UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session 2007/2008

October/November 2007

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 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] Write the comparison of step-growth polymerization and chain-growth polymerization.

Tuliskan perbezaan antara pempolimeran langkah dan pempolimeran rantai.

(30 marks/*markah*)

[b] Write and explain the following free radical polymerization mechanisms of styrene.

(i) Initiation by dicumyl peroxide

(ii) Propagation

(iii) Termination by combination

Tuliskan dan jelaskan mekanisme pempolimeran radikal bebas bagi stirena seperti berikut:

(i) permulaan dengan dikumil peroksida

(ii) perambatan

(iii) penamatan dengan gabungan

(70 marks/*markah*)

2. [a] Describe briefly the following with specific example for each:

(i) Carbonium

(ii) Carbanion

(iii) Chain transfer

(iv) Termination by disproportionation

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

(i) Karbonium

(ii) Karbanion

(iii) Pemindahan rantai

(iv) Penamatan dengan disproporsionasi

(40 marks/*markah*)

[b] Write and explain the following cationic polymerization mechanism of isobutylene.

(i) Initiation by $AlCl_3/H_20$

(ii) Propagation

(iii) Termination by uni-molecular rearrangement

Tuliskan dan jelaskan mekanisme pempolimeran kationik bagi isobutilena seperti berikut:

(i) permulaan dengan $AlCl_3/H_20$

(ii) perambatan

(iii) penamatan dengan penyusunan semula uni-molekul

(60 marks/*markah*)

3. [a] Discuss on living polymer. Discussion should be supported by chemical reaction.

Bincangkan polimer hidup. Perbincangan perlu disokong dengan tindakbalas kimia.

(60 marks/*markah*)

[b] Write and explain the following anionic polymerization mechanisms of acrylonitrile.

(i) Initiation by butyllithium

(ii) Propagation

Tuliskan dan jelaskan mekanisme pempolimeran anionik bagi akrilonitril seperti berikut:

(i) permulaan dengan butillitium

(ii) perambatan

(40 marks/*markah*)

4. [a] Discuss on ring opening polymerization. Answer must be supported by TWO examples.

Bincangkan pempolimeran pembukaan-gelang. Jawapan mesti disokong dengan DUA contoh.

(50 marks/*markah*)

[b] Write the chemical reaction for the synthesis of the following:

(i) Poly(ethylene terephthalate)

(ii) Polyamide 6,6

(iii) Polyimide

(iv) Polyurethane

(v) Polycarbonate

Tuliskan tindakbalas kimia untuk sintesis bagi polimer berikut:

(i) poli(etilena tereftalat)

(ii) poliamida 6,6

(iii) poliimida

(iv) poliuretana

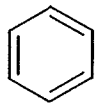
(v) polikarbonat

(50 marks/*markah*)

5. [a] Cyclohexene is non-aromatic but benzene is an aromatic structure (see Figure). Discuss their differences in terms of stability, conformation and reactivity.

Sikloheksena bersifat tak-aromatik manakala benzena bersifat aromatik. Bincangkan perbezaan antara keduanya berdasarkan kestabilan, konformasi dan reaktiviti.

cyclohexene

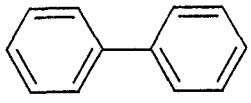


benzene

(40 marks/*markah*)

[b] In gaseous phase the biphenyl unit is non-coplanar (torsional angle 45°C) but in aromatic polyetherketone the backbone subunit rings are coplanar. Explain.

Dalam fasa gas, unit bifenil adalah tak-koplanar (sudut kilasan 45°C) tapi dalam polieterketon aromatik, subunit tulang belakang ini adalah koplanar. Jelaskan.

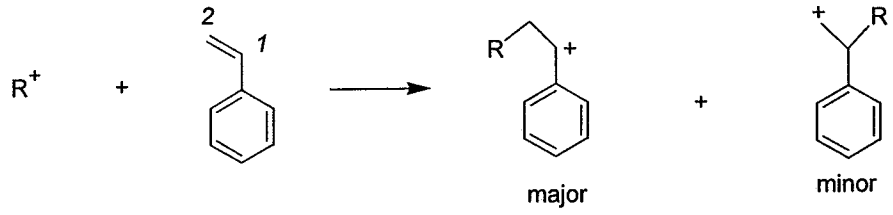


Diphenyl

(30 marks/*markah*)

[c] Consider propagation step of cationic polymerization of styrene as shown below:

Pertimbangkan langkah perambatan pempolimeran kationik bagi stirena seperti yang ditunjukkan di bawah:



Why is the attack of propagating cationic centre occur at 2-carbon rather than at 1-carbon?

Kenapakah serangan pusat perambatan kationik berlaku pada karbon-2 berbanding karbon-1?

(30 marks/*markah*)

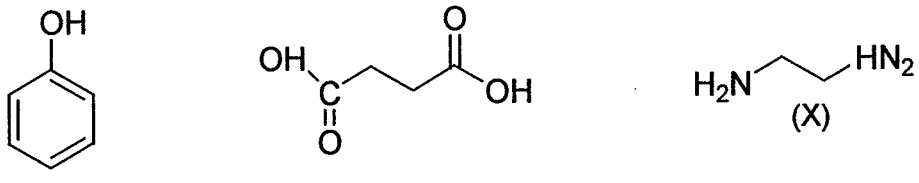
6. [a] Define electrophile and nucleophile.

Berikan definisi bagi elektrofil dan nukleofil.

