# CBCS SCHEME

USN

15BT42

## Fourth Semester B.E. Degree Examination, Dec.2019/Jan.2020

## Biochemical Thermodynamics

Time: 3 hrs. Max. Marks: 80

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

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

### Module-1

1 a. Explain the following:
(i) State and properties of a system.
(ii) Heat reservoir and Heat pump. **(08 Marks)**

b. Gas at a pressure of 0.2 MPa is contained in a closed system. Weight of the piston is so that the gas pressure is maintained at 0.2 MPa. Heat is added so that the piston moves through a distance of 120 mm. Determine the work done. Assume the cross sectional area of piston as 0.01 $m^2$ and atmospheric pressure is 0.1 MPa. **(06 Marks)**

c. Define Zeroth Law of Thermodynamics. **(02 Marks)**

**OR**

2 a. Derive First Law of Thermodynamics for steady state flow process. **(08 Marks)**

b. 10 kg of liquid water in thermal equilibrium with atmosphere at 25°C, is cooled to 5°C at constant P, by a reversible heat pump operating between water and atmosphere. Find the minimum work required? $C_p$ of water = 4.187 KJ/kgK. **(08 Marks)**

### Module-2

3 a. Calculate the volume occupied by one mole of oxygen at 300 K and 100 bar using,
(i) Ideal gas law.
(ii) Van-der-Waal's equation.
($a = 0.1378\ Nm^4/mol^2$ and $b = 3.18\times10^{-5}\ m^3/mol$) **(04 Marks)**

b. Explain the effect of temperature on standard heat of reaction. **(12 Marks)**

**OR**

4 Air at 1 bar and 298.15 K is compressed to 5 bar at 298.15 K by two different processes.
(i) Cooling at constant pressure followed by heating at constant volume.
(ii) Heating at constant volume followed by cooling at constant pressure.
Calculate the heat and work requirements $\Delta u$ and $\Delta H$ of air for each patti.

Assume $C_V = \frac{5}{2}R$ and $C_P = \frac{7}{2}R$ $(J/molK)$ **(16 Marks)**

### Module-3

5 a. Obtain the Maxwell equations. **(08 Marks)**

b. Derive the Gibbs-Helmholtz equation. **(08 Marks)**

**OR**

6 a. Explain the effect of pressure and temperature on activity. **(06 Marks)**

b. Molar volume of an organic liquid at 300 K and 1 bar is 0.1 $m^3$/Kmol and its co-efficient of expansion is $1.25\times10^{-3}\ K^{-1}$. Calculate the change in entropy if pressure is increased to 20 bar at 300 K. **(05 Marks)**

c. Obtain Clausius-Clapeyron equation. **(05 Marks)**

## Module-4

7 a. Explain the methods considered for the determination of partial molar properties. **(08 Marks)**

b. Obtain the different forms of Gibbs Duhem equation. **(08 Marks)**

**OR**

8 a. 30% mol methanol-water solution is to be prepared. How many $cm^3$ of pure methanol (molar volume = $40.727 \times 10^{-6}$ $m^3$/mol) & pure water (molar volume = $18.068 \times 10^{-6}$ $m^3$/mol) are to be mixed to prepare 2 $m^3$ of desired solution? Partial molar volumes of methanol and water in a 30% solution are $38.632 \times 10^{-6}$ $m^3$/mol and $17.765 \times 10^{-6}$ $m^3$/mol respectively? **(08 Marks)**

b. What are azeotropes? Explain.
  (i) Minimum boiling azeotropes.
  (ii) Maximum boiling azeotropes. **(08 Marks)**

## Module-5

9 a. Explain the factors affecting the equilibrium constant. **(08 Marks)**

b. Calculate K at 298 K of reaction.
$N_2O_{4(g)} \rightarrow 2NO_{2(g)}$ given that the standard free energies of formation at 298 K are 97540 J/mol for $N_2O_4$ and 51310 J/mol for $NO_2$. **(04 Marks)**

c. Determine the degree of freedoms for gaseous systems containing CO, $CO_2$, $H_2$, $H_2O$, $CH_4$ Number of independent chemical reactions occurring in the system will be determined. **(04 Marks)**

**OR**

10 a. Explain the criteria of chemical reaction equilibrium. **(06 Marks)**

b. Standard heat of formation and the standard free energy of ammonia at 298 K are $-46100$ J/mol and $-16500$ J/mol. Calculate K for the reaction :
$N_{2(g)} + 3H_2(g) \rightarrow 2NH_3(g)$ at 500 K assuming that standard heat of $rX^n$ is constant in the temperature range of 298 K to 500 K. **(10 Marks)**

* * * * *