CBCS Scheme

USN | | | | | | | | | | |

15BT42

Fourth Semester B.E. Degree Examination, June/July 2018

Biochemical Thermodynamics

Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. How are the efficiency of a heat engine and the COP of a heat pump defined? **(04 Marks)**

b. Calculate the absolute entropy of water vapour at 473 K and 101.3 kPa above 273 K base temperature the average heat capacity of water = 4.2 kJ/kg.K and that of water vapour between 373 K and 473K = 1.9 kJ/kg.K. Latent heat of vapourization at 373 K = 2257 kJ/kg. **(06 Marks)**

c. What is enthalpy of a system? How is it related to the internal energy? **(06 Marks)**

OR

2 a. How do you state mathematically the first law of thermodynamics that can be used for solving steady state fluid flow problems? **(10 Marks)**

b. State and prove the Clausius inequality. **(06 Marks)**

Module-2

3 a. Define and explain:
i) Standard heat of reaction
ii) Standard heat of formation
iii) Standard heat of combustion **(06 Marks)**

b. Explain the physical significance of the triple point and the critical point of pure fluids. **(10 Marks)**

OR

4 a. An ideal gas is compressed adiabatically from 1.5 bar, 338 K to 9 bar. The process is reversible and $\gamma = 1.23$ is constant over the entire range of conditions. Calculate:
i) Temperature at the end of compression
ii) Work of compression
iii) Heat transferred
iv) Change in internal energy
v) Change in enthalpy **(10 Marks)**

b. Calculate the theoretical flame temperature for CO when burned with 100% excess air when both the reactants are at 373 K. The heat capacities (J/mol.K) may be assumed constant at 29.23 for CO, 34.83 for O_2, 33.03 for N_2 and 53.59 for CO_2 standard heat of combustion at 298 K is –283.178 kJ/mol CO. **(06 Marks)**

Module-3

5 a. Define fugacity and show that the fugacity and pressure are identical for ideal gases. What is the standard state for fugacity for real gas? **(10 Marks)**

b. How would you obtain an equation for the free energy as a function of temperature using the Gibbs Helmholtz equation? **(06 Marks)**

OR

6 a. What are the Maxwell's equations and what is their importance in establishing relationships between thermodynamic properties? **(10 Marks)**

b. Show that C_p and C_v of an ideal gas depend on temperature alone. **(06 Marks)**

Module-4

7 a. A 30 percent by mole methanol-water solution is to be prepared, how many cubic meters of pure methanol (molar volume, 40.727×10^{-6} m^3/mol) and pure water (molar volume, 18.068×10^{-6} m^3/mol) are to be mixed to prepare 2 m^3 of the desired solution? Partial molar volumes of methanol and water in a 30% solutions are 38.632×10^{-6} m^3/mol and 17.775×10^{-6} m^3/mol respectively. **(10 Marks)**

b. State Raoult's law. Show that it is a simplified form of the Lewis-Randell rule. **(06 Marks)**

OR

8 a. Discuss the Gibbs Duhem equation and its various forms. What are the major fields of application of the Gibbs Duhem equations? **(10 Marks)**

b. State your point of view on consistency test for VLE data. **(06 Marks)**

Module-5

9 a. Explain phase rule for reacting system. **(06 Marks)**

b. Discuss on the concept of liquid-liquid equilibrium and coupled reactions. **(10 Marks)**

OR

10 a. Write a short note on Le Chatelier's principle. **(06 Marks)**

b. Industrially important water gas shift reaction is given by $CO_{(g)} + H_2O_{(g)} \rightarrow CO_{2(g)} + H_{2(g)}$.

Calculate:

i) Standard Gibbs free energy change and equilibrium constand at 298°K and 0.1 MPa.

ii) Assuming that the standard heat of reaction is constant in the temperature range 298°K to 1000°K. Determine the equilibrium constant at 1000°K and 0.1 MPa. **(10 Marks)**

* * * * *