

[Time : 3Hours]

[Total marks :100]

N.B. : (1) All questions are compulsory.

(2) Figures to the right indicate full marks.

(3) Use of logarithmic table/non-programmable calculator is allowed.

Physical Constants:

$$N = 6.022 \times 10^{23}$$

$$c = 3.0 \times 10^8 \text{ m/s}$$

$$R = 8.314 \text{ J/K mol}$$

$$h = 6.626 \times 10^{-34} \text{ Js}$$

$$\frac{2.303 RT}{nF} = \frac{0.0592}{n} \text{ at } 298 \text{ K}$$

1. Attempt **any four** of the following:

- A. Define activity and activity coefficient of an electrolyte. Give the expression for activity of the following electrolytes **5**
 i) AlCl_3 ii) CuSO_4 iii) Na_2SO_4
- B. Explain the function of the salt bridge. Why is a saturated solution of KCl generally used in preparation of salt bridge? **5**
- C. Derive an expression for the e.m.f of an electrode concentration cell of the following cell **5**
 $\text{Cd(Hg)}a_1 / \text{CdSO}_4(\text{aq}) / \text{Cd(Hg)}a_2$
- D. Derive an expression for the e.m.f of an electrolyte concentration cell with transference reversible with anion **5**
- E. Calculate the mean activity coefficient of NaCl in a solution containing 0.02 mol/dm^3 of NaCl and 0.05 mol/dm^3 of CaCl_2 ($A=0.509$ at 298K for water) **5**
- F. Define hydrogen overvoltage. In the electrolysis of 2N sulphuric acid the hydrogen overvoltage at lead cathode was found to be 0.352V at 298 K for a given current density what will be the hydrogen overvoltage if the current density is increased six times its present value for the same cathode under the same conditions. (Given: $b = 0.12 \text{ V}$ at 298 K) **5**

2. Attempt **any four** of the following.

- A. Explain the terms **5**
 i) Monomer
 ii) Polydispersity Index
 iii) Degree of polymerization
- B. In a polymer sample 30% molecules have a molecular weight 20,000, 40% have molecular weight 30,000 and 30% have 60,000. Calculate number average and weight average molecular weights for given polymer. **5**
- C. Explain the classification of polymers on the basis of the structure. **5**
- D. Explain the viscosity method for determination of molecular weight of polymers. **5**
- E. Explain number average molecular weight and weight average molecular weight **5**
- F. Describe advantages and applications of light emitting polymers. **5**

3. Attempt **any four** of the following:
- A. Explain the Compton effect using Quantum mechanics and also give limitations of Classical mechanics in explaining it. **5**
 - B. Find the eigen value and state whether the function is an Eigenfunction for then operator $\frac{d^2}{dx^2}$ for the following function. **5**
 - i) $6\cos 4x$ ii) $3e^{5x}$
 - C. Write a note on: **5**
 - i) Wave matter duality of matter ii) Heisenberg Uncertainty Principle
 - D. What is a commutative operator? Explain and prove it with an example. **5**
 - E. Discuss the classification of conductor, semiconductor and insulator on the basis of band gap. **5**
 - F. Explain production of hydrogen gas using electrolysis of water and mention advantages of hydrogen gas as fuel. **5**
4. Attempt **any four** of the following:
- A. Explain the working of NMR Spectrometer with the help of a neat labelled diagram **5**
 - B. Derive the fundamental equation of NMR spectroscopy **5**
 - C. Explain the relaxation processes in NMR spectroscopy. **5**
 - D. Explain the principle of ESR spectroscopy **5**
 - E. Draw diagram of ESR spectrometer and explain functions of following in ESR spectrometer i) Klystron oscillator ii) Sample cavity iii) Crystal detector **5**
 - F. Explain fine splitting and hyperfine splitting of hydrogen ESR spectrum. **5**
5. **Answer the following:**
- A. Select whether the following statements are **true** or **false** (**Any five**) **5**
 - a. For a concentration cell, the standard emf of the cell is unity
 - b. Reduction involves the decrease in the oxidation state of the metal ion
 - c. The deviation of an electrolyte solution from its ideal behaviour is called as activity
 - d. A plot of log of mean activity coefficient versus square root of ionic strength gives a positive slope
 - e. The value of liquid junction potential depends on the volume of the electrolyte in a galvanic cell
 - f. The minimum external potential that must be applied between electrodes in an electrolytic solution to bring continuous electrolysis is called as decomposition potential
 - g. The cause of polarization phenomenon in an electrolytic cell is due to back emf
 - h. Overvoltage is dependant on temperature
 - B. Fill in the blank with appropriate words (**Any five**) **5**
 - a. _____ is an example of natural polymer (nucleic acid, PVC, Rayon, polyester)
 - b. Thermoplast are the polymers which soften when heated and _____ when cooled. (brittle, harden, blackned, colourless)

- c. Weight average molecular weight is defined by symbol _____
($\overline{M}_n, \overline{M}_w, \overline{M}_z, \overline{M}_v$)
- d. Heating rubber with sulphur is called _____
(Galvanization, Vulcanization, Sulphonation, Bessmerisation)
- e. Which is a naturally occurring polymer _____
(polythene, protein, PVC, Polypropylene)
- f. In linear polymers monomeric units are ----- together (break up,
branched,cross linked, linked)
- g. PVC is an example of----- polymer
(inorganic, organic, bio-organic, natural)

C. Select and write the appropriate answer. (Any five)

5

- a. According to Quantum mechanics, ejection of electrons from metal in Photoelectric effect is dependant on _____ of the radiation
a) Intensity b) Frequency c) temperature
- b. In Black body radiation as temperature of the body increases, _____ of the emitted radiation
a) wavelength and intensity increase
b) wavelength and intensity decrease
c) wavelength decreases, intensity increases
- c. The wave function defined for a system has to be -----
a) single valued b) infinite c) discontinuous
- d. Which of the following is not correct about standing waves?
a) amplitude vary with time b) confined in a space c) Do not propagate
- e. If operator satisfies, $\hat{A} [f(x) + g(x)] = \hat{A} f(x) + \hat{A} g(x)$, operator is said to be ---
a) commutative b) linear c) harmonic
- f. Which of the following is a nonrenewable source of energy?
a) Tidal b) CNG c) Solar
- g. A solar cell works on the principle of
a) Photovoltaic effect b) Photoelectric effect c) Thermoelectric effect
- h. Which of the following is an advantage in using hydrogen as a future fuel?
a) transportation b) high calorific value c) storage

D.

Match the column: (Any five)

5

Column A

Column B

- | | |
|------------------------------------|--------------------------------|
| a. C_{12}^6 | i. 2.0023 |
| b. Precessional angular frequency | ii. $I = \frac{1}{2}$ |
| c. Degenerate energy level | iii. Tetramethylsilane(TMS) |
| d. D_1^2 | vi. ∞ |
| e. N_7^{15} | v. $I = 1$ |
| f. g value of free electron in ESR | vi. Absence of magnetic field |
| g. Reference compound in NMR | vii. 2.2003 |
| | viii. $I=0$ |
| | ix. Presence of magnetic field |
| | x. $I = \frac{3}{2}$ |