

**2021**

**BIOCHEMISTRY — HONOURS**

**Third Paper**

**(Module – V)**

**Full Marks : 50**

*The figures in the margin indicate full marks.*

*Candidates are required to give their answers in their own words  
as far as practicable.*

1. Answer **any ten** questions : 2×10
- (a) What is van't Hoff factor? Write its limiting value for  $\text{H}_2\text{SO}_4$ .
  - (b) State the laws of thermochemistry.
  - (c) Write Stern–Volmer equation of quenching of fluorescence mentioning each term involved.
  - (d) What is Nernst Distribution Law? Mention its significance.
  - (e) Calculate the ionic strength of a solution containing 0.2M NaCl and 0.1M  $\text{Na}_3\text{PO}_4$ .
  - (f) What is the work done when 3 moles of an ideal gas expands in vacuum from 300cc to 400cc at 273K?
  - (g) Name the amino acids responsible for protein fluorescence.
  - (h) What are 'hot bands' in IR spectroscopy?
    - (i) Between CO and  $\text{CO}_2$ , the symmetric stretch will be IR active in which case and why?
    - (j) Mention one use of each of  $\text{C}^{14}$  and  $\text{P}^{32}$ .
  - (k) Draw the NMR pattern observed for ethanol mentioning the intensity and splitting of each band.
  - (l) Under what conditions  $\Delta A \leq 0$  can be used as a criterion for spontaneity and equilibrium of a process?
  - (m) What are half-life and average life of a radioelement?
  - (n) 'Absorbance is additive'— Justify or criticize the statement.
  - (o) State Debye–Huckel limiting law and discuss its validity range.

**Unit – I**

Answer **any one** question.

2. (a) What is Joule coefficient? Show that the Joule coefficient  $\eta = -\frac{1}{C_V} \left( \frac{\partial u}{\partial V} \right)_T$ .
- (b) A resting human being typically heats the surrounding at a rate of  $100\text{Js}^{-1}$ . Estimate the entropy generated in the surroundings in the course of an entire day at  $25^\circ\text{C}$ .

**Please Turn Over**

(c) For the adiabatic reversible process in an ideal gas from  $p_1, T_1 \rightarrow p_2, T_2$ , evaluate the relationship between  $p$  and  $T$ . Hence use this expression to show that  $\Delta S = 0$  is obtained from it.

(d) Starting from Clausius inequality show that  $\Delta S_{u,v} < 0$  for a spontaneous process.

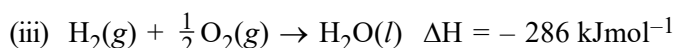
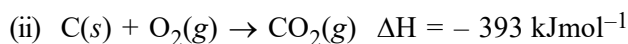
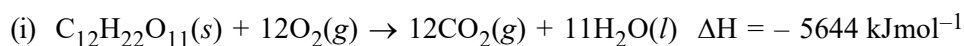
(1+2)+2+(2+1)+2

3. (a) Evaluate 'q' for each step in a Carnot cycle and hence show that the quantity  $\left(\frac{q}{T}\right)$  for the entire

cycle  $\left[\oint \frac{dq}{T}\right]$  is zero. What is the significance of this quantity  $\left(\frac{q}{T}\right)$ ?

(b) Give the characteristics of a first-order phase transition with example.

(c) Calculate the enthalpy of formation of  $C_{12}H_{22}O_{11}$  from the given data :



(2+2+1)+2+3

## Unit – II

Answer **any one** question.

4. (a) Derive  $\frac{d \ln k_p^0}{dT} = \frac{\Delta H^\circ}{RT^2}$  and hence comment on the sign of the slope of the curve  $\ln k_p^0$  vs.  $\frac{1}{T}$  for both exothermic and endothermic reactions.

(b) The equilibrium constant is doubled when the temperature of a reaction is raised from 300 to 310K. Find the standard enthalpy for the reaction. Mention the assumption used in the calculation.

(c) For the cell reaction  $Zn(s) + CuSO_4(aq) = ZnSO_4(aq) + Cu(s)$ , write down the Nernst equation for the emf of the cell.

4+(2+1)+3

5. (a) Using the concept of chemical potential, derive the relationship between osmotic pressure and molar concentration of a solute in solution. Mention two assumptions used to derive this relationship.

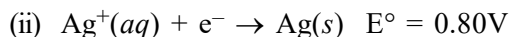
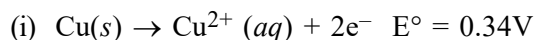
(b) Write short notes on :

(i) Critical micelle concentration (cmc)

(ii) Electrophoresis

(iii) Zeta Potential.

(c) Two half-cell reactions are given below along with their standard reduction potential values ( $E^\circ$ ) :



Comment on the spontaneity of the cell reaction involving these half-cells.

(3+2)+(1×3)+2

### Unit – III

Answer *any one* question.

6. (a) At 360 nm, a blue filter transmits 40% and a yellow filter transmits 20% of the incident radiation. Evaluate the total absorbance of the two filters in combination at the same wavelength.
- (b) Explain the stability of the nucleus in terms of the ratio of number of neutrons and protons.
- (c) In an organic compound  $\text{C}_3\text{H}_6\text{O}$ , there is a carbonyl group. How can its  $^1\text{H}$ -NMR spectrum decide whether it is an aldehyde or a ketone group?
- (d) How fluorescence resonance energy transfer could be applied for measuring the distance between two domains in a protein?
7. (a) Proteins with optically inactive amino acid glycine can be active in circular dichroism. Justify.
- (b) Arrange the following in ascending order of their bond stretching vibrations with suitable reasoning :
- (i)  $-\text{C}-\text{Br}$ ,  $-\text{C}-\text{F}$ ,  $-\text{C}-\text{Cl}$ ,  $-\text{C}-\text{I}$
- (ii)  $-\text{C}-\text{H}$ ,  $-\text{O}-\text{H}$ ,  $-\text{N}-\text{H}$
- (c) What is chemical shift and how is it expressed? Will the chemical shift value change for the aromatic protons in benzene if we measure the  $^1\text{H}$ -NMR spectrum in a 300 MHz and a 600 MHz instrument? Justify.

2+(2+2)+(2+2)