B.Sc. 6th Semester (Honours) Examination, 2025 (CBCS)

Subject : Chemistry

Course: DSE-3

(Polymer Chemistry)

Time: 2 Hours **Full Marks: 40**

The figures in the right hand margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.

1. Answer *any five* questions from the following: 2×5=10

(a) What is polydispersity index? What does it signify?

(b) (i) Define monomer of a polymer.

(ii) Write down the criterion of a molecule to act as monomer.

(c) Crosslinking changes the physical properties of polymer.— Explain.

(d) Why are the numbers 6, 6 and 6 put in the names of nylon–6,6 and nylon–6?

(e) Give one example each of cationic and anionic polymerization.

(f) Write down the characteristic property of a good plasticizer with one example.

(g) What is tacticity of polymers? Give examples.

(h) Write the structure of repeating units in (i) polyvinyl alcohol and (ii) polyisoperene.

2. Answer *any two* questions from the following: 5×2=10

(a) (i) Mention two advantages and two disadvantages of solution polymerization over bulk polymerization.

(ii) What is vulcanization? How is it done? What is butyl rubber? 2+(1+1+1)

(b) (i) Explain with reaction how the production of polyethylene using Ziegler–Natta catalyst differs from production of polyethylene using free radical initiators.

(ii) A high-molecular-weight polyethylene has an average molecular weight of 410,000 g/mol. What is its average degree of polymerization? 3+2

(c) (i) Differentiate between molecular structure and behaviour of thermoplastic and thermosetting plastic. Give one example of each type.

(ii) Why is plasticizer used during moulding of plastics? 3+2

(d) (i) Derive kinetics of addition polymerization using steady state approximation.

(ii) Explain briefly "auto acceleration" in radical polymerization. Why does it happen? 3+2

3. Answer *any two* questions from the following: 10×2=20

(a) (i) Draw and explain the molecular weight distribution curves for monodisperse and polydisperse polymers.

(ii) Calculate the number and weight average molecular weights of a polymer sample containing 20% of polymer A and 80% of polymer B by numbers. The molecular weights of A and B are 3000 g mol^{-1} and 30,000 g mol^{-1} respectively.

(iii) Write the synthesis of Novolac and give its industrial applications. 3+4+3

(b) (i) Derive the rate expression for the step-growth polymerisation in terms of extent of reaction, considering an example of polyester formation in absence of catalyst.

(ii) What are the types of intermolecular forces that govern the chemistry of polymers? State their effects.

(iii) Show that $\overline{M}_w \geq \overline{M}_n$ for a polymer sample. When are they equal? 4+3+3

(c) (i) Differentiate between the following (*any two*):

(I) Condensation and Addition polymers

(II) Random and Block copolymers

(III) Suspension and Solution polymerization

(ii) Colligative properties are used to determine which type of average molecular weight distribution? Explain the limitations of cryoscopy and ebulliometry.

(iii) Give the relationship for changing molecular weight and glass transition temperature (T_g). Discuss one method for determining T_g. 4+3+(1+2)

(d) (i) Define viscosity average molecular weight of polymer. How can it be determined from intrinsic viscosity?

(ii) Give the relationship between cohesive density and heat of vaporization of solvent.

(iii) What is free volume of polymer? How does it affect glass transition temperature, T_g?

(iv) What is the role of inhibitor in free radical polymerization? Explain. (2+2)+2+2+2

B.Sc. 6th Semester (Honours) Examination, 2025 (CBCS)

Subject : Chemistry

Course: DSE-3 (OR)

(Green Chemistry)

Time: 2 Hours **Full Marks: 40**

The figures in the right hand margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.

1. Answer *any five* questions from the following: 2×5=10

(a) Mention two important differences between 'Atom Economy' and 'E-factor'.

(b) Point out two distinct advantages of polyethylene glycol (PEG) as a solvent over other green solvents.

(c) Mention the domains of life cycle assessment (LCA) which are used as a potential tool to assess environmental impact.

