UNIVERSITY COLLEGE TATI

UNIVERSITY COLLEGE TATI (UCTATI)

FINAL EXAMINATION QUESTION BOOKLET	
COURSE CODE	: BPE 3153
COURSE	: POLYMER DEGRADATION AND ENVIRONMENT
SEMESTER/SESSION	: 1 - 2023/2024
DURATION	: 3 HOURS

Instructions:

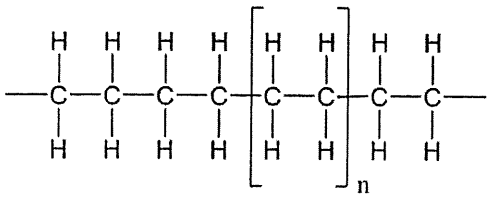
1. This booklet contains 4 questions. Answer **ALL** questions.
2. All answers should be written in answer booklet.
3. Write legibly and draw sketches wherever required.
4. If in doubt, raise your hands and ask the invigilator.

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO

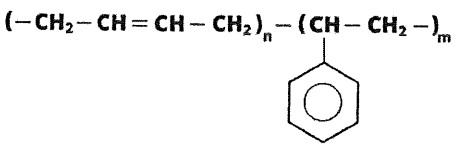
THIS BOOKLET CONTAINS 6 PRINTED PAGES INCLUDING COVER PAGE

QUESTION 1

a)



Polyethylene



Styrene-Butadiene Rubber (SBR)

Figure 1

Figure 1 shows illustrations of two types of polymers which have different structure of monomers.

i) Examine two polymers above and identify which one is copolymer. (2 marks)

ii) Distinguish between the terms of homopolymer and copolymer. (6 marks)

b) When plastic is exposed to high UVA, it tends to break down and create free radical. Illustrate the photo degradation of polymer with example. (4 marks)

c) Biodegradable polymers are special class of polymers that disintegrate over a period of time due to environmental degradation by bacterial activities. Break down the different levels of biodegradation process. (6 marks)

d) Compostable and biodegradable plastics are regarded as bioplastics with different properties. Compare and differentiate these two types of bioplastics. (4 marks)

e) Biodegradability testing can aid in product development and provide information on how a material may or may not degrade in its surrounding environment. Among analytical methods to evaluate biodegradation, identify **one (1)** method that use least analytical tool but most relevance to practice. (3 marks)

QUESTION 2

a) In your first career job, a company hired you as polymer scientist to lead the research and development (R&D) section. Educate your boss and R&D team by debating the potential of bioplastics. Your argument should include the **three (3)** reasons why traditional plastics should be substituted with biodegradable polymer in the near future. (6 marks)

b) Classify **three (3)** types of natural occurring biodegradable polymer and give **one (1)** example for each class. (6 marks)

c) Starch is a natural polymer. Molecule A is the molecular structure of a monomer that can make starch. Identify the molecule and write its molecular formula. (4 marks)

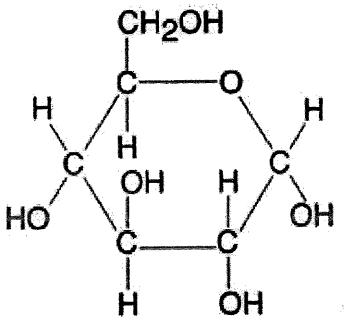
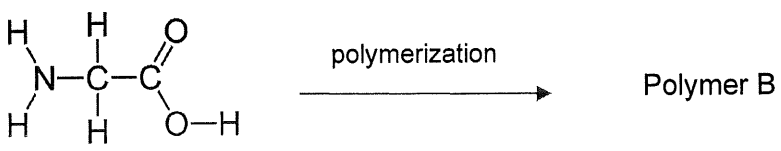


Figure 2: Molecule A

d)



Amino acid

Figure 3: Polymerization of Amino acid

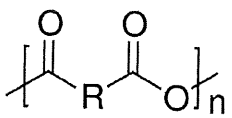
Figure 3 shows the polymerization of amino acid. Amino acid is a monomer for a natural occurring biodegradable polymer, Polymer B.

i) Sketch the molecular structure of Polymer B and predict the general name of the polymer. (5 marks)

ii) Polymer B occurs naturally in living things including human and animal. Polymer B that extracted from animal called as gelatin. Discuss **two (2)** applications of gelatin. (4 marks)

QUESTION 3

a)



R group

Figure 4: Polymer X

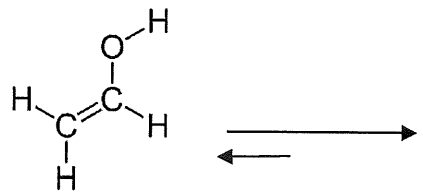
i) Examine the structure of Polymer X and name the polymer. (4 marks)

ii) Polymer X has been used as drug delivery carrier. Discover **three (3)** characteristics of Polymer X that make it ideal as drug carrier. (6 marks)

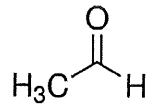
b) Choose **two (2)** renewable resources in producing polylactic acid (PLA). (4 marks)

c) Polyvinyl alcohol (PVA) is commercially important polymer that is often used as a classic example in illustrating the shortcomings of source-based nomenclature. PVA is produced commercially from vinyl acetate, rather than by the polymerization of vinyl alcohol, because vinyl alcohol is less stable than its tautomer, acetaldehyde (Eq 1). By using given chemical (6 marks)

structures in Figure 5 below, illustrate the reactions how vinyl acetate can be used to produce PVA. Show each reaction step clearly.

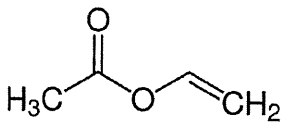


Vinyl alcohol

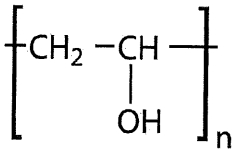


Acetaldehyde

Eq 1



Vinyl acetate



Polyvinyl alcohol

Figure 5

d)

Polymer Y

- Mixture of two types of polymers classes (polyamide and polyesther).
- Excellent thermal & mechanical properties
- High biocompatibility & biodegradability
- The properties can be modified based on the polymer content.

Polymer Y is a synthetic biodegradable polymer. Based on the properties given, predict the name & illustrate the chemical structure of Polymer Y. (5 marks)

QUESTION 4

a) Stabilizers are used at all stages of the polymer life-cycle. Justify the purpose of adding stabilizer to the polymer. (3 marks)

b) Elastomers are susceptible to degradation, however there are some variables in compounding that resist degradation. Discover **three (3)** of the variables. (3 marks)

c) As an engineer, you were asked to develop various automotive parts of hybrid car such as bumper, door panels, door trim and instrument panels. Automotive parts are frequently exposed to demanding environmental conditions such as sunlight, heat, and moisture, which require materials that can endure the exposure and maintain their performance over their lifetime. These above conditions can cause significant damage to the materials used in automotive applications, leading to discoloration, cracking, and premature aging. To address these challenges, identify **three (3)** types of polymer stabilizers that you should add to the materials in order to extend the life and performance of the automotive parts. (6 marks)

d) Distinguish between recycling and incineration in term of their advantages and disadvantages. (8 marks)

e) Based on your knowledge about polymer and environment, debate whether incineration or recycling is better. Justify your answer. (5 marks)

----------End of question----------