CBCS SCHEME

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18BT45

Fourth Semester B.E. Degree Examination, Jan./Feb. 2023
Biochemical Thermodynamics

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Distinguish between:
i) Thermal equilibrium and Mechanical equilibrium.
ii) Closed and open system.
iii) Intensive and Extensive properties.
iv) System and Surrounding. **(10 Marks)**

b. Consider a closed system (Piston and cylinder) with constant pressure process. Suffix 1 and 2 represents initial and find state respectively $P_1 = 2bar$, $V_1 = 0.5m^3/kg$, $V_2 = 0.75m^3/kg$, $t_1 = 25°C$, $t_2 = 300°C$, $C_p = \left[0.5 + \frac{20}{(T+30)}\right]\frac{KJ}{kg}$, when T is in °C.

Calculate: i) Heat added ii) Work done iii) Δu iv) Δh. **(10 Marks)**

OR

2 a. Briefly discuss the following:
i) Carnot principle
ii) Third law of Thermodynamics. **(06 Marks)**

b. State the different statements of second law of thermodynamic. **(06 Marks)**

c. When a system is taken from state 'a' to state 'b' along the path acb, 80kJ of heat flow into the system and the system does 30kJ of work.
i) How much heat flow into the system along the path adb, if the workdone is 10kJ.
ii) When the system is returned from 'b' to 'a' along the curved path, the work done on the system is 20kJ. Does the system absorb and liberate the heat and how much?
iii) If $W_a = 0$ and $W_d = 40kJ$, find the heat absorbed in the process 'ad' and 'db'. **(08 Marks)**

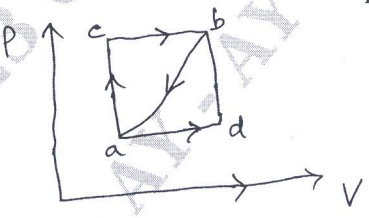

Fig.Q.2(c)

Module-2

3 a. Determine the pressure exerted by oxygen in a container of $2m^3$ capacity when it contains 5kg at 27°C using
i) Ideal gas equation
ii) Vander walls equation
Take Vander walls constant.

$a = 139.25 \frac{kN\,m^4}{kgmol^2}$

$b = 0.0314\ m^3/Kmol.$ **(08 Marks)**

b. The equation of state of a certain substance is given by the expression $V = \frac{RT}{\rho} - \frac{e}{T^3}$, and specific heat is given by the relation Cp = A + BT, when A, B and C and constant derive expression for changes in internal energy, enthalpy and entropy for
i) Isothermal process ii) An isobaric process. **(12 Marks)**

OR

4 a. State Hess's law of constant heat summation. Derive an equation for the effect of temperature on standard heat of reaction. **(12 Marks)**

b. Using Hess's law calculate the heat of formation of gaseous ethanol at 298K using the following data:
Data:
ΔH_f of CO_2 = -393.51 kJ/mol
ΔH_f of H_2O = -285.83kJ/mol
ΔH_c of C_2H_5OH = -1410.09 kJ/mol. **(08 Marks)**

Module-3

5 a. Explain the classification of thermodynamic properties. **(08 Marks)**

b. Derive Maxwell's equation from I law and II law of thermodynamics. **(12 Marks)**

OR

6 a. Derive Gibb's Helmholtz equation. **(10 Marks)**

b. Explain fugacity coefficient. Discuss the effect of temperature on fugacity. **(10 Marks)**

Module-4

7 a. Explain the criteria for phase equilibria. **(06 Marks)**

b. Explain Lewis-Randall rule and Henry's law. **(08 Marks)**

c. Discuss the effect of temperature and pressure on activity coefficient. **(06 Marks)**

OR

8 a. Derive Gibb's-Duhem equation and mention the various forms of the equation. **(08 Marks)**

b. Explain the following:
i) Determination of partial molar properties by graphical methods.
ii) Consistency test for VLE data using coexisting equation and binary liquid – liquid equilibria. **(12 Marks)**

Module-5

9 Write a short notes on the following:
a. Criteria for biochemical reaction equilibrium.
b. Effect pressure on equilibrium constant.
c. Factors affecting equilibrium conversion.
d. Heterogeneous bioreaction equilibria. **(20 Marks)**

OR

10 a. Show that $\Delta G^\circ = -RT \ln k$. **(10 Marks)**

b. The standard heat of formation and standard free energy of formation of NH_3 at 298K are -46100J/mol and -16500J/mol respectively. Calculate the equilibrium constant at 500K for the reaction. $N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$ assuming that the standard heat of reaction is constant in the temperature range 298K to 500K. **(10 Marks)**

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