October 2025
B.A./B.Sc.
Third Semester
MAJOR – 4
CHEMISTRY
Course Code: CHM 3.21
(Chemical Thermodynamics & Its Application)

Total Mark: 50 *Pass Mark: 20*
Time: 2 hours

I. Answer the following questions.

1. (a) Differentiate between intensive and extensive properties. Classify the following properties in these two categories: 2+2=4
   (i) Mass (ii) Time
   (iii) Free energy (iv) Specific heat
   (b) What do you understand by heat capacities of a system? Explain the two types of heat capacity of a system. 1+3=4
   (c) Explain the change in thermodynamic functions in mixing of ideal gases for free energy. 4

2. (a) What is enthalpy of combustion? Why is it dependent upon the physical state of a substance? 3
   (b) The heat of combustion of ethyl alcohol is –330 kcal. If the heat of formation of CO_2 (g) and H_2O (l) are –94.3 kcal and –68.5 kcal respectively, calculate the heat of formation of ethyl alcohol. 4
   (c) Discuss the Maxwell's relationship. 5

3. (a) Derive the thermodynamic relation between Gibbs free energy of reaction and reaction quotient. 6
   (b) Define vapour pressure of a liquid. Give its thermodynamic derivation using chemical potential in terms of molar mass determination of solute. 6

II. Answer <u>any two</u> *of the following questions.*

4. (a) What are state functions and path functions? 3

(b) Calculate the entropy change in the thermodynamic expansion of 2 moles of gas from: 2×2=4

(i) A volume of 5 litres to 50 litres at 303 K.

(ii) From a pressure of 10 atmosphere to a pressure of 2 atmosphere at 293 K.

OR

5. (a) Calculate the pressure-volume and work performed by the system during reversible isothermal expansion of two moles of ideal gas from 2 litres to 10 litres at 20°C. 3

(b) What is a spontaneous process? Give the criteria for spontaneity of a process. 1+3=4

6. (a) Derive the Kirchoff's equation. 4

(b) The standard heat of formation of C_2H_5OH (l), CO_2 (g) and H_2O (l) are: –277.0, –393.5 and 285.5 kJ/mol respectively. Calculate the standard heat change for the reaction. 3

OR

7. (a) Derive an expression for variation of entropy with P, T, V. 5

(b) What are partial molar properties? Explain. 2

8. (a) State Le Chatelier's principle. Explain the effect of temperature and pressure on the state of equilibrium with examples. 1+4=5

(b) The value of K_P at 20°C for the reaction $2NO(g) + Cl_2(g) \rightleftharpoons 2NOCl(g)$ is 1.9×10^3 atm^{-1}. Calculate the value of K_C at the same temperature. 2

OR

9. (a) What do you mean by degree of advancement of a chemical reaction? 3

(b) Acetic acid associates in benzene to form dimmers 1.65 g acetic acid when dissolve in 100 g 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 (K_b = 2.57K kg mol^{-1}). 4