UNIVERSITY OF NORTH BENGAL

B.Sc. Honours 2nd Semester Examination, 2021

CC4-CHEMISTRY

PHYSICAL CHEMISTRY

Full Marks: 40

ASSIGNMENT

The figures in the margin indicate full marks.
All symbols are of usual significance.

Answer any *four* questions 10×4 = 40

1. (a) State the First Law of Thermodynamics and show how it leads to the concept of internal energy. 3

   (b) Show that adiabatic P-V curves are steeper than isothermal curves. 3

   (c) One mole of an ideal gas expands from 10 litres to 50 litres at 27°C in the following way: 4

   (i) Isothermally and reversibly

   (ii) Against a constant pressure of 1 atmosphere

   Show by calculation in which case more heat will be absorbed during expansion.

2. (a) Draw the S-T diagram of Carnot engine and find out its efficiency. 3

   (b) Calculate the efficiency of a reversible Carnot engine working between 100 K and 500 K. Calculate the maximum work obtained in joules if the engine absorbs 1 kJ of heat from source. 4

   (c) State and explain Third Law of Thermodynamics. 3

3. (a) Derive Gibbs-Helmholtz equation: 4

   $$[\partial(\Delta G/T)/\partial T]_P = -\Delta H/T^2$$

   (b) Explain the significance of the Gibbs-Helmholtz equation. 2

   (c) Calculate the enthalpy change for the process: 4

   $$H_2O\,(l, -10°C) \rightarrow H_2O(s, -10°C)$$

   Given, C_p for water(liquid) = 75.4 JK^{-1} mol^{-1}

   C_p for ice(solid) = 37.2 JK^{-1} mol^{-1}

   Latent Heat of Fusion of ice at 0°C = 6.008 kJK^{-1} mol^{-1}

4. (a) What is Joule-Thomson Effect? 2

   (b) Deduce the relationship: $\mu_{J,T} = -1/C_P\,(\partial H/\partial P)_T$ 3

   (c) What do you understand by inversion of temperature? Why do He and H_2 show heating instead of cooling? 2+1

   (d) Derive the Maxwell relation: $(\partial S/\partial P)_T = -(\partial V/\partial T)_P$ 2

5. (a) Derive the relation between the equilibrium constants K_P, K_C and K_X. Under what conditions, $K_P = K_C = K_X$. (where P, C, X stand for partial pressure, molar concentration and mole fraction). 2+1

   (b) Derive the van't Hoff equation in the form of: $\frac{d(InK_P)}{dT} = \frac{\Delta H^\circ}{RT^2}$. Integrate this equation and discuss the effect of temperature on K_P. 3+4

6. (a) State Le Chatelier's Principle. On the basis of Le Chatelier's Principle, discuss the effect of: 2+(1+1)

   (i) Temperature on Solubility of gases.

   (ii) Pressure on melting point of ice.

   (b) Explain the effect of temperature and pressure on the following equilibria: $(2\frac{1}{2}+2\frac{1}{2})$

   (i) $N_2(g) + O_2(g) \rightleftharpoons 2NO_2(g) \quad \Delta H = +180\,kJ$

   (ii) $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3 \quad \Delta H = -92\,kJ$

   (c) Distinguish between ΔG and ΔG°. 1

7. (a) State Raoult's Law. 1

   (b) Give the thermodynamic derivation of relative lowering of vapour pressure. 4

   (c) Establish from Thermodynamic consideration, $\Delta T_f = K_f\ m$. 5

8. (a) What are abnormal solutions? 2

   (b) Show that the van't Hoff factor i and degree of association α of a solute in a solution are related in the given reaction: $nA \rightleftharpoons (A)n$. 3

   (c) What is Reverse Osmosis? 2

   (d) A 5.13% of solution is isotonic with a 0.9% solution of an unknown non-volatile solute. Calculate the molar mass of the solute. 3

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