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# UNIVERSITI SAINS MALAYSIA

First Semester Examination  
Academic Session 2008/2009

November 2008

**EBP 103/3 – Polymer Organic Chemistry**  
**[Kimia Organik Polimer]**

Duration : 3 hours  
[Masa : 3 jam]

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Please ensure that this examination paper contains NINE printed pages before you begin the examination.

*[Sila pastikan bahawa kertas peperiksaan ini mengandungi SEMBILAN muka surat yang bercetak sebelum anda memulakan peperiksaan ini.]*

This paper contains **TWO** questions from **PART A** and **FIVE** questions from **PART B**.

*[Kertas soalan ini mengandungi **DUA** soalan dari **BAHAGIAN A** dan **LIMA** soalan dari **BAHAGIAN B**.]*

**Instruction:** Answer **ALL** questions from **PART A** and **THREE** questions from **PART B**.

If candidate answers more than five questions only the first five questions answered in the answer script would be examined.

**Arahan:** Jawab **SEMUA** soalan dari **BAHAGIAN A** dan **TIGA** soalan dari **BAHAGIAN B**. *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.]*

**PART A / BAHAGIAN A**

1. [a] List down the differences between carbocation, carbanion and radical species.

*Senaraikan perbezaan antara spesies karbokation, karbanion dan radikal.*

(30 marks/markah)

- [b] Describe the secondary forces that are available between molecules.

*Perihalkan daya sekunder yang terdapat di antara molekul-molekul.*

(30 marks/markah)

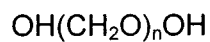
- [c] Polyethylene oxide is soluble in water but polyethylene is not. Suggest a reason.

*Polietilena oksida adalah larut dalam air manakala polietilena tidak. Berikan alasan.*



Polyethylene/

*Polietilena*



Polyethylene oxide/

*Polietilena oksida*

(40 marks/markah)

2. [a] Write the following reactions:
- (i) photolysis decomposition of 2,2'-azobisisobutyronitrile
  - (ii) decomposition reaction of dicumyl peroxide
  - (iii) when dibenzoyl peroxide heated at 65°C

*Tuliskan tindakbalas berikut:*

- (i) *penguraian fotolisis bagi 2,2'-azobisisobutironitril*
- (ii) *tindakbalas penguraian bagi dikumil peroksida*
- (iii) *apabila dibenzoil peroksida dipanaskan pada suhu 65°C*

(30 marks/markah)

- [b] State the differences between chain-growth polymerization and step-growth polymerization.

*Nyatakan perbezaan di antara pempolimeran rantai dan pempolimeran langkah.*

(40 marks/markah)

- [c] State the differences between free radical polymerization and ionic polymerization.

*Nyatakan perbezaan di antara pempolimeran radikal bebas dan pempolimeran ionik.*

(30 marks/markah)

**PART B / BAHAGIAN B**

3. [a] Discuss the mechanism of absorption of electromagnetic radiation in an organic molecule which give rise to FTIR spectrum.

*Bincangkan mekanisme penyerapan sinaran elektromagnetik di dalam sebatian organik bagi menghasilkan spektrum FTIR.*

(25 marks/markah)

- [b] Describe the various mode of bond vibration in organic molecules which could give rise to various peaks in FTIR spectrum.

*Perihalkan pelbagai bentuk getaran ikatan di dalam sebatian organik bagi menghasilkan puncak-puncak dalam spektrum FTIR.*

(25 marks/markah)

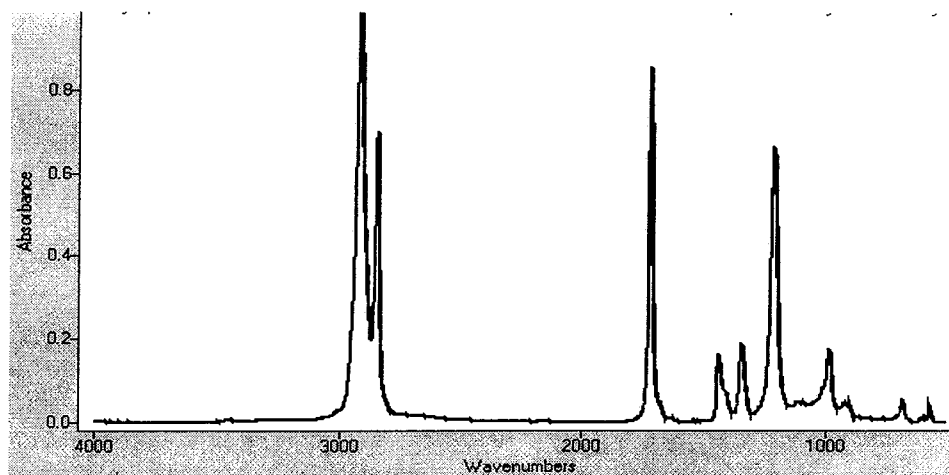
- [c] In FTIR spectroscopy, what is meant by infra-red active. Illustrate your answer with an example.

