



DEPARTMENT OF CHEMISTRY
FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA.
FIRST SEMESTER 2021/2022 SESSION EXAMINATION

Course Code: CHM452

Course Title: Physicochemical Properties of Polymers

Unit: 2

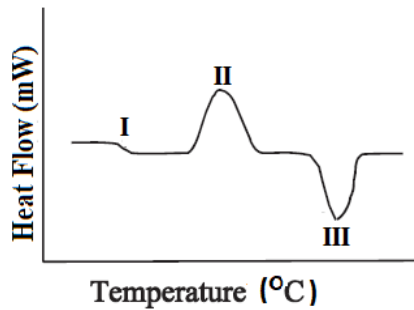
Time allowed: 2 Hours

Instructions: Answer question 1 and any other two.

Q1. Answer **True** or **False** in each of the following sentences. Please, think carefully before answering as cancellations will be penalized (**40 Marks**)

- i. Primary bond forces are sensitive to the distance between molecules.
- ii. A fully cross-linked polymer exhibits plastic deformation.
- iii. Polymer chains packs more tightly together in branched than in linear polymers.
- iv. Increase in crystallinity increases the impact strength of a polymer.
- v. When a polymer sample melts, the sample experiences an increase in energy without a change in temperature.
- vi. A highly crystalline polymer has an irregular placement of atoms in the chain.
- vii. Both amorphous and semi crystalline polymers have well defined T_g .
- viii. High intermolecular forces in polymers increases its free volume.
- ix. A semi crystalline polymer contains crystalline regions embedded in an amorphous phase.
- x. Below T_g , polymers are soft and flexible.
- xi. Random, alternate, graft and block structures are characteristics of homopolymers.
- xii. A polymer whose T_g is -80°C can be used to package frozen foods.
- xiii. Crosslinking in polymers can only be generated during polymerization.
- xiv. Polystyrene is an amorphous polymer.
- xv. At the yield point of a polymer under strain-stress deformation, there is increase in strain as well as the stress.
- xvi. A crystalline polymer exhibits a random molecular orientation in the molten state.
- xvii. Amorphous polymers do not have a melting point.
- xviii. A polymer with a narrow molecular weight distribution melt over a wider temperature range.
- xix. The covalent bond is the predominant bond in polymers.
- xx. Polyvinyl chloride exhibits hydrogen bonding.

Q2. a. Study the following differential scanning calorimetric curve of a semicrystalline polymer sample cooled from the melt and answer the questions that follows (**5 Marks**)



- i. Label points I, II and III.
 - ii. Name the morphologies of a polymer characteristic of points I and III respectively.
 - iii. If the polymer is to be used in the manufacture of a picnic table, suggest a value of point I that will allow for a comfortable use of the table.
 - iv. List four factors that can affect the process at point II.
- b. Indicate how the following properties change with increase in the amorphous content of a polymer (**5 Marks**).
- i. Opacity
 - ii. Density
 - iii. Permeability
 - iv. Tear resistance
 - v. Impact strength
 - vi. Ductility
 - vii. Ultimate elongation
 - viii. Toughness
 - ix. Tensile strength
 - x. Compressive strength

Q3.a. Justify the following observations: (**8 Marks**)

- i. Syndiotactic and isotactic polypropylene can crystallize while atactic polypropylene does not.
- ii. Atactic polyvinyl alcohol and polyvinyl fluoride can crystallize.
- iii. Syndiotactic general-purpose polystyrene is mainly amorphous.
- iv. Step-reaction polymers made from monomers containing three or four functional groups are generally amorphous.

b. The density of a polymer sample is 0.56 g/cm^3 and that of fully crystalline polymer is 1.00 g/cm^3 . Given that the crystallinity of the sample on mass basis is 57.30%. What is the crystallinity on a volume basis? **(2 Marks)**

Q4. a. Indicate the type of orientation in each of the following polymer products: **(2 Marks)**

i. Shopping/carrier bag

ii. Coca-Cola bottle

iii. Gee-Pee tank

iv. Pure water sachet

b. State the type of mechanical property being exerted on the material in each of the following situations: **(2 Marks)**

i. A woman holding a shopping/carrier bag loaded with potatoes.

ii. A student sitting on a plastic stool.

iii. A table tennis ball being played by two boys.

iv. A man lying on a mattress.

c. Given that the T_m of a hypothetical polymer is 100°C .

i. Estimate its T_g . **(2 Marks)**

ii. If the T_g is the only information available on the polymer, draw a well labelled stress-strain deformation diagram for the polymer. **(4 Marks)**