

Fourth Semester B.E. Degree Examination, Dec.2019/Jan.2020
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 the following with examples.
i) System and surrounding
ii) Open and closed system
iii) Intensive and extensive properties
iv) State and path function. (08 Marks)
- b. What is Zeroth law of thermodynamics? How it is useful in measuring temperature? (04 Marks)
- c. Explain in detail about Heat reservoir, Heat engine and Heat pump. (08 Marks)

OR

- 2 a. Derive equation for first law of thermodynamics for non-flow process. (08 Marks)
- b. Heat is transferred to 10kg of air which is initially at 100KPa and 300K until its temperature reaches 600K. Determine change in internal energy, the change in enthalpy and heat supplied, and the work done in the following processes.
i) Constant volume process
ii) Constant pressure process
- Assume that air is ideal gas for which P-V-T relationship in $PV = nRT$, where n is the number of moles, $R = 8.314 \text{ kJ/K mol K}$; $C_p = 29.029 \text{ kJ/K mol}$; $C_v = 20.785 \text{ kJ/K mol}$; mol.wt of air = 29. (12 Marks)

Module-2

- 3 a. With neat sketch explain PVT behavior of fluids and pure metals. (10 Marks)
- b. Explain in detail constant volume process and constant pressure process. (10 Marks)

OR

- 4 a. One Kilo mole CO_2 occupies a volume of 0.381 m^3 at 313K. Compare the pressure given by
i) Ideal gas equation ii) Vander Waals equation. (06 Marks)
- Take $a = 0.365 \text{ Nm}^4/\text{Mol}^2$; $b = 4.28 \times 10^{-5} \text{ m}^3/\text{mol}$.
- b. i) Standard heat of reaction
ii) Standard heat of combustion
iii) Standard heat of formation
iv) Hess law. (08 Marks)
- c. Calculate the heat of formation of methane gas from the following heat of combustion data :
i) $\text{CH}_4(\text{g}) + 2\text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l}); \Delta H_{298}^\circ = -890.94 \text{ kJ}$
ii) $\text{C}(\text{s}) + \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}); \Delta H_{298}^\circ = -393.79 \text{ kJ}$
iii) $\text{H}_2(\text{g}) + \frac{1}{2}\text{O}_2(\text{g}) \rightarrow \text{H}_2\text{O}(\text{l}); \Delta H_{298}^\circ = -286.03 \text{ kJ}$ (06 Marks)

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-3

- 5 a. How do you classify thermodynamic properties? (06 Marks)
 b. From basics derive and discuss work function. (06 Marks)
 c. Develop equation for evaluating change in internal energy and change in enthalpy for process involving ideal gases. (08 Marks)

OR

- 6 a. Write a note on fugacity and fugacity coefficient. (08 Marks)
 b. Discuss various methods of determining fugacity of pure gas. (12 Marks)

Module-4

- 7 a. Derive equation for partial molar properties and properties of solution. (10 Marks)
 b. Discuss the effect of temperature and pressure on chemical potential. (10 Marks)

OR

- 8 a. Derive the most useful form of Gibbs – Duhem equation. (08 Marks)
 b. Mixture of n-Heptane (A) and n-octane (B) are expected to behave ideally. The total pressure over the system is 101.3KPa. Using the vapour pressure data is given below
 i) Construct the B.P diagram
 ii) Deduce an equation for the equilibrium diagram using arithmetic average and valves

T, K	371.4	378	38.3	388	393	398.6
P _A , KPa	101.3	125.3	140.0	160	179.9	205.3
P _B , KPa	44.4	55.6	64.5	74.8	86.6	101.3

(12 Marks)

Module-5

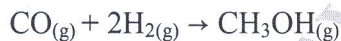
- 9 a. Discuss the effect of temperature on equilibrium constant. (10 Marks)
 b. N-Butane is isomerized to i-butane by the action of catalyst at moderate temperature. It is found that the equilibrium is attained at the following compositions

Temperature, K	Mol% n-butane
317	31.00
391	43.00

Assuming that activities are equal to the mole fractions. Calculate the standard free energy of the reaction at 317K and 391K and average value of heat of reaction over this temperature range. (10 Marks)

OR

- 10 a. Discuss the factor that affect equilibrium conversion. (10 Marks)
 b. A gas mixture containing 25% CO, 55% H₂ and 20% inert gas is to be used for methanol. The gases issue from the catalyst chamber in chemical equilibrium with respect to the reaction.



At a pressure of 300 bars temperature of 625K. Assume that the equilibrium mixture forms an ideal solution and K_f and K_ϕ are 4.5×10^{-5} and 0.35 respectively. What is the percent conversion of CO? (10 Marks)