*Dalam spektroskopi FTIR, apakah yang dimaksudkan dengan infra-merah teraktif. Perihalkan jawapan anda dengan satu contoh sesuai.*

(20 marks/markah)

- [d] Based on the FTIR spectrum of a polymer shown below, determine four functional groups that are available in the structure. (Marks will be deducted for any wrong answer).

*Berdasarkan spektrum FTIR suatu polimer di bawah, tentukan empat kumpulan fungsi yang hadir di dalam struktur tersebut. (Markah akan dipotong bagi mana-mana satu jawapan yang salah).*



(30 marks/markah)

4. [a] Write and explain the chemical reaction for the synthesis of phenol-formaldehyde resins.

*Tuliskan dan jelaskan tindakbalas kimia untuk sintesis bagi fenol-formaldehid.*

(40 marks/markah)

- [b] Discuss the initiation, propagation and termination mechanism for polymerization of styrene in liquid ammonia, with potassium amide as initiator.

*Bincangkan mekanisme pemulaan, perambatan dan penamatan bagi pempolimeran bagi stirena di dalam ammonia cecair dengan kalium amida sebagai pemula.*

(60 marks/markah)

5. [a] Write and explain the chemical reaction for the synthesis of urea-formaldehyde resins.

*Tuliskan dan jelaskan tindakbalas kimia untuk sintesis bagi urea-formaldehid.*

(40 marks/markah)

- [b] Write and explain the following free radical polymerization mechanisms of methyl methacrylate:

- (i) initiation by benzoyl peroxide
- (ii) propagation
- (ii) termination occurs at temperature above 333K

*Tuliskan dan jelaskan mekanisme pempolimeran radikal bebas bagi metil metakrilat seperti berikut:*

- (i) permulaan dengan benzoil peroksida
- (ii) perambatan
- (iii) penamatan berlaku pada suhu melebihi 333K

(60 marks/markah)

6. [a] Write the chemical reaction for the synthesis of the following polymers:
- (i) poly(hexamethylene adipamide)
  - (ii) poly(ethylene terephthalate)
  - (iii) epoxy prepolymer
  - (iv) unsaturated polyester

*Tuliskan tindakbalas kimia untuk sintesis bagi polimer:*

- (i) *poli(heksametilena adipamida)*
- (ii) *poli(etilena tereftalat)*
- (iii) *prapolimer epoksi*
- (iv) *poliester tak tepu*

(40 marks/markah)

- [b] Write and explain the following cationic polymerization mechanism of isobutylene:
- (i) initiation by  $\text{AlCl}_3$  and  $\text{CH}_3\text{Cl}$
  - (ii) propagation
  - (iii) termination by a uni-molecular rearrangement of the ion pairs

*Tuliskan dan jelaskan mekanisme pempolimeran kationik bagi isobutilena seperti berikut:*

- (i) *pemulaan dengan  $\text{AlCl}_3$  dan  $\text{CH}_3\text{Cl}$*
- (ii) *perambatan*
- (iii) *penamatan dengan penyusunan semula uni-molekul bagi pasangan ion*

(60 marks/markah)



7. [a] Step growth polymerizations can be divided into two main categories, i.e. polycondensation and polyaddition. Discuss polycondensation and polyaddition-type step growth polymerization. The answer must be supported by chemical reactions.

*Pempolimeran langkah boleh dibahagikan kepada dua kategori yang utama, iaitu poli-kondensasi dan poli-penambahan. Bincangkan pempolimeran langkah jenis poli-kondensasi dan poli-penambahan. Jawapan mesti disokong dengan tindakbalas kimia.*

(40 marks/markah)

- [b] Describe briefly the following with specific example for each:

- (i) chain transfer
- (ii) ring opening polymerization
- (iv) crosslinking

*Jelaskan secara ringkas beserta dengan contoh spesifik bagi istilah-istilah berikut:*

- (i) *pemindahan rantai*
- (ii) *pempolimeran pembukaan gelang*
- (iii) *penyambung-silangan*

(60 marks/markah)

