CBCS Scheme

USN | | | | | | | | | | 15BT42

Fourth Semester B.E. Degree Examination, Dec.2017/Jan.2018
Biochemical Thermodynamics

Time: 3 hrs. Max. Marks: 80

Note: *Answer FIVE full questions, choosing one full question from each module.*

Module-1

1 a. Define the following with suitable examples:
(i) Closed and open system.
(ii) Intensive and extensive properties **(08 Marks)**

b. Derive first law of thermodynamics for steady state flow process. **(08 Marks)**

OR

2 a. Explain the carnot cycle with P-V coordinates and give the equation for efficiency of reversible heat engine. **(08 Marks)**

b. A system consisting of some fluid is stirred in a tank. The rate of work done on the system by the stirrer is 2.25 hp. The heat generated due to stirring is dissipated to the surroundings. If the heat transferred to the surrounding is 3400 KJ/h, determine the change in internal energy. **(08 Marks)**

Module-2

3 a. With a neat sketch, explain PVT behavior of pure fluids. **(08 Marks)**

b. Find the second and third virial co-efficients of the Vander Waals equation when it is expressed as $z = \frac{PV}{RT} = 1 + \frac{B}{V} + \frac{C}{V^2} + \frac{D}{V^3} + \ldots$ **(08 Marks)**

OR

4 a. Write a note on law of corresponding states and compressibility factor chart. **(06 Marks)**

b. State Hess's law of constant heat summation and calculate the standard heat of formation of chloroform gas from its elements using Hess law.
Data:

$$CHCl_3(g) + \frac{1}{2}O_2(g) + H_2O(l) \rightarrow CO_2(g) + 3HCl(g) \quad \Delta H^{\bullet}_{298} = -509.93\ KJ$$

$$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l); \quad \Delta H^{\bullet}_{298} = -296.03\ KJ$$

$$C(s) + O_2(g) \rightarrow CO_2(g); \quad \Delta H^{\bullet}_{298} = -393.78\ KJ$$

$$\frac{1}{2}H_2(g) + \frac{1}{2}Cl_2(g) \rightarrow HCl(g); \quad \Delta H^{\bullet}_{298} = -167.57\ KJ$$ **(10 Marks)**

Module-3

5 a. Derive the Maxwell's equation, from thermodynamics. **(08 Marks)**

b. Calculate the fugacity of liquid water at 303 K and 10 bar if the saturation pressure at 303 K is 4.241 KPa and the specific volume of liquid water at 303 K is $1.004 \times 10^{-3}\ m^3/kg$. **(08 Marks)**

OR

6 a. Differentiate between reference properties, energy properties and derived properties. **(06 Marks)**

b. Show that $dH = C_V dT + \left[VdP - T\frac{(\partial V/\partial T)_P}{(\partial V/\partial T)_T} dV \right]$. **(10 Marks)**

Module-4

7 a. Derive Gibbs Duhem equation and static its uses. **(06 Marks)**

b. Define chemical potential and derive an expression to show how it varies with temperature and pressure. **(10 Marks)**

OR

8 a. Briefly explain Azeotropes with suitable systems and VLE plots. **(08 Marks)**

b. Explain consistency test for VLE (Vapour Liquid Equilibria) data using slope of $\ln\gamma$ curves. **(08 Marks)**

Module-5

9 a. A gas mixture containing 3 mol CO_2, 5 mol H_2 and 1 mol water is undergoing the following reactions:

$CO_2 + 3H_2 \rightarrow CH_3OH + H_2O$

$CO_2 + H_2 \rightarrow CO + H_2O$

Develop expressions for the mole fraction of the species in terms of the extent of reaction. **(08 Marks)**

b. Show that equilibrium constant and standard free energy change is given by $\Delta G^\circ = -RT\ln K$ **(08 Marks)**

OR

10 a. The standard heat of formation and standard free energy of formation of ammonia at 298 K are $-46{,}100$ J/mol and $-16{,}500$ J/mol respectively. Calculate the equilibrium constant for the reaction,

$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

at 500 K assuming that the standard heat of reaction is constant in the temp range 298 to 500 K. **(08 Marks)**

b. Discuss heterogeneous reaction equilibria for,

(i) Reactions in solutions and

(ii) Equilibria involving pure solids and liquids. **(08 Marks)**

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