UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session 2012/2013

January 2013

EBP 201/3 – Polymer Synthesis
[Sintesis Polimer]

Duration : 3 hours
[Masa : 3 jam]

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

This paper consists of 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.]*

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, the English version shall be used.
[Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah diguna pakai.]

1. [a] Discuss the following subjects:

(i) Carothers equation.

(ii) Prediction of gel-point in step growth reactions.

Bincangkan perkara-perkara berikut:

(i) Persamaan Carothers.

(ii) Ramalan titik gel di dalam tindakbalas pertumbuhan langkah.

(50 marks/*markah*)

[b] Calculate the conversion percentage of the monomer $HO(CH_2)_{14}COOH$ in order to obtain a polymer with number average molecular weight of 24,000. Give assumption.

Hitungkan peratusan penukaran bagi monomer $HO(CH_2)_{14}COOH$ *untuk mencapai satu polimer yang mempunyai berat molekul purata nombor 24,000. Berikan anggapan.*

(50 marks/*markah*)

2. [a] Discuss the following subjects:

(i) Autoacceleration.

(ii) Chain transfer.

Bincangkan perkara-perkara berikut:

(i) Auto-pemecutan.

(ii) Pemindahan rantai.

(50 marks/*markah*)

[b] The decomposition of benzoyl peroxide is characterized by a half-life of 7 hours at 70^{o}C and an activation energy of 29.5 kcal/mol. What concentration of this peroxide (in mol/L) is needed to convert 50% of a vinyl monomer to polymer in 6 hours at 60^{o}C? Given that f = 0.4; k_p^2/k_t = 1.04 x 10^{-2} L/mol-s at 60^{o}C.

Penguraian bagi benzoil peroksida telah dicirikan dengan separuh hayat 7 jam pada suhu 70^{o}C dan tenaga pengaktifan 29.5 kcal/mol. Apakah kepekatan bagi peroksida tersebut (dalam unit mol/L) yang diperlukan untuk menukar 50% bagi suatu monomer vinil kepada polimer dalam 6 jam pada suhu 60^{o}C? Diberikan f = 0.4; k_p^2/k_t = 1.04 x 10^{-2} L/mol-s pada suhu 60^{o}C.

(50 marks/*markah*)

3. [a] Discuss the following subjects:

(i) Copolymerization.

(ii) The Q-e scheme.

Bincangkan perkara-perkara berikut:

(i) Pengkopolimeran.

(ii) Skema Q-e.

(50 marks/*markah*)

[b] The molecular weight of a polystyrene sample was measured by Ubbelohde technique. The limiting viscosity number [η] was found for each sample in toluene at 30^{o}C using an Ubbelohde viscometer and the results are given in Table 1. Calculate K and a value for polystyrene in toluene at 30^{o}C.

Berat molekul bagi suatu sampel polistirena telah diukur dengan kaedah Ubbelohde. Nombor kelikatan dihadkan [η] telah didapati bagi setiap sampel dalam toluena pada suhu 30^{o}C dengan viskometer Ubbelohde dan keputusannya telah diberikan dalam Jadual 1. Hitungkan nilai K dan a bagi polistirena dalam toluena pada suhu 30^{o}C.

Table 1: The limiting viscosity number results

Jadual 1: Keputusan nombor kelikatan dihadkan

M/g mol^{-1}	[η]/m^{3} kg^{-1}
76,000	0.0382
135,000	0.0592
163,000	0.0696
336,000	0.1054
440,000	0.1292
556,000	0.1650
850,000	0.2210

(50 marks/*markah*)

...5/-

4. [a] Discuss the Ziegler-Natta catalyst.

Bincangkan pemangkin Zielger-Natta.

(30 marks/*markah*)

[b] How does tacticity can be controlled by the use of metallocene catalyst during polymerization reaction.

Bagaimana taktisiti boleh dikawal semasa penggunaan mangkin metalosin dalam tindakbalas pempolimeran.

(30 marks/*markah*)

[c] Describe the emulsion polymerization.

Huraikan pempolimeran emulsi.

(40 marks/*markah*)

5. Explain the following:
Jelaskan yang berikut:

[a] The T_g of polyimide is extremely high (> 260^oC) which mostly deter the use of the available processing techniques. Suggest a synthetic method to overcome this.