(d) What are the two principles of green chemistry relating to industrial vibility of synthesis.

(e) What type of reactions are suitable in flourous solvents and why?

(f) Why is green chemistry called sustainable chemistry?

(g) Ionic liquids are called designer solvents.— Justify.

(h) Name a green alternative reagent for bromine molecule.

2. Answer *any two* questions from the following: 5×2=10

(a) Read the following passage and answer the questions that follow: 1+3+1

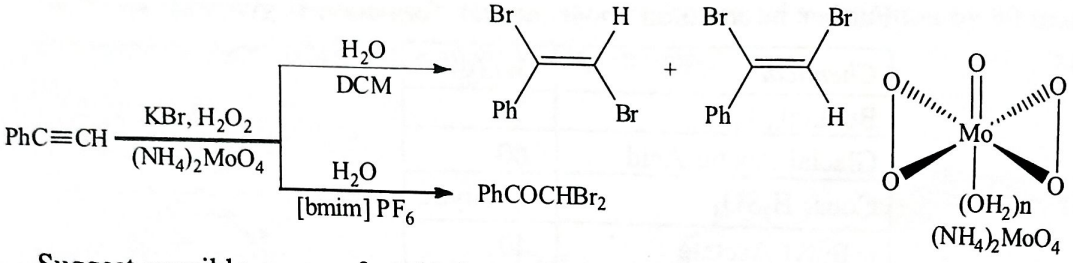
To avoid organic solvents, use of $scCO_2$ has drawn attention of present-day chemists as an environmental measure. To carry out the polymerization reaction between cyclohexane epoxide and CO_2, $scCO_2$ was used for dual character (i) as solvent (ii) as reactant. The nature of the catalyst is also needed to be modified to make it soluble in $scCO_2$; polyfluoroalkyl maleate-Zn complex is used instead of old zinc catalysts as the solubility of the former is such that it behaves as a homogeneous catalyst during such polymerization reaction.

(I) Indicate the category of solvent in which $scCO_2$ can be classified?

(II) What are the advantages of using such solvents? Mention any three.

(III) Give another example where $scCO_2$ is used popularly.

(b) (i) Changing the solvent from the traditional organic solvent to ionic liquid in the following scheme below changes the products entirely. 2+2

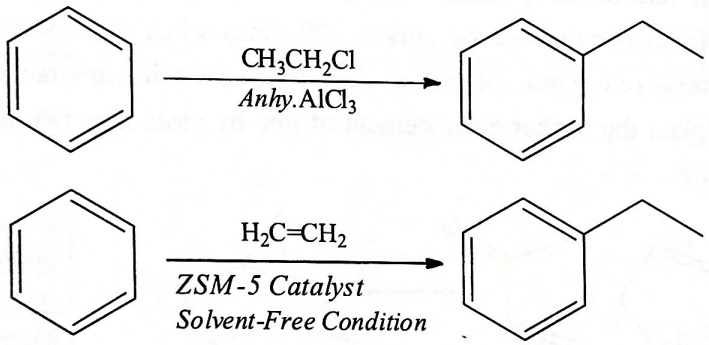


Suggest possible cause of such change with plausible mechanism.

(ii) What is meant by ionicity of an ionic liquid (IL)? 1

(c) (i) Why is microwave a non-ionizing radiation? Give two reasons. 2

(ii) Given below two methods of preparation of ethyl benzene. Indicate the greener method citing three reasons. 3



(d) Read the following extract and answer the question that follows:

(i) Grignard reaction or Simmons–Smith cyclopropanation is generally initiated by stirring few crystals of iodine to augment the reaction of alkyl halide with the metal but the reaction is often uncontrolled i.e. either sometimes slow or sometimes vigorous. The reaction can be controlled nicely under sonication and sometimes proceeds without the use of iodine.

