UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session 2008/2009

November 2008

EBP 201/3 – Polymer Synthesis
[Sintesis Polimer]

Duration : 3 hours
[Masa : 3 jam]

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

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

Instruction: Answer **FIVE** questions. If candidate answers more than five questions only the first five questions answered in the answer script would be examined.
*[**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.]

...2/-

1. [a] Based on the mechanism of chain polymerization show that the rate of polymerization is proportional to monomer concentration and square root of initiator concentration.

Berdasarkan mekanisme pempolimeran rantai, buktikan kadar pempolimeran adalah berkadar terus dengan kepekatan monomer dan punca ganda kuasa dua kepekatan pemula.

(30 marks/*markah*)

[b] What is activation energy and how is it determined for a radical polymerization.

Apakah maksud tenaga pengaktifan dan bagaimana ia boleh ditentukan untuk pempolimeran radikal.

(30 marks/*markah*)

[c] The rate of change of ethylene monomer performed during radical polymerization at 35°C is shown in table below. Determine the order of the reaction and calculate the rate constant for the polymerization.

Kadar perubahan monomer etilena semasa menjalankan pempolimeran radikal pada 35°C adalah ditunjukkan dalam jadual di bawah. Tentukan tertib tindakbalas dan kira pemalar kadar tindakbalas pempolimeran ini.

Time/*min*	$[CH_2CH_2]$/mmHg
0	306.5
10	262.7
20	243.2
30	224.5
40	207.5
50	191.2
60	176.8
70	163.5
80	151.9
90	140.1
100	129.4

(40 marks/*markah*)

2. [a] Describe factors which affect the degree of polymerization in chain growth polymerization.

Perihalkan faktor-faktor yang mempengaruhi kadar pempolimeran dalam pempolimeraan pertumbuhan rantai.

(30 marks/*markah*)

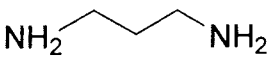
[b] Chain transfer in toluene occur much more readily than in benzene solvent during radical polymerization. Explain.

Perpindahan rantai dalam pelarut toluena berlaku dengan lebih mudah berbanding dalam benzena semasa pempolimeran radikal. Jelaskan.

(30 marks/*markah*)

[c] Calculate the feed ratio of suberic acid and hexamethyl diamine (shown below) that should be employed to obtain a polyamide of approximately 15000 molecular weight at 90% conversion.

Hitung nisbah asal asid suberic dan heksametil diamina (ditunjukkan di bawah) yang perlu digunakan bagi menghasilkan polimida dengan berat molekul lebih kurang 15000 pada pertukaran 90%.



Trimethyldiamine

$HOOC(CH_2)_6COOH$

Suberic acid

(40 marks/*markah*)

3. [a] What is compositional drift during copolymerization.

Apakah maksud anjakan komposisi semasa pengkopolimeran

(20 marks/*markah*)

[b] Determine the monomer A and B feeding ratio having reactivity ratio r_A = 55 and r_B = 0.003 to give the mole ratio of monomer A with copolymer composition at 0.25, 0.5 and 0.75.

Tentukan nisbah asal monomer A dan B dengan nisbah reaktiviti r_A = 55 dan r_B = 0.003 bagi menghasilkan nisbah mol monomer A dalam komposisi kopolimer pada 0.25, 0.5, 0.75.

(40 marks/*markah*)

[c]

	Q	e
Acrylonitrile / *Akrilonitril*	0.48	1.23
Butadiene / *Butadiena*	1.70	-0.50
Maleic anhydride / *Malik Anhidrida*	0.86	3.69
Styrene / *Stirena*	1.00	-0.800
Methyl methacrylate / *Metil metakrilat*	0.74	0.40
Vinyl acetate / *Vinil asetat*	0.026	-0.88

In terms of Q and e values in above tables, explain why styrene would form an alternating copolymer with butadiene. Suggest one monomer in the above table which would form a block copolymer with styrene.

Berdasarkan nilai-nilai Q dan e dalam jadual di atas jelaskan mengapa stirena membentuk kopolimer selang-seli dengan butadiena. Cadangkan satu monomer dalam jadual di atas yang akan membentuk kopolimer blok dengan stirena.

(40 marks/*markah*)

...6/-

4. [a] In Ziegler-Natta catalysis, discuss the following:

(i) Isotacticity is produced with the shift of vacant orbital of catalytic metal atom between axial and equatorial position.

(ii) A component of the catalyst should be from a transition metal compounds.

(iii) Propylene and 1-butene works well with this catalyst compared to 2-butene or 2-pentene.

Dalam pemangkinan Ziegler-Natta, bincangkan yang berikut:

(i) Isotaktisiti terhasil apabila orbital kosong atom logam pemangkin berpindah dari kedudukan paksi dan khatulistiwa.

(ii) Salah satu komponen pemangkin adalah berupa sebatian logam peralihan.

(iii) Pemangkin ini hanya sesuai untuk propelina dan 1-butena tapi tidak bagi 2-butena atau 2-pentena.

(50 marks/*markah*)

[b] In metallocene catalysis, discuss the following:

(i) The catalytic centre is chiral and rigid.

(ii) The catalytic site is 'clamp'-shaped.

(iii) The central metal at the catalytic site is electron deficient.

Dalam pemangkinan metalosin, bincangkan yang berikut:

(i) Pusat pemangkin adalah kiral dan tegar.

(ii) Pusat pemangkin berbentuk 'kerang'.

(iii) Logam pusat di ruang pemangkinan adalah kekurangan elektron.

(50 marks/*markah*)

5. [a] Compare and contrast between bulk and emulsion polymerization.

Bincangkan persamaan dan perbezaan antara pempolimeran emulsi dan pukal.

