

- (b) Explain the construction and working of a glass electrode.
- (c) What is the source of alkaline error ? Illustrate the alkaline error of selected glass electrodes at room temperature. **4,5,3**

Roll No.

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LMDQ/M-24

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PHYSICAL CHEMISTRY SPECIAL-IV
CHEM-402

Time : Three Hours]

[Maximum Marks : 60

Note : Attempt *Five* questions in all, selecting at least *one* question from each Section. All questions carry equal marks.

Section A

1. (a) List any *two* successes and failures of classical free electron theory of solids.
- (b) Using quantum free electron theory of solids, calculate the relaxation time and fermi energy for aluminium at 300 K. Given that $\rho_m = 2700 \text{ kg/m}^3$, $\rho = 6.8 \times 10^7 \text{ } \Omega\text{m}$, Atomic Mass = 26.98 g/mol.
- (c) Discuss qualitatively the origin of band gaps in solids. **4,3,5**
2. (a) Prove that for an intrinsic semiconductor at 0 K, the fermi level lies in the middle of conduction and valence band.

- (b) What is the threshold energy required to generate electron-hole pair in direct and indirect band gap materials ? Explain in detail.
- (c) Draw band energy diagram for rectifying contact between metal and n-type semiconductor. **4,5,3**

Section B

- 3. (a) Explain the working principle of conventional solar cell with the help of band energy diagram.
- (b) Derive the expression for V_{OC} in terms of I_0 and I_L .
- (c) What is the maximum power that can be obtained from a solar cell ? Discuss. **6,2,4**
- 4. (a) Discuss the salient features of cell design of a solar cell belonging to class of III-V semiconductors.
- (b) Differentiate between LCPV and HCPV.
- (c) How does doping improve the conversion efficiency of a solar cell ?
- (d) What are deep cycle batteries ? Explain in brief the working of any *one* kind of batteries used in PV storage system. **3,3,3,3**

Section C

- 5. (a) Derive current-overpotential equation.
- (b) Derive Tafel equations from Butler Volmer equation and discuss the significance of Tafel plot. **8,4**
- 6. (a) What is Overpotential ? Briefly discuss its different types.
- (b) Explain the shape of cyclic voltammogram obtained for a reversible electrochemical reaction.
- (c) Discuss different Nyquist plots that can be obtained for an electrochemical system.
- (d) What is Electrocatalysis ? Illustrate with an example. **3,3,2,4**

Section D

- 7. (a) Based on thermodynamics of water splitting, explain the electrolysis of sea-water.
- (b) With the help of potential-pH diagram, explain the stability of oxide and hydroxide of a metal.
- (c) Write a short note on surface modified electrodes and discuss their applications. **4,4,4**
- 8. (a) Describe crystalline membrane electrodes. Discuss these with reference to fluoride ion.