T_g bagi poliimida adalah amat tinggi (> 260^oC) yang menghalang penggunaan teknik pemprosesan sedia ada. Cadangkan satu kaedah sintetik bagi mengatasi masalah ini.

(25 marks/*markah*)

[b] In order to reduce radiative degradation and brittleness, an epoxy resin is preferentially copolymerized with a polysiloxane rather than an acrylate. Give reasons.

Untuk mengurangkan degradasi radiasi serta kerapuhan, resin epoksi lebih sesuai dikopolimerkan dengan polisiloksana berbanding akrilat. Berikan alasannya.

(25 marks/*markah*)

[c] A gel is a three-dimensional crosslinked network. Give a structure of an acrylate suitable to be use as the crosslinker for the formation of a gel.

Suatu gel adalah jaringan sambung-silang tiga dimensi. Berikan satu struktur akrilat yang sesuai digunakan sebagai agen sambung-silang bagi pembentukan suatu gel.

(25 marks/*markah*)

[d] Suggest a synthethic route for the production of a non-yellowing polyurethane foam.

Cadangkan satu kaedah sintetik bagi penghasilan busa poliuretana nyah-kekuningan.

(25 marks/*markah*)

6. [a] Compare and contrast between the techniques of soxhlet and reflux during separation of impurities from a solid product.

Bandingkan dan bezakan antara teknik sokhlet dan refluks semasa pemisahan bendasing daripada hasil pepejal.

(20 marks/*markah*)

[b] Sketch a diagram for the experimental set-up of the following reaction procedure: A three neck round bottom flask was purged with nitrogen gas for 5 mins. Vinyl-trimethoxysilane (0.49 mol) was added and thoroughly mixed with platinum hydrochloric acid catalyst (5.4 ml) in a thermostated bath of 80^{o}C for 0.5 h. 4-hydroxybutylacrylate in toluene solution (0.5 mol, 10% w/w) was then added dropwisely over 20 mins into the reaction mixture. The reaction mixture was then allowed to react for 2 h at 80^{o}C.

Lakarkan satu rajah susunatur radas untuk tatacara tindakbalas berikut: Satu kelalang tapak bulat dialirkan dengan gas nitrogen selama 5 minit. Vinil-trimetoksisilana (0.49 mol) dimasukkan dan dicampurkan dengan pemangkin platinum asid hidroklorik (5.4 ml) dalam mandian air pada suhu 80^{o}C selama 0.5 jam. 4-hidrosilbutilakrilat dalam larutan toluena (0.5 mol, 10% w/w) dititiskan selama 20 minit ke dalam campuran ini. Tindakbalas dibiarkan selama 2 jam pada suhu 80^{o}C.

(20 marks/*markah*)

[c] Explain the followings:
Jelaskan yang berikut:

(i) The order of reactivity of alcohols towards isocyanate during production of polyurethane is primary alcohol > secondary alcohol > tertiary alcohol.
Turutan kereaktifan tindakbalas alkohol terhadap isosianat semasa penghasilan poliuretana adalah dalam turutan alkohol primer > alkohol sekunder > alkohol tertier.

(20 marks/*markah*)

(ii) The temperature for hydrosilylation of polysiloxane is in the range of 65 – 75^{o}C.
Suhu bagi tindakbalas hidrosililasi untuk polisiloksana adalah dalam julat 65 – 75^{o}C.

(20 marks/*markah*)

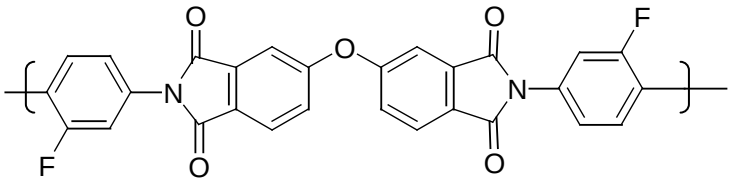
(iii) N,N-dimethylaniline is added during curing of epoxy resin with carboxylic acid anhydride.
N,N-dimetilanilina ditambah semasa pematangan resin epoksi dengan asid karboksilik anhidrida.

