PHYSICAL CHEMISTRY-III

(Semester-III)

(Common with B.Sc., Bio-Technology, Industrial Microbiology)

Time : Three Hours] [Maximum Marks : 35

Note : Attempt five questions in all, selecting two questions from each of Section A and B. Question No. IX (Section C) is compulsory. Use of scientific non-programmable calculator is allowed.

Section-A

I. (a) Show that for reversible adiabatic expansion of an ideal gas $TV^{\gamma-1}$ = constant. 3

(b) Define First Law of Thermodynamics in atleast three ways. Derive mathematical expression for ist law. 2

(c) Prove that C_p for an ideal gas is constant and nearly equal to 5 cal. $degree^{-1}$ mol^{-1}. 2

II. (a) Prove that Joule-Thomson coefficient for an ideal gas is zero. What is inversion temperature. 3

(b) 10 moles of an ideal gas expand isothermally and reversibly from a pressure of 10 atm. to 2 atm. at 300 K. Calculate the work done in the process. 2

(c) Define Enthalpy of neutralization. Explain why enthaply of neutralization of a strong acid and strong base remains the same and changes of one of them is weak. 2

III. (a) State and explain Carnot's theorem. Explain how on the basis of efficiency of a reversible heat engine thermodynamic scale of temperature was developed by Lord Kelvin. 3

(b) Distinguish between :
(i) Isothermal and Adiabatic process. (ii) Dependent and Independent variables.
(iii) Reversible and Irreversible processes. 3

(c) What are the limitations of First law of Thermo-dynanics ? How have these been overcome by the second law of thermodynamics ? Define it in as many ways as you can. 2

IV. (a) Define Heat Capacity. Derive a relationship between Heat capacity at constant pressure and Heat capacity at constant volume. 3

(b) Calculate the maximum efficiency of a stream engine operating between 110°C and 25°C. What would be the efficiency of the engine if the boiler temperature is raised to 140°C, the the temperature of the sink remaining the same ? 2

(c) Define 'Bond Energy'. How is the bond energy of a bond calculated for a polyatomic molecule? How is it used to calculate the enthalpy change of a reaction ? 2

Section-B

V. (a) Derive an expression for the entropy change on mixing of ideal gases. From this expression what do you conclude about decrease or increase of entropy on mixing. 3

(b) Apply Le-Chatelier's principle to predict suitable condition for getting maximum yield of the product in the manufacture of hydrogen by Bosch process. 2

(c) Defice thermodynamically the relationship $(\Delta G)_T = nRT \ln \frac{P_2}{P_1}$

VI. (a) Show that $(\Delta G) = \Delta H + T\left[\frac{\partial(\Delta G)}{\partial T}\right]_p$ 3

(b) Prove that there is no net change in entropy in a reversible process and $\Delta S_{system} + \Delta S_{surrounding} \geq 0$ for an irreversible process. 2

(c) Derive the following thermodynamic expression

(i) $\left(\frac{\partial A}{\partial V}\right)_T = -P$. (ii) $\left(\frac{\partial A}{\partial T}\right)_V = -S$.

VII. (a) State third law of thermodynamics. Describe its importance in detail. 2

(b) For a gaseous reaction in equilibrium derive the relation $\Delta G^0 = -RT \ln k_p$. 3

(c) One mole of helium gas is heated from a temperature of 300 K to 600 K. Calculate the enteropy change if (i) Volume is kept constant (ii) Pressure is kept constant. Assume that 2

helium behaves like an ideal gas and $C_v = \frac{3}{2}R$. 2

VIII. (a) Derive Van't Hoff equation (Reaction-isochore) giving the effect of temperature on equilibrium constant. 3

(b) Define law of chemical equilibrium. How can it be derived thermodynamically ? 2

(c) The normal boiling point of water is 100°C. It vapour pressure at 80°C is 0.4672 atm. Calculate the enthalpy of vaporization per mole of water. 2

Section - C
(Compulsory Question)

IX. Attempt in short :

(a) Under what conditions an extensive property may become intensive property. Give an example. 1

(b) How will you distinguish between a path function and state function. 1

(c) State Le-Chateller's principle. 1

(d) Explain the effect of temperature on entropy change of mixing of ideal gases. 1

(e) What is Residual entropy. 1

(f) What happens to the concentrations of different reactants and products after equilibrium is attained. Give reason. 1

(g) Define enthaply of ionization. 1