

B.TECH. DEGREE EXAMINATIONS: APRIL / MAY 2010

Fourth Semester

BIOTECHNOLOGY

U07BT403: Chemical Thermodynamics and Bio Thermodynamics

Time: Three Hours

Maximum Marks: 100

Answer ALL the Questions:-

PART A (10 x 1 = 10 Marks)

1. The four properties of a system viz. P, V, T, S are related by
 - a. Gibbs-Duhem equation
 - b. Gibbs-Helmholtz equation
 - c. Maxwell's equation
 - d. Clapeyron equation
2. Fugacity and pressure are numerically equal when the gas is
 - a. in standard state
 - b. at high pressure
 - c. at low temperature
 - d. in ideal state.
3. For a multicomponent system, the chemical potential is equivalent to
 - a. molal concentration difference
 - b. molar free energy change
 - c. partial molar free energy
 - d. molar free energy
4. Free energy change at equilibrium is
 - a. Zero
 - b. Positive
 - c. Negative
 - d. Indeterminate
5. The temperature at the eutectic point of the system is the ----- temperature that can be attained in the system
 - a. Lowest
 - b. Highest
 - c. Average
 - d. None of these
6. The equilibrium constant is independent of
 - a. The pressure at equilibrium
 - b. The temperature at equilibrium
 - c. The temperature and pressure at the equilibrium
 - d. The number of moles involved in the stoichiometric equation for the reaction
7. Which law of the thermodynamics provides basis for measuring thermodynamic property
 - a. First law
 - b. Zeroth law
 - c. Third law
 - d. Second law

8. In a binary liquid solution of components A and B, if component A exhibits positive deviation from Raoult's law then component B
- Obeys Raoult's law
 - May exhibit either positive or negative deviation from Raoult's law
 - Exhibits negative deviation from Raoult's law
 - Exhibits positive deviation from Raoult's law
9. An exothermic gas-phase reaction proceeds according to the equation $3A+2B\rightarrow 2R$ the equilibrium conversion for this reaction :
- Is affected by the presence of a catalyst
 - Decrease on dilution with an inert gas
 - Decrease with an increase in pressure
 - Increase with an increase in temperature
10. Entropy change in case of reversible adiabatic process is
- Minimum
 - Zero
 - Maximum
 - Indeterminate

PART B (10 x 2 = 20 Marks)

- Define Gibbs free energy.
- Define fugacity.
- What is an excess property?
- Define chemical potential. What is its physical significance?
- State the Duhem's theorem.
- What is Poynting correction?
- How would you predict the feasibility of a reaction from the value of the standard free energy change?
- Define equilibrium constant K of a chemical reaction.
- What is Bernoulli's equation?
- Define COP of a refrigerator.

PART C (5 x 14 = 70 Marks)

21. (a) (i) Derive the fundamental differential equations in terms of the four reference properties. (8)
- (ii) Show that for ideal gases $C_p - C_v = R$. (6)

(OR)

(b) Derive Maxwell relations from first principle.

22. (a) (i) Explain about the effect of temperature and pressure on chemical potential. (10)

(ii) Write a short note on Gibbs-Duhem Equations. (4)

(OR)

(b) (i) At 300 K and 1 bar, the volumetric data for a liquid mixture of benzene and cyclohexane are represented by $V = 109.4 \times 10^{-6} - 16.8 \times 10^{-6} X - 2.64 \times 10^{-6} X^2$, Where, X is the mole fraction of benzene and V has the unit of m^3 / mol . Find expression for the partial molar volumes of benzene and cyclohexane. (4)

(ii) Define Activity coefficient & derive the expressions for the effect of temperature and pressure on it. (10)

23. (a) (i) Explain the Phase Equilibria in Multicomponent systems. (10)

(ii) n-Heptane & toluene form ideal solution. At 373K, their vapour pressures are 106 & 74 kPa respectively. Determine the composition of the liquid and vapour in equilibrium at 373 K and 101.3 kPa. (4)

(OR)

(b) (i) What are azeotropes? With proper phase diagrams, distinguish between minimum and maximum boiling azeotropes. What is the effect of pressure on the azeotropic composition? (10)

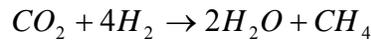
(ii) Write about any two activities coefficient equations in VLE at low pressures. (4)

24. (a) (i) Explain and Derive the Van't Hoff Equation. (4)

(ii) Derive the relation between equilibrium constant and Standard free energy change. (10)

(OR)

- (b) (i) For the following reaction, the standard heat of reaction (ΔH^0_T) at 298 K is -164.987 KJ.

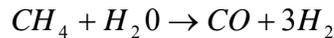


The constants in heat capacity (J/mol K). For the equation $C_p = \alpha + \beta T + \gamma T^2$, the values are given below

Component	α	$\beta \times 10^3$	$\gamma \times 10^6$
CO ₂	26.75	42.26	- 14.25
H ₂	26.88	4.35	- 0.33
H ₂ O	29.16	14.49	- 2.02
CH ₄	13.41	77.03	- 18.74

Calculate the standard heat of reaction at 773 K. (10)

- (ii) The following reaction occurs in a mixture consisting of 2 mol methane, 1 mol water, 1 mol carbon monoxide and 4 mol hydrogen initially.



Deduce expression relating the mole fractions of various species to the extent of reaction. (4)

25. (a) (i) Explain about entropy is a state function. (7)
(ii) Write about liquefaction processes & its methods. (7)

(OR)

(b) (i) Explain about Rankine cycle & draw T-S diagram. (10)

- (ii) Oil of specific heat 3.2 kJ/kg K is cooled from 495 K to 315 K at a rate of 5000 kg/h by exchanging heat with a large thermal reservoir at a constant temperature of 300 K. What is the lost work in the process? (4)