Suggest possible cause of such observation. 3

(ii) Elucidate the criteria for a solvent to be green. 2

3. Answer *any two* questions from the following: 10×2=20

(a) (i) What are "Rightfit Pigments"? Mention its two important characteristics. 1+2

(ii) Esterification of butanol with acetic acid can be illustrated by the following equation which proceeds with 69% yield.

$$CH_3(CH_2)_3OH + CH_3CO_2H \longrightarrow CH_3CO_2(CH_2)_3CH_3 + H_2O$$

Further information about the transformation is given as:

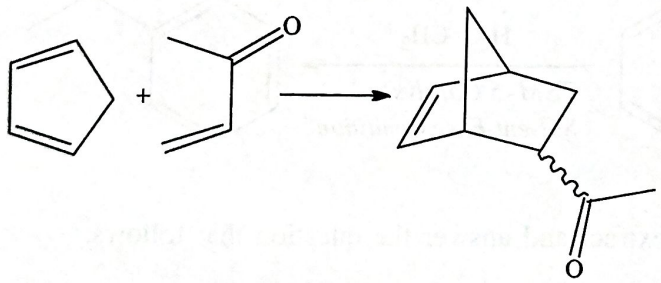
Chemical	*Wt.*(g)
Butanol	37
Glacial Acetic Acid	60
Conc. H_2SO_4	Catalytic
n-Butyl Acetate	40

(I) Calculate Atom Economy, E-Factor, EMY (Effective Mass Yield) for the above reaction.

(II) Point out the green context of the reaction in terms of each of the environmental factors calculated by you. 4.5+1.5

(iii) Name the two factors on which the term Risk depends. 1

(b) (i) The rate of Diels Alder reaction between cyclopentadiene and methyl vinyl ketone (MVK) is enhanced by almost 700 times when the reaction is carried out in water instead of organic solvents as depicted in the following table. Explain the result. Also explain the further enhancement of rate by more than two times when LiCl added to water. 2+2



Solvent	*Relative Rate*
Isooctane	1
Methanol	12.5
Water	740
Water/LiCl	1800

(ii) Explain the following terms giving one example in each case (*any three*): 4

(I) VOC

(II) Toxic chemical

(III) Bio-catalyst

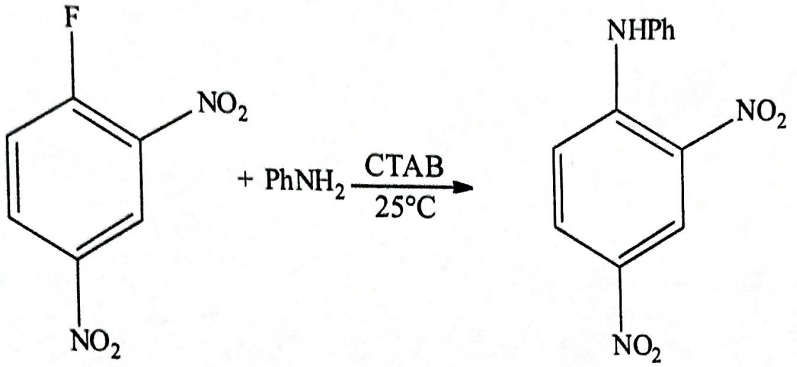
(IV) Non-biodegradable polymer

(iii) Define and explain acoustic cavitation with example. 2

(c) (i) Discuss the advantages and disadvantages of PLA in polymer industry. 2+2

(ii) What is Bio-diesel? How is it prepared? Why are these classes of biofuels called 'Carbon dioxide-neutral'? 2+2+2

(d) (i) Mention the factors responsible for rate enhancement of organic reaction carried out in aqueous micellar medium compared to aqueous medium. Also explain why in the following reaction, the cationic micelle increases the rate of substitution by 30 times compared to water while the anionic variety inhibits. 2+3



CTAB = Cetyltrimethylammonium bromide

(ii) Name four different alternate energy sources other than thermal energy used in chemical reaction. 2

(iii) Define sonoluminescence. Why are sonochemical reactions beneficial over conventional heating? 1+2