

CBCS SCHEME

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15BT42

Fourth Semester B.E. Degree Examination, Dec.2018/Jan.2019 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. Distinguish between : i) Open system and Closed system ii) Intensive and Extensive property iii) State function and Path function. (09 Marks)
- b. Heat is transferred to 10 kg of air which is initially at 100 KPa and 300 K until its temperature reaches 600K. Determine the change in internal energy, the change in enthalpy, the heat supplied and work done in following process.
- i) Constant volume process ii) Constant pressure process.
- Assume that air is an ideal gas for which the P – V – T relationship in $PV = nRT$,
 $R = 8.314 \text{ kJ/k mol K}$.
- Data : $C_p = 29.099 \text{ kJ/k mol}$, $C_v = 20.785 \text{ kJ/k mol}$, Molecular weight of air = 29. (07 Marks)

OR

- 2 a. Define the Third law of Thermodynamics. (03 Marks)
- b. Derive an expression for efficiency of heat engine working on reversible Carnot's cycle with a neat diagram. (07 Marks)
- c. Oil at 500 K is to be cooled at a rate of 5000 kg/h in a counter – current exchanger using cold water available at 295 K. A temperature approach of 10 K is to be maintained at both ends of exchanger. The specific heats of oil and water are respectively 3.2 and 4.2 kJ/kg.K. Determine total entropy change in process. (06 Marks)

Module-2

- 3 a. Show that $C_p - C_v = R$ for an ideal gas. (04 Marks)
- b. Derive the equation to calculate work done in an adiabatic process from fundamentals. (08 Marks)
- c. State Hess's law of constant heat summation. (04 Marks)

OR

- 4 a. For the following reaction the standard heat of reaction at 298 K is - 164.987 kJ. (08 Marks)
 $\text{CO}_2(\text{g}) + 4\text{H}_2(\text{g}) \rightarrow 2\text{H}_2\text{O}(\text{g}) + \text{CH}_4(\text{g})$. The constants in heat capacity (J/mol K) are

	α	β	γ
CO_2	26.75	42.26×10^{-3}	-14.25×10^{-6}
H_2	26.88	4.35×10^{-3}	-0.33×10^{-6}
H_2O	29.16	14.49×10^{-3}	-2.02×10^{-6}
CH_4	13.41	77.03×10^{-3}	-18.74×10^{-6}

Calculate the standard heat of reaction at 773 K.

- b. Discuss the virial equation of state and its use to calculate molar volume. Derive the relationship between Vander waals constant and Virial co-efficient. (08 Marks)

Module-3

- 5 a. Write a note on Fugacity. (04 Marks)
 b. Show that $d_S = \frac{CV}{T} d_T + \frac{B}{K} d_V$. (08 Marks)
 c. Explain the classification of Thermodynamic property. (04 Marks)

OR

- 6 a. Explain the Fugacity coefficient. Discuss the effect of temperature on fugacity. (08 Marks)
 b. Calculate the fugacity of liquid water at 303 K and 10 bar if the saturation pressure at 303K is 4.24KPa and specific volume of liquid water at 303 K is $1.004 \times 10^{-3} \text{ m}^3/\text{kg}$. (08 Marks)

Module-4

- 7 a. State and discuss Lewis – Randall rule and conditions under which it is valid. (08 Marks)
 b. Establish the relationship between L – R rule, Rawult's and Henry's law. (08 Marks)

OR

- 8 a. Derive Gibbs – Duhem equation and state its uses. (06 Marks)
 b. Write a short note on : i) Consistency tests for VLE data ii) Azeotropes. (10 Marks)

Module-5

- 9 a. Calculate the equilibrium constant for the reaction $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightarrow 2\text{NH}_3(\text{g})$ at 500K, given that free energy function. (08 Marks)

$$\phi_0 = \frac{G_T^0 - H_0^0}{T}$$
 at 500K, N_2 , H_2 and NH_3 are respectively -177.5 , -116.9 and -176.9J/mol K.
 The function $(H_{298}^0 - H_0^0)$ for nitrogen , hydrogen and NH_3 are respectively 8669, 8468 and 9920 J/mol. The free energy of formation of ammonia at 298 K is - 46,100 J/mol.
 b. Explain the effect of pressure and Equilibrium constant. (08 Marks)

OR

- 10 Write short notes on :
 a. Liquid – Liquid equilibrium.
 b. Bubble point and Dew point.
 c. Vapour – liquid equilibria.
 d. Phase rule for reacting system. (16 Marks)