(30 marks/*markah*)

[b] Describe the on-off mechanism during propagation step in emulsion polymerization hence show that the rate of polymerization is as shown below:

$$\frac{-d[M]}{dt} = k_p \frac{[M]N}{2}$$

where [*M*] is monomer concentration, *N* is number of particles per unit volume and k_p is propagation rate constant.

Perihalkan mekanisme 'on-off' semasa langkah perambatan dalam pempolimeran emulsi dan seterusnya buktikan kadar pempolimeran adalah seperti di bawah:

$$\frac{-d[M]}{dt} = k_p \frac{[M]N}{2}$$

di mana [M] adalah kepekatan monomer, N adalah bilangan partikel per unit isipadu dan k_p adalah pemalar kadar perambatan.

(30 marks/*markah*)

[c] The average molecular weight of a polymer during emulsion polymerization can be increased by reducing the number of initiator and increase the surfactant concentration. Explain.

Purata berat molekul suatu polimer semasa pempolimeran emulsi boleh ditingkatkan dengan mengurangi jumlah pemula serta meningkatkan kepekatan surfaktan. Jelaskan.

(40 marks/*markah*)

6. [a] What is meant by epoxy equivalent weight and how is it determine.

Apakah yang dimaksudkan dengan berat setara epoksi dan bagaimana ia ditentukan.

(30 marks/*markah*)

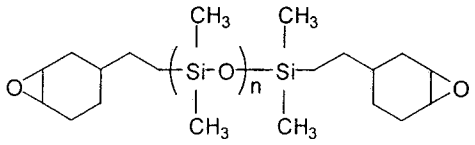
[b] Give an example of an amine curing agent and hence draw the cross-link structure between the curing agent and diglycidylether-bisphenol A (DGEBA) resin.

Berikan contoh suatu agen pematangan amina dan seterusnya lukiskan gambarajah rangkaian sambung silang antara agen pematangan ini dengan resin diglisidileter-bisfenol A (DGEBA).

(30 marks/*markah*)

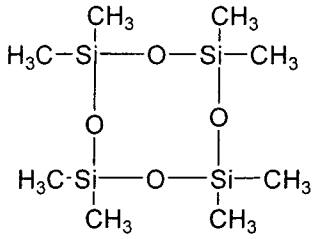
[c] Suggest a reaction scheme to produce a polysiloxane-epoxy resin as shown below:

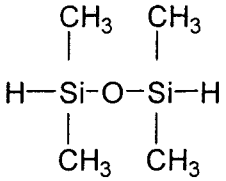
Cadangkan suatu skema tindakbalas untuk menghasilkan resin polisiloksana-epoksi seperti berikut:

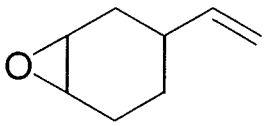


You may use the monomers as given below:

Anda boleh menggunakan monomer-monomer yang diberi di bawah:



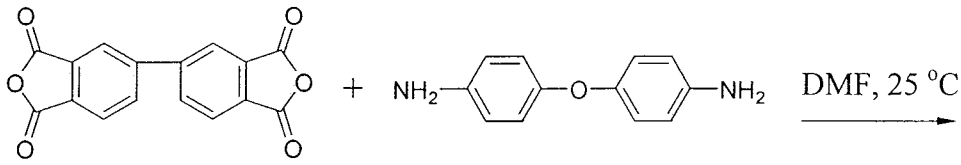


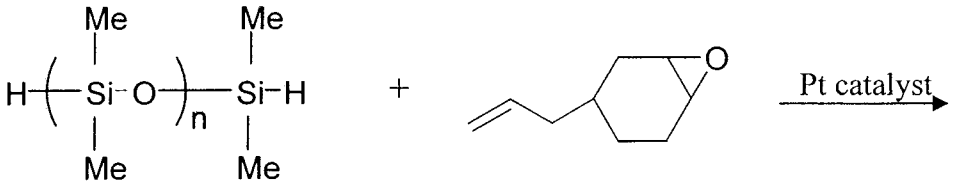


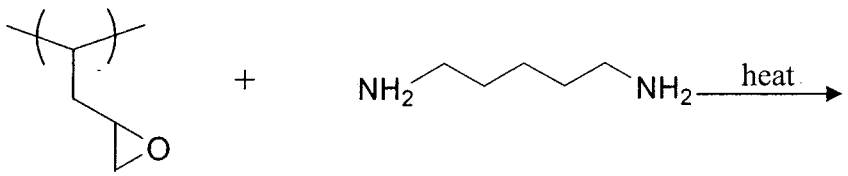
(40 marks/*markah*)

7. [a] Determine the products of the following reaction:

Tentukan hasil penyediaan bagi tindakbalas berikut:

i. 

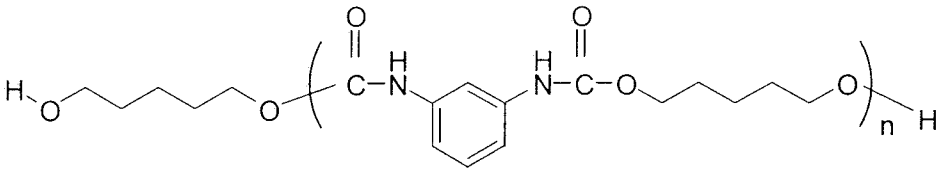
ii. 

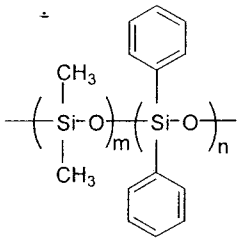
iii 

(50 marks/*markah*)

[b] Determine the monomers required to synthesise the following:

Tentukan monomer-monomer yang diperlukan bagi menghasilkan yang berikut:

i. 

ii. 

(50 marks/*markah*)

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