[Time: 2hr] **[Marks:50]**

Please check whether you have got the right question paper.

N.B.: 1. All questions are compulsory.
2. Figure to the right indicates full marks.
3. Use of non – programmable scientific calculator is allowed.

Useful constants

$c = 2.998 \times 10^{8}$ m.s^{-1}	$e = 1.602 \times 10^{-19}$ C
$R = 8.314$ J.K^{-1}mol^{-1}	$k = 1.3811$ x 10-23 J.K^{-1}
$= 2.0$ cal.K^{-1} mol^{-1}	
$h = 6.626 \times 10^{-34}$ Js	$1J = 6.24 \times 10^{18}$ eV
$m_e = 9.110 \times 10^{-31}$ kg	$1eV = 8.06 \times 10^{3}$ cm^{-1}
$NA = 6.022 \times 10^{23}$ mol^{-1}	1 amu = 1.66×10^{-27} kg

Atomic mass of H = 1, C = 12, N = 14, O = 16, S = 32, Cl = 35.5

1. Attempt ***any two*** of the following:
   - i) Derive the following Maxwell equation. $(\partial T/\partial V)_S = -(\partial P/\partial S)_V$ 05
   - ii) Calculate μ_{JT} for certain gas at 373 K and 1.01235 X 10^{-5} pa taking C_P as 55.5JK^{-}mol^{-} . The Van der Waals constant a and b are 0.0125 Nm^{4}mol^{-2} and 3.15 X 10^{-5} m^{3}mol^{-}. Given R = 0.0821 Cal. 05
   - iii) Define entropy. Write the expression for entropy change in the following phase transition. 05
     1) Vaporization 2) Melting 3) Sublimation 4) Allotropic transformation.
   - iv) State the third law of thermodynamics. How will you determine the absolute entropy of a liquid using third law of thermodynamics. 05

2. Attempt ***any two*** of the following:
   - i) Set up a Schrodinger wave equation for a particle in one dimensional box and obtain a normalised wave function for it.
   - ii) State the postulates of Quantum Mechanics.
   - iii) Determine the degeneracy of the levels.
     a) $E = \frac{9h^2}{8ma^2}$ b) $E = \frac{26h^2}{8ma^2}$
   - iv) Derive the Hermite differential from the relation.
     $\frac{d^2\Psi}{dy^2} + (\frac{\alpha}{\beta} - y^2)\Psi = 0$

3. Attempt ***any two*** of the following:
   - i) Explain the kinetics of free radical polymerization. 05
   - ii) Explain the Rice-Ramsperger-Kassel-Marcus theory. 05
   - iii) Write the reaction mechanism for the decomposition of acetaldehyde and using steady state principle show that $d/dt[CH_4] = k[CH_3CHO]^{3/2}$. 05
   - iv) The rate of formation of C in the reaction, 05
     $2A + B \rightarrow 2C + 3D$ is 4molL^{-1}s^{-1}.
     State the rate of reaction and the rates of formation or consumption of A, B and D.

4. Attempt ***any two*** of the following:

i) a) Explain Wein effect for the conductance of strong electrolytes. 02

b) Calculate mean ionic activity coefficient of 0.05m $Al_2(SO_4)_3$ in aqueous solution at 298K. (Given: A = 0.509 at 298 K). 03

ii) With the help of diagram explain construction and working of Alkaline fuel cell. Also write one advantage of fuel cell over conventional cell. 05

iii) a) Write a note on the electrochemical enzyme – catalysed oxidation of Styrene. 03

b) Calculate the resting membrane potential for the following: 02

Ion Species	Intracellular concentration in mM	Extracellular concentration in mM
Cl^-	12	0.003

(Given that $\frac{2.303RT}{F}$ at $298K = 61$)

iv) a) What is ion atmosphere? Explain the relaxation effect for the conductance of strong electrolytes. 03

b) Draw well labelled diagram and write one application of Molten carbonate fuel cell. 02

5. Attempt ***any five*** of the following:

i) Explain the term residual entropy. 02

ii) Explain exact differential equation. 02

iii) If $\hat{A} = \frac{d^2}{dx^2}$, and f(x)=cos(2x) then show that f(x)=cos(2x) is an eigen function of operator $\frac{d^2}{dx^2}$ .Find its eigen value 02

iv) Define a) Commutative Operator b) Hamiltonian Operator 02

v) In the following reaction scheme, write the rate equation for the removal of species C and D in differential form. 02

1) $A + B \xrightarrow{k_1} C + D$
2) $C + D \xrightarrow{k_2} A + B$
3) $C + B \xrightarrow{k_3} E + D$
4) $2D \xrightarrow{k_4} F$

vi) Explain any two explosion limits of non – stationary chain reaction. 02

vii) Write Debye-Huckel-Onsager equation and briefly explain its validity for non-aqueous solutions. 02

viii) Write two functions of cell membrane. 02

****