(20 marks/*markah*)

[b] Identify electrophilic or nucleophilic centres in the following structures:

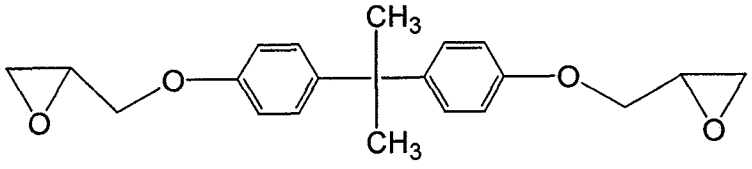
Kenal pasti pusat elektrofilik atau nukleofilik dalam struktur yang berikut:



(30 marks/*markah*)

[c] Epoxy resin can be cured using diamine (X) in the above figure. Show the formation of cross-link structure of glycidy ether-bisphenol *A* epoxy resin shown below with diamine (X).

Resin epoksi boleh dimatangkan menggunakan diamina (X) dalam struktur di atas. Tunjukkan pembentukan sambung-silang yang terjadi terhadap resin epoksi glisidil eter-bisfenol A menggunakan diamina (X) tersebut.



(50 marks/*markah*)

7. [a] Using an example, what is meant by infra-red active in Fourier Transform Infra-Red spectroscopy?

Dengan memberikan contoh, jelaskan apakah yang dimaksudkan dengan infra-merah aktif dalam Spektroskopi Infra-Merah Anjakan Fourier (FTIR)?

(25 marks/*markah*)

[b] In nuclear magnetic resonance (NMR) spectroscopy, what is meant by chemical shift?

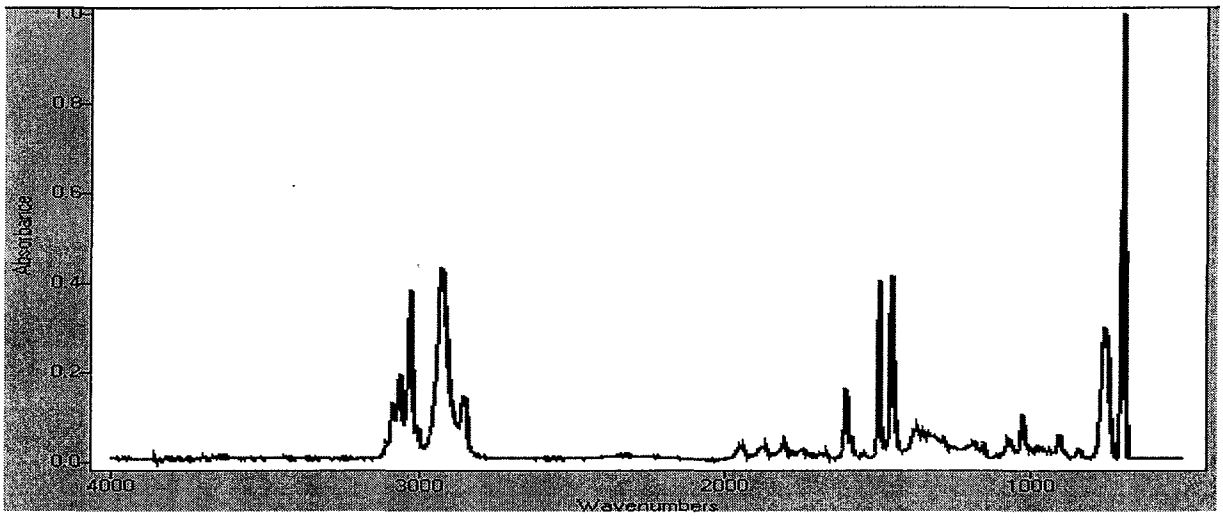
Dalam spektroskopi nuklear magnetik resonans (NMR), apakah yang dimaksudkan dengan anjakan kimia?

(25 marks/*markah*)

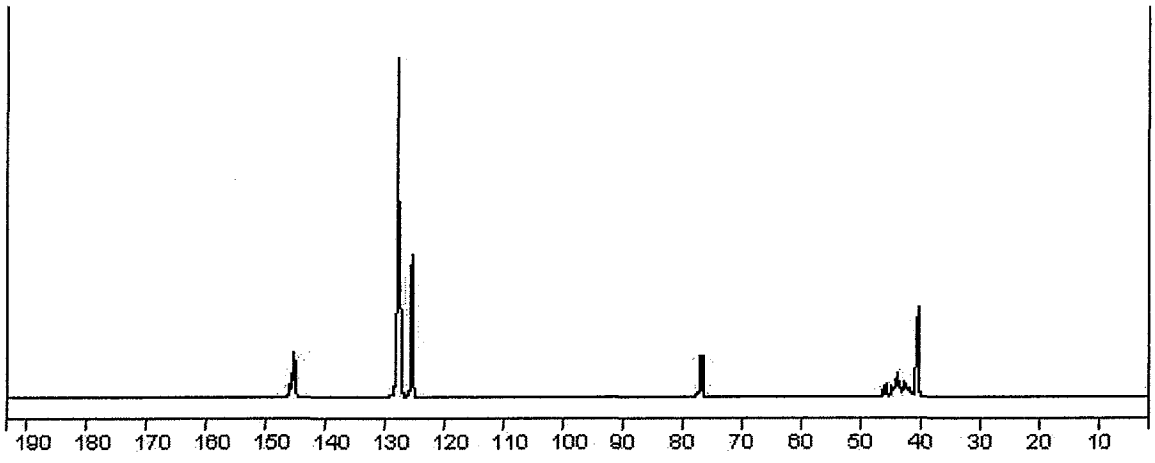
[c] Predict the structure of a polymer based on the given FTIR, H-NMR and ^{13}C-NMR spectroscopy data given below. Explain your choice of prediction:

Ramalkan struktur suatu polimer berdasarkan data spektroskopi FTIR, H-NMR dan ^{13}C-NMR yang diberi. Berikan alasan terhadap ramalan anda:

(50 marks/*markah*)



FTIR



13C-NMR