
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]

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)

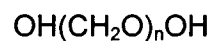
- [c] Polyethylene oxide is soluble in water but polyethylene is not. Suggest a reason.

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)

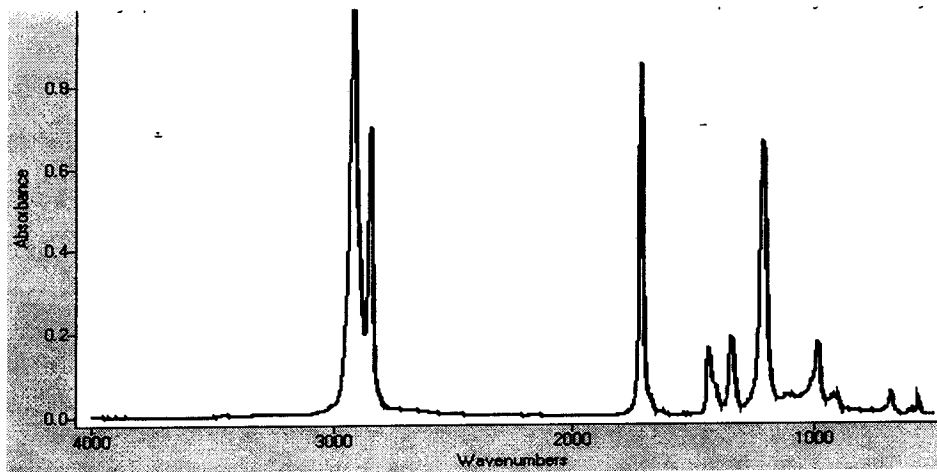
- [c] In FTIR spectroscopy, what is meant by infra-red active. Illustrate your answer with an example.

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 pemolimeran 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 AlCl_3 and CH_3Cl
- (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 AlCl_3 dan CH_3Cl*
- (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)