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 H_2SO_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 Na_3PO_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 CO_2, the symmetric stretch will be IR active in which case and why?

(j) Mention one use of each of C^{14} and 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 $100 Js^{-1}$. Estimate the entropy generated in the surroundings in the course of an entire day at 25°C.

(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 :

(i) $C_{12}H_{22}O_{11}(s) + 12O_2(g) \rightarrow 12CO_2(g) + 11H_2O(l)$ $\Delta H = -5644$ kJmol^{-1}

(ii) $C(s) + O_2(g) \rightarrow CO_2(g)$ $\Delta H = -393$ kJmol^{-1}

(iii) $H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l)$ $\Delta H = -286$ kJmol^{-1} (2+2+1)+2+3

Unit – II

Answer ***any one*** question.

4. (a) Derive $\frac{d\, ln\, k_p^o}{dT} = \frac{\Delta H^\circ}{RT^2}$ and hence comment on the sign of the slope of the curve $ln\, k_p^o$ 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°) :

(i) $Cu(s) \rightarrow Cu^{2+}(aq) + 2e^-$ $E° = 0.34V$

(ii) $Ag^+(aq) + e^- \rightarrow Ag(s)$ $E° = 0.80V$

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 C_3H_6O, there is a carbonyl group. How can its ^{1}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? 3+2+2+3

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) – C – Br, – C – F, – C – Cl, – C – I

(ii) – C – H, – O – H, – N – 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}H-NMR spectrum in a 300 MHz and a 600 MHz instrument? Justify. 2+(2+2)+(2+2)