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CBCS SCHEME

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18BT45

Fourth Semester B.E. Degree Examination, Feb./Mar. 2022
Biochemical Thermodynamics

Time: 3 hrs. Max. Marks: 100

Note : 1. ***Answer any FIVE full questions, choosing ONE full question from each module.***
2. ***Use of Steam Table is allowed.***

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. Define i) First Law of Thermodynamic ii) Second Law of Thermodynamics . **(04 Marks)**

b. Calculate ΔU and ΔH in kJ for 1 Kmol of water, as it is vapourised at a constant temperature of 373K and constant pressure of 101.3 kPa. The specific volumes of liquid and vapour at these conditions are 1.04×10^{-3} and $1.675 m^3/k$ mol respectively. 1030 kJ of heat is added to water for this change. **(06 Marks)**

c. Calculate the change in internal energy, change in enthalpy, work done and the heat supplied in the process.
i) An ideal gas is expanded from 5 bar to 4 bar Isothermally at 600 K.
ii) An ideal gas contained in a vessel of $0.1 m^3$ capacity is initially at 1 bar and 298K. It is heated at constant volume to 400K. Assume Cp = 30J/mol. K. **(10 Marks)**

OR

2 a. Explain the principle of Carnot cycle and derive the relationship to determine the efficiency of Carnot cycle. **(10 Marks)**

b. One kg of superheated steam at 1.5MPa and 523K (H = 2923.5 kJ/kg , S = 6.71 kJ/kg. K) is contained in a Piston – Cylinder assembly. The unit is kept at ambient conditions of 300K and the steam condenses to saturated liquid (H = 845 kJ/kg , S = 2.32kJ/kg. k) at constant pressure. Calculate the change in entropy and check whether the process in reversible (or) not. **(10 Marks)**

Module-2

3 a. A mass of 200g of saturated liquid water is completely vapourised at a constant pressure of 100 Kpa. Determine i) Volume changes ii) Amount of energy transferred to the water. **(06 Marks)**

b. Explain the characteristics of Super heated vapour compared with Saturated vapour. **(04 Marks)**

c. Explain about polytrophic process characterized by the specific values 'δ' for different conditions : i) Isothermal process ii) isobaric condition iii) Adiabatic process iv) Isochoric process. **(10 Marks)**

OR

4 a. Air is compressed from a initial condition 1 bar and 298.15K (25 °C) to a final state of 5 bar and 298.15K (25 °C) by three different mechanically reversible process in a closed system.
i) Heating at constant volume followed by cooling at constant pressure.
$C_V = 20.785$, $C_p = 29.009$ J/mol K , $V_1 = 0.02479$, $V_2 = 0.04958 m^3$. **(10 Marks)**

b. State Hesse's law of constant heat summation. Derive an equation for the effect of temperature on standard heat and reaction. **(10 Marks)**

Module-3

5 a. Show that Cp – Cv = R, for an ideal gas conditions. **(10 Marks)**

b. Derive the Maxewell Relation and explain its significance. **(10 Marks)**

OR

6 a. Determine the fugacity of Pure gas using compressibility factor Z. **(10 Marks)**

b. Derive an expression for the fugacity co-efficient of gas obeying the equation of state $P(V - b) = RT$ and estimate the fugacity of ammonia at 10 bar and 298 K, given that $b = 3.707 \times 10^{-5}$ m^3/mol. **(10 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 $2m^3$ of the desired solution? The partial molar volumes of methanol and water in a 30 percent solution are 38.632×10^{-6} m^3/mol and 17.765×10^{-6} m^3/mol respectively. **(10 Marks)**

b. Explain and derive the relationship of Lewis – Randall rule. **(10 Marks)**

OR

8 a. Explain about Chemical potential with its physical significance. **(10 Marks)**

b. The fugacity of component 1 in binary liquid mixture of components 1 and [2] at 298 K and 20 bar is given by $\bar{f}_1 = 50x_1 - 80x_1^2 + 40x_1^3$. Where $\bar{f}_1$ is in bar and x_1 is the molar fraction of component 1. Determine i) The fugucity f_1 of the pure component 1.

ii) The Fugacity co-efficient ϕ_1 iii) The Henry's law constant K_1.

iv) The Activity co-efficient γ_1. **(10 Marks)**

Module-5

9 a. Show that $\Delta G^\circ = -RT\ell nK$. **(10 Marks)**

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

OR

10 a. Calculate the equilibrium constant at 298K of the reaction $N_2O_{(g)} \rightarrow 2NO_{2(g)}$, given that the standard free energies of formation at 298K are 97,540 J/mol for N_2O_4 and 51,310 J/mol. **(10 Marks)**

b. Write a short note on Le – Chatelier's principle and derive Van't Hoff equation. **(10 Marks)**

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