UNIVERSITI SAINS MALAYSIA

Second Semester Examination
Academic Session 2020/2021

June 2021

KIT 358 – POLYMER CHEMISTRY

Duration: 2 hours

Please check that this examination paper consists of **FOUR (4)** pages of printed material before you begin the examination.

Answer **FOUR (4)** questions only.

Answer each question on a new page.

If a candidate answered more than four questions, only the first four questions in order of the arrangement in the received answer scripts will be graded.

1. (a) Spaghetti and watering hose are both polymers. By identifying the main differences between the two polymers, discuss **FOUR (4)** distinctive properties that differentiate between the two polymers.
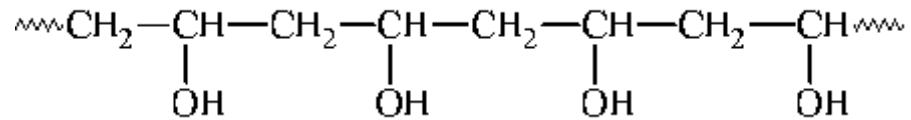
(10 marks)

(b)

$$\text{www}CH_2-CH-CH_2-CH-CH_2-CH-CH_2-CH\text{www}$$
$$\qquad\quad |\qquad\qquad |\qquad\qquad |\qquad\qquad |$$
$$\qquad\quad OH\qquad\quad OH\qquad\quad OH\qquad\quad OH$$

Figure 1

(i) Deduce the synthesis of the monomer for the polymer in Figure 1.
(ii) Explain the reasons the monomer does not contain an alcohol functional group.

(8 marks)

(c) State the role of phthalic anhydride in the preparation and curing of an unsaturated polyester resin.

(2 marks)

(d) Differentiate between viscous deformation and elastic deformation with the aid of appropriate graphs.

(5 marks)

2. (a) Straws and plastic bags are commonly used items on daily basis. However, they have been found to pose big threats to the environment. In your opinion, comment on the properties of the polymers used to produce these items which makes them harmful to the environment.

(10 marks)

(b) Briefly explain the reason epoxies are preferred to polyesters.

(3 marks)

(c) Deduce ways to overcome the high viscosity of epoxies that makes it hard to handle.

(8 marks)

(d) Polydispersity characterizes the shape of the molecular weight distribution of the polymer. Describe the effects of polydispersity on a polymer.
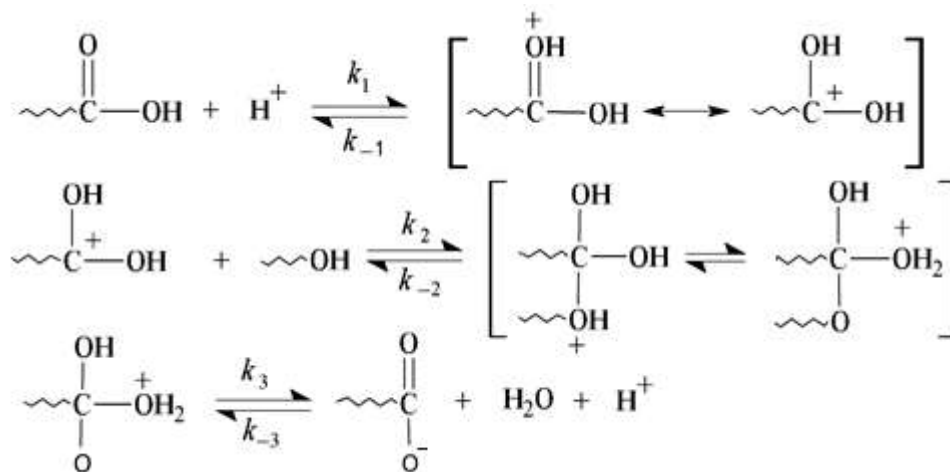
(4 marks)

3.   (a)   Referring to Table 1, predict the reasons for the vast differences in the properties between the two polymers which are made from the same material.

Table 1

Polymers	Tensile strength (M N/m^2)	Elongation at break (%)
Nylon 6,6	700	25
Plastic	70	100

(10 marks)

(b)

Figure 2

(i)   Name the mechanism shown in Figure 2.

(ii)   Determine the rate limiting step for the reaction shown above.

(iii) Derive the equation for the extent of reaction, *p* for self-catalyzed reaction.

(10 marks)

(c)   By giving **TWO (2)** examples of phenomena, analyse the behaviour that is reflected due to the viscoelastic properties of polymer.

(5 marks)

4. (a) Justify the percentage changes in the value of M_n and M_w of polystyrene A (M_n = 40,000; M_w = 80,000) when 1 g of polystyrene B (M_n = 20,000; PDI = 2) is added to 10 g of polystyrene A.

(15 marks)

(b) Predict **THREE (3)** types of polymers where the viscosity can be measured using Dilute Solution Viscometry (DSV) method.

(3 marks)

(c) Deduce the effects of chain transfer reaction on weight average molecular weight ($\overline{M_w}$) of a polymer.

(7 marks)

5. (a) Both polybutadiene and polycarbonate are two distinctively different polymers. Referring to Table 2, comment on the importance of glass transition temperature in producing functional plastic materials.

Table 2

Polymer	Polybutadiene	Polycarbonate
Glass transition temperature, T_g (°C)	-106	140 - 150
Potential uses	Tires, belts, hoses	Protective gears, automotive components

(12 marks)

(b) (i) Given an unknown polymer material, thoroughly analyse the applicability (name of the method, fundamentals, and application) of **TWO** (2) types of chemical instrumentation methods to identify the unknown.

(ii) Predict **THREE (3)** more chemical instrumentation methods that can be used to assist in the identification of unknown in (i).

(13 marks)

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