PHYSICAL CHEMISTRY

(Common with B.Sc., B.Sc. Biotechnology, B.Sc. Industrial Microbilogy Semester–III) – III

Time Allowed : Three Hours] [Maximum Marks : 35

Note : Attempt *five* questions in all, selecting *two* questions from each of Section A and B. Question 9th is compulsory. Use of scientific non-programmable calucator is allowed.

Section : A

1. (a) Show that for isothermal reversible expansion of an ideal gas: $q = 2.303\ n\ R\ T \log \frac{P_1}{P_2}$. 3

   (b) Calculate the enthalphy of hydrogenatin of ethylene, given that the enthalpy of combustion of ethylene, hydrogen and ethane are –1410.0, –286.2 and –1560.0 kJmol^{-1} resp. at 298 K. 2

   (c) Show that the change in internal energy is a state function whereas heat and work are path functions. 2

2. (a) What do you understand by inversion temperature ? How is this temperature connected with the gas constant a, b and R? 3

   (b) Explain, giving example where appropriate, the following : (i) Open, closed and isolated system (ii) Extensive and Intensive property. 2

   (c) Show that $C_p - C_v = R$. 2

3. (a) What are the limitation of Ist law of thermodynamics ? How have these been overcome by IInd law of thermodynamics ? Define it in as many ways as you can. 3

   (b) Show that for adiabatic reversible expansion of an ideal gas : PV^{γ} = constant. 2

   (c) Calculate the amount of heat supplied to Carnot Cycle working between 368 K and 288 K, if maximum work obtained is 895 joules. 2

4. (a) Describe Carnot Cycle. Derive an expression for the efficiency of a reversible heat engine working between temperatures T_1 and T_2 ($T_2 > T_1$). 3

   (b) Two moles of H_2 are compressed adiabatically from S.T.P. conditions to occupy a volume of 4.48 litres. Calculate the final temperature. (γ for μ_2 = 1.41). 2

   (c) Calculate the amount of heat evolved when 200 cm^3 of 0.2 M sulphuric acid is mixed with 400 cm^3 of 0.5 M potassium hydroxide solution. 2

Section : B

5. (a) What is Nernst Heat Theorem ? What result follows from it regarding entropy change and heat capacity change ? 3

   (b) Show that : $\left(\frac{\partial G}{\partial T}\right)_p = -S$. 2

   (c) Derive an expression for the calculation of entropy change of an ideal gas when the temperature changes from T_1 to T_2 and pressure changes from P_1 to P_2. 2

6. (a) What is Clausius inequality ? Show that for spontaneous expansion ΔS_{total} is positive. 3

   (b) Show that $\Delta G \leq 0$ is a criterion of spontaneity and equilibrium. 2

   (c) Calculate the entropy change when 10 kJ of heat flows from a body at a temperature of 327°C to a body at a temperature of 27°C when brought in contact with it. 2

7. (a) Derive Clausius–Clapeyron equation for liquid–vapour equilirbium. Show that the equation can be expressed in the integrated form. 3

   (b) For a gasesous reaction derive the following relationship : $\Delta G = -RT \ln k + RT \ln Q$. 2

   (c) Calculate the standard free chergy change (ΔG^0) for the reaction: Give that the standard entropies of CO, and O_2 are 51.1, 47.3 and 49.0 cal |degree| mol respectively. Predict whether the reaction is feasible or not at the standard state. 2

8. (a) What is Van't Hoff Reaction Isotherm ? Why is it so called ?

   $$CO + \frac{1}{2}O_2(g) \rightarrow CO_2(g) \Delta H^\circ = -67.6\,kcal$$ 3

   (b) Derive the following for the gaseous reaction :

   $aA + bB \square\ mM + nN + \ldots\ldots$ $\frac{P_M^m . P_N^n}{P_A^a\ P_B^b} = e^{-\Delta G^\circ/RT}$ 2

   (c) Apply Le–Chaterlier's principle to predict suitable conditions for getting maximum yield of the product in the manufacture of ammonia by Haber's process. 2

Section : C

9 Write briefly :

(1) The net entropy of the universe tends to increase. Justify. 1
(2) What should be the temperature of the sink for efficiency of Carnot engine to be unity. 1
(3) Write expression for total change in Helmholtz function at constant temperature when volume changes from V_1 to V_2. 1
(4) What is the advantage of free energy criterion for spontaneity over entropy change ? 1
(5) Define Ist law of thermodynamics in two ways. 1
(6) Distinguish between :
(i) Reversible and Irreversible process 1
(ii) Isothermal and Adiabatic process.
(7) What is the difference between Helmholtz function and Gibbs function ? Under what condition ΔG beccomes equal to ΔA ? 1