PHYSICAL CHEMISTRY - 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. 9 (Section C) is compulsory. Use of scientific non-programmable calculator is allowed.

Section - A

1. (a) Show that for reversible adiabatic expansion of an ideal gas TV^{r-1} = constant.
   (b) Define First Law of Thermodynamics is atleast three ways. Derive mathematical expression for Ist law. 2
   (c) Prove that C_v for an ideal gas is constant and nearly equal to 5 cal. $degree^{-1}$ mol^{-1}. 2
2. (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 doen in the process. 2
   (c) Define Enthalpy of neutralization. Explain why enthalpy of neutralization of a strong acid and strong base remains the same and changes of one of them is weak. 2
3. (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 Irrversible process. 2
   (c) What are the limitations of First law of Thermodynamics ? How have these been overcome by the second law of thermodynamics ? Define its is an many ways as you can. 2
4. (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 steam 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 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

5. (a) Derive an expression for the entropy change on mixing of ideal gases. From this expresion what do you conclude about decrease or increase of entropy on mixing. 3
   (b) Apply Le-Chaterlier's principle to predict suitable condition for getting maximum yield of the product in the manufacture of hydrogen by Bosch process. 2
   (c) Derive thermodynamically the relationship $(\Delta G)_T = nRT \ell n \frac{P_2}{P_1}$ 2
6. (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 and irreversible process. 2
   (c) Derive the following thermodynamic expression

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

7. (a) State third law of thermodynamic. Describe its importance in detail. 2
(b) For a gaseous reaction in equilibrium derive the relation $\Delta G^\circ = -RT \ln k$. 3
(c) One mole of helium gas is heated from a temperature of 300K to 600 K. Calculate the entropy change if 2
(i) Volume is kept constant. (ii) Pressure is kept constant.

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

8. (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. Its vapour pressure at 80°C is 0.4672 atm. Calculate the enthalpy of vaporization per mole of water. 2

Section - C
(Compulsory Questions)

9. 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 functior and state function. 1
(c) State Le-Chatelier'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 enthalpy of ionization.