(20 marks/*markah*)

7. [a] Determine the monomers of the following polymer/prepolymer:

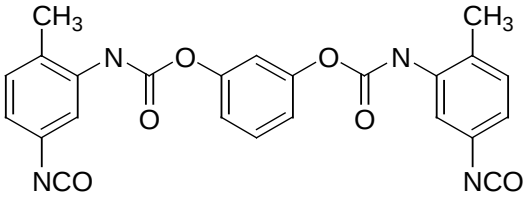
Tentukan monomer-monomer bagi penghasilan polimer/prepolimer yang berikut:

(i)



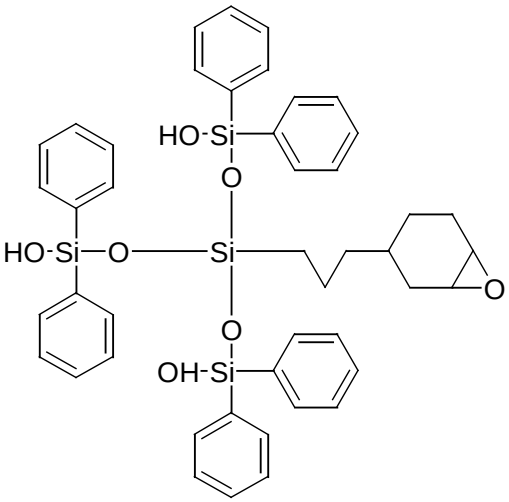
(20 marks/*markah*)

(ii)



(20 marks/*markah*)

(iii)



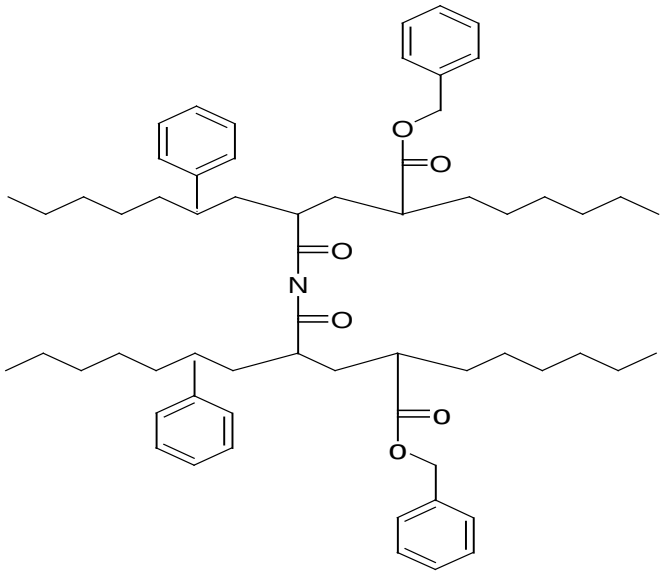
(20 marks/*markah*)

…10/-

[b] Determine the monomers involved in the formation of crosslink network structure below:

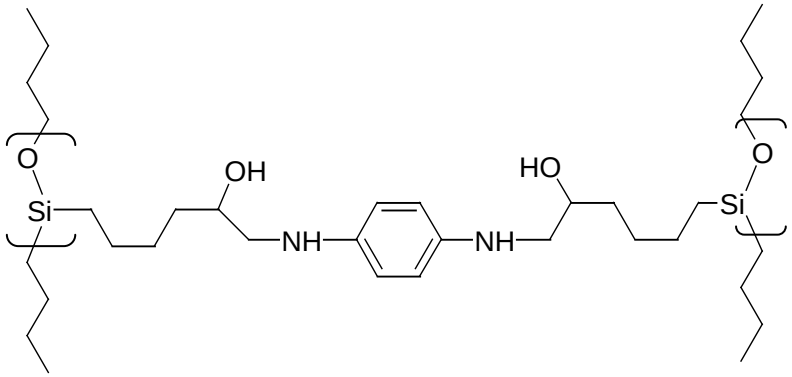
Tentukan monomer-monomer yang terlibat bagi penghasilan struktur jaringan sambungsilang yang berikut:

(i)



(20 marks/*markah*)

(ii)



(20 marks/*markah*)

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