2024
B.A./B.Sc.
Second Semester
CORE – 4
CHEMISTRY
Course Code: CHC 2.21
(Physical Chemistry - II)

Total Mark: 70 *Pass Mark: 28*
Time: 3 hours

Answer five *questions, taking* one *from each unit.*

UNIT–I

1. (a) With the help of an example, define intensive and extensive property of a system. Suggest a method to check whether the given property of a system is extensive or intensive. 6
   (b) Derive an expression of an entropy change for an ideal gas when temperature changes from T_1 to T_2 and the volume changes from V_1 to V_2. 5
   (c) What are state functions and path functions? 3

2. (a) Deduce a relation between C_p and C_v. 4
   (b) Discuss molecular and statistical interpretation of entropy. 3+3=6
   (c) Define the following terms: 1×4=4
   (i) Isothermal process (ii) Adiabatic process
   (iii) Isochloric process (iv) Isobaric process

UNIT–II

3. (a) Discuss how to determine absolute entropy of a substance using Debye T^3 law. 6
   (b) Describe the application of bond energy in determining: 3×2=6
   (i) Enthalpies of reaction
   (ii) Enthalpies of formation of compound
   (c) Show how to give sign to ΔU (internal energy change) for endothermic and exothermic reactions. 2

4. (a) State and explain Hess's law of constant heat summation. Discuss the application of Hess's law for calculating the enthalpies of reactions by taking specific example. 6
   (b) Derive Kirchorff's equation for the effect of temperature on heat of reaction. 5
   (c) What is enthalpy of combustion? Why is it dependent upon the physical state of a substance? 3

UNIT–III

5. (a) Establish the relation of Joule Thomson coefficient with other thermodynamic parameters. 5
   (b) Define chemical potential. Discuss its variation with temperature and pressure. 1+4=5
   (c) Mention some limitations of the criteria of spontaneity. 4

6. (a) Derive an expression for criterion for spontaneity in terms of: 3×2=6
      (i) Change of enthalpy
      (ii) Free energy change
   (b) What are partial molar properties? Derive Gibbs-Duhem equation. 1+3=4
   (c) Discuss the change in entropy on mixing ideal gases. 4

UNIT–IV

7. (a) Present the concept of fugacity to express the free energy of real gases. 5
   (b) Calculate the free energy change accompanying the compression of 1 mole of a gas at 57°C from 25 to 200 atm. The fugacities of the gas at 57°C may be taken as 23 and 91 atm respectively at pressure of 25 and 200 atom. 4
   (c) With the help of Le-Chatelier's principle, work out the conditions which would favour the formation of ammonia and nitric oxide in the following reaction. 5

$$N_2\,(g) + 3H_2\,(g) \longleftrightarrow 2NH_3\,(g)\ ;\ \Delta H = -99.38\ KJ$$

$$N_2\,(g) + O_2\,(g) \longleftrightarrow 2NO\,(g)\ ;\ \Delta H = 180.75\ KJ$$

8. (a) Thermodynamically derive a relation between Gibb's free energy of reaction and reaction quotient. 6

(b) Establish the relation of, effect of mixing on the Gibb's free energy of a binary solutions and its spontaneity. 5

(c) Calculate the standard free energy of formation of H_2O (l)

H_2 (g) + ½O_2 (g) $\longrightarrow$ H_2O (l) $\Delta H_f^\circ = -286.2$ KJ

Given: standard entropies of H_2(g), O_2 (g) and H_2O (l) are 130.60, 205.11 and 70.29 JK^{-1} mol^{-1} respectively. 3

UNIT–V

9. (a) State and explain Henry's law. Also mention its limitation. 6

(b) What is Vant Hoff factor? With the help of this factor, deduce a relation for degree of association in abnormal solution. 4

(c) Acetic acid associates in benzene to form dimmers 1.65g acetic acid when dissolve in 100g of benzene raised the boiling point by 0.36°C. Calculate the Vant Hoff factor and the degree of association of acetic acid in benzene (Kb =2.57K Kg mol^{-1}). 4

10. (a) Discuss the free energy change on mixing for an ideal solution. 5

(b) Using chemical potential derive thermodynamically the depression of freezing point. 5

(c) Define the following terms: 1×4=4

(i) Normality (ii) Molarity

(iii) Molality (iv) Mole fraction