B 2250

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2007.

Third Semester

Industrial Biotechnology

IB 235 — CHEMICAL THERMODYNAMICS AND BIOTHERMODYNAMICS

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Differentiate a system from surroundings. Distinguish between homogenous system and heterogenous system.

2. What is meant by entrance work in flow systems?

3. What do you mean by enthalpy and entropy departures?

4. What is meant by the activity of a pure fluid?

5. Differentiate an ideal solution from non-ideal solution.

6. What is the usefulness of Gibbs Duhem equation.

7. Derive the phase rule: $F = C - \pi + 2$ for non reactive system

8. What is meant by Clausius inequality? How it is useful in phase equilibria?

9. Define reaction coordinate and its uses in chemical reaction.

10. Compare the quantum of energy released from glucose through calorimeter and in human system. What is the efficiency of human system?

PART B — (5 × 16 = 80 marks)

11. (a) (i) How do you state mathematically the first law of thermodynamics that can be used for solving steady state fluid flow problems? (8)

(ii) Specific heat at constant pressure is always greater than at constant volume ($C_p > C_v$) – Why? Prove for ideal gases it is equal to R. (8)

Or

(b) (i) Increase in entropy accompanying a spontaneous process is a measure of least work – how it is quantified? (8)

(ii) Quantify for the following process: An oil is to be cooled from 425 K to 345 K at a rate of 5,000 kg/hr in a parallel flow heat exchanger. Cooling water at a rate of 10,000 kg/hr at 295 K is available. The mean specific heats of the oil and water respectively 2.5 and 4.2 kJ/kg K. (8)

12. (a) (i) What are the Maxwell's equations and what is their importance in establishing relationships between thermodynamic properties? (8)

(ii) Show that for ideal gases C_p and C_v depend only on temperature. (8)

Or

(b) (i) Differentiate between reference properties, energy properties and derived properties (8)

(ii) What are the fundamental differential equations for the energy properties? List the canonical variables for U, H, A and G. (8)

13. (a) (i) Show that fugacity and pressure are identical for ideal gases. What is the standard state for fugacity of a real gas? (8)

(ii) Explain any three methods for estimating the fugacity of a pure gas. (8)

Or

(b) (i) The activity coefficients are parameters, strongly reflecting the functions of solution concentration — Comment. (8)

(ii) What is the physical meaning of partial molar properties? Give any three methods of determining partial molar properties. (8)

14. (a) (i) Explain the criteria for phase equilibrium under the following condition: constant U and V; constant T and V; constant P and T. (6)

(ii) Enumerate how vapour-liquid equilibrium (VLE) equation is helpful in designing a distillation unit. How *Poynting correction* is useful in the above? (10)

Or

(b) (i) Correlate equilibrium constant with standard free energy of a chemical reaction. What for Van't Hoff equation is developed over the above? (8)

(ii) Compare the nitrogen conversion at 20 bar and 200 bar respectively, in Haber process at 675 K; taken together the equilibrium constant of the reaction is 2×10^{-4}. (8)

15. (a) (i) As long as the overall metabolic pathway is exergonic, it will operate in the forward direction- Analyze a case study. (8)

(ii) Enumerate the different factors responsible for the high energy character of ATP. How is it different in NADH? (8)

Or

(b) (i) How electrons are stripped off from metabolite to channelize into electron transport chain (ETC), towards harnessing energy? (8)

(ii) How degree of reduction concept is employed in mitochondria for ATP production? (8)