B.Sc. 3rd Semester (Pass) (New Scheme)

Examination, November–2018

BIOTECHNOLOGY

Paper–BT-305

Physical Chemistry

Time allowed : 3 hours]   *[Maximum marks : 40*

*Note : Attempt **five** questions in all, selecting **one** question from each section. **Question No. 1 is compulsory.** All question carry equal marks.*

1. (a) State law of mass action.

(b) What is the change in enthalpy when an ideal gas expands reversibly and isothermally ?

(c) State first law of thermodynamics.

(d) Can the equilibrim : $CaCO_{3(s)} \rightleftharpoons CaO_{(s)} + CO_{2(g)}$ be obtained in an open vessel. Explain the reason of your answer.

(e) Distribution law is valid if solute has .... molecular state in .... of the solvent.

(f) Differentiate between isothermal and adiabatic process.

(g) Which out of the following thermodynamic properties is/are intensive S, T, U, H, P and V ?

(h) Define extensive and intensive properties.   8×1

Section–A

2. (a) What is Joule-Thomson effect ? Justify that during this process, enthalpy of the system remains constant. 3

(b) Explain the terms (i) 'Enthalpy' and 'Enthalpy Change' (ii) Heat capacity. Derive expressions for heat capacity at constant volume and at constant pressure. 5

3. (a) Prove thermodynamically that Joule-Thomson coefficient for an ideal gas is zero. Also deduce expression for Joule-Thomson coefficient for real gases in terms of Van der Waals constants 'a' and 'b'. 5

(b) State Zeroth law of thermodynamics. What is its most important application ? 3

Section–B

4. (a) Derive that for reversible adiabatic expansion of an ideal gas PV^γ = constant. 3

(b) Define bond energy for a diatomic molecule and for a polyatomic molecule. 3

(c) Calculate the heat of formation of H_2O (liquid) at 383K, if ΔH for the reaction

$$H_2(g) + \tfrac{1}{2} O_2(g) \longrightarrow H_2O\,(l)$$

at 298 K is –298.06 kJ. The average value of heat capacities between the two temperatures for $H_2(g)$, $O_2(g)$ and H_2O (l) are 27.61, 29.50 and 75.31 J K^{-1} mol^{-1} respectively. 3

5.   (a)   Define standard enthalpy of formation. Taking a suitable example prove that the standard enthalpy of a compound is equal to standard enthalpy of formation.   4

      (b)   Derive thermodynamically Kirchoff's equation giving the variation of heat of reaction with temperature.   4

Section–C

6.   (a)   Thermodynamically derive an expression for the Law of chemical equilibrium.   4

      (b)   Derive Van't Hoff equation :

            $d(lnK_p) / dT = \Delta H^0 / RT^2$ 4

      (a)   Derive the relationship between equilibrium constants K_p and K_c.   2

      (b)   Explain the effect of change of temperature as per Le-Chatelier's principle with a suitable example.
                                                          3

      (c)   Calculate K_p for the reaction :   3

            $3/2 \, O_2 \rightleftharpoons O_3(g)$ at 298 K, ΔG^0 for the reaction is 163.43 $kJmol^{-1}$

            $(R = 8.314 \text{ JK mol}^{-1})$

Section–D

8. (a) Define chemical potential. Applying the concept of chemical potential, how Nernst distribution law can be derived ?   3

   (b) Prove that multi step extraction is more economical than single step extraction.   2

   (c) How is the Distribution Law modified, when distributing species undergoes chemical combination in either phase ?   3

9. (a) How distribution law can be applied to determine the equilibrium constant of chemical equilibrium leading to the formation of potassium tri-iodide complex from KI and I_2 ?   3

   (b) State and explain Nernst distribution law. What are the conditions under which this law is applicable ?

                                                        2

   (c) Explain the use of Nernst Distribution Law in the determination of hydrolysis constant for aniline hydrochloride.   3