03/04/24

[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:

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

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

$R = 8.314$ J/K mol

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

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

$Cd(Hg)a_1 / CdSO_{4\,(aq)} / Cd(Hg)a_2$

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 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) 6cos4x 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. $I = ½$
c. Degenerate energy level	iii. Tetramethylsilane(TMS)
d. D_1^2	vi. ω_o
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. $I = \frac{3}{2}$
