ACHARYA INSTITUTE OF TECHNOLOGY
Bangalore - 560090

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10BT42

Fourth Semester B.E. Degree Examination, Dec.2016/Jan.2017
Biochemical Thermodynamics

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting atleast TWO questions from each part.***

PART – A

1 a. Explain schematic representation of heat engine and heat pump. **(08 Marks)**

b. Define C_p and C_v. Why is C_p always greater than C_v. **(04 Marks)**

c. A 10 g lead ball at 300 K is dropped from a height of 10 m. Calculate (i) the kinetic energy and speed of the ball as it reaches the ground and (ii) the temperature rise of the ball if all its kinetic energy is transformed into internal energy as the ball is suddenly stopped after 10 m, given that the specific heat of lead is 125.6 J/kg.K and its volume change in negligible. **(08 Marks)**

2 a. Define Carnot principle and derive an expression for efficiency of Carnot engine. **(10 Marks)**

b. Water at 95°C is pumped from storage tank 1 to a second storage tank which is 15 m above it, by thin water in a heat exchanger. If the rate of water flow in 183 kg/min, what is the temperature of water in the second tank? Take C_p of water as 4.18 kJ/kg.K. **(10 Marks)**

3 a. Derive the expression for the work done in adiabatic process interms of pressure ratio. **(08 Marks)**

b. An ideal gas is compressed adiabatically from 1.5 bar, 338 K to 9 bar. The process is reversible, and $\gamma = 1.23$ is constant over the entire range of conditions. Calculate

(i) the temperature at the end of compression
(ii) the work of compression
(iii) the heat transferred.
(iv) change in internal energy
(v) change in enthalpy **(12 Marks)**

4 a. Derive Vant Hoff's equation in relation with equilibrium constant and temperature. **(08 Marks)**

b. One mole of steam undergoes water gas shift reaction at a temperature 1100 K and pressure of 1 bar.

$$CO_{(g)} + H_2O_{(g)} \longrightarrow CO_{2(g)} + H_{2(g)}$$

The equilibrium constant of the reaction is k = 1. Calculate the fraction of steam reacted in the following cases:

(i) CO supplied is 100% excess of stoichiometric requirement.
(ii) CO supplied is only 50% of theoretical requirement. **(12 Marks)**

PART – B

5 a. Derive Clausius – Clapeyron equation starting from Clapeyron equation. **(10 Marks)**

b. Discuss how the fugacity of gas is estimated by

(i) Compressibility factor method
(ii) Residual volume method. **(10 Marks)**

6 a. Explain the method of determination of partial molar properties by Tangent – Intercept method. **(08 Marks)**

b. Derive Gibbs Duhem equation. State its uses. **(06 Marks)**

c. A mixture of ethylene and oxygen (67% C_2H_4 and 33% O_2) exists at 25 atm and 0°C at which partial fugacities of components are reported to be $\bar{f}C_2H_4$ = 14.38 atm, $\bar{f}O_2$ = 8.12 atm. Compute partial fugacities of C_2H_4 and O_2 using Lewis Randall rule, activity of C_2H_4 and O_2 and activity coefficient of C_2H_4 and O_2. The fugacities of pure components are $f^{\circ}C_2H_4$ = 20.6 atm , $f^{\circ}O_2$ = 24.5 atm. **(06 Marks)**

7 a. How do you check the consistency of VLE data by slope of ln γ curves? **(10 Marks)**

b. Water hydrazine system forms an azeotrope containing 58.5 mol% hydrazine at 393 K and 1 atm. Calculate the equilibrium vapour composition for a solution containing 20 mol% hydrazine. The relative volatility of water with reference to hydrazine is 1.6 and may be assumed to remain constant in the temperature range involved. The vapour pressure of hydrazine at 393 K in 124.76 kPa. **(10 Marks)**

8 Write short notes on the following :

a. Azeotropes

b. Lewis Randall Rule

c. Chemical Potential

d. Partial Molar Property. **(20 Marks)**

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