymer.

Jelaskan secara ringkas bagaimana berat molekul dan darjah penghabluran mempengaruhi sifat ketahanan polimer semihablur.

(30 marks/markah)

- [c] Table 1 shows a hypothetical polymer molecule size distribution for polypropylene on the basis of weight fraction of molecules. Calculate;
- Weight average molecular weight
 - Degree of polymerization.

Jadual 1 menunjukkan satu taburan saiz molekul polimer secara hipotetik untuk polietilena berasaskan pecahan berat. Kirakan

- Purata berat molekul berat*
- Darjah pempolimeran.*

Table 1 - Hypothetical polymer molecule size distribution for polypropylene on the basis of weight fraction.

Jadual 1 - Taburan saiz molekul polimer secara hipotetik untuk polietilena yang berasaskan pecahan berat.

Molecular weight <i>Berat Molekul</i> (g/mol)	Weight fraction <i>Pecahan berat</i> (w_i)
8000-16000	0.05
16000-24000	0.16
24000-32000	0.24
32000-40000	0.28
40000-48000	0.2
48000-56000	0.07

(40 marks/markah)