Exam.Code:0908
Sub. Code: 6702

1089

B.E. (Biotechnology) Fourth Semester

BIO-412: Thermodynamics

Time allowed: 3 Hours

Max. Marks: 50

NOTE: Attempt five questions in all, including Question No. I which is compulsory and selecting two questions from each Section.

x-x-x

Q.1.a) The locus of standard liquid line and standard vapor line meets at _____

b) The enthalpy of dry saturated steam _____ with an increase in pressure.

c) A law which is applicable only to ideal vapors and liquids, that equates the equilibrium partial pressures of a solution component in the coexisting phases, is known as _____

d) During Joule Thompson expansion of gases _____ remains constant.

e) The amount of heat absorbed to evaporate 1 kg of water from its saturation temperature without change of temperature is called _____

f) The SI units of pressure _____

g) Define closed system.

h) As pressure approaches zero, fugacity coefficient value tends to _____

i) Assuming CO_2 obeys perfect gas law, calculate the density of CO_2 in kg/m^3 at 263°C and 2 atm.

j) State Zeroth law of thermodynamics.

(1×10)=10

SECTION-A

Q.2a). An ideal gas contained in a vessel of 0.1 m^3 capacity is initially at 1 bar and 298 K. It is heated at constant volume to 400 K. Calculate the change in internal energy, change in enthalpy, work done and heat supplied. Assuming C_v= 21.686 J/mol K

b). Estimate the molar volume of CO_2 at 500 K and 100 bar pressure using the vander Waals equation. The vander Waals constants are 0.364 m^4N/mol^2 and 4.267×10^{-5} m^3/mol. (5,5)

Q.3a). With the help of a diagram explain the Claude process for air liquefaction. Derive an expression in terms of enthalpies that can be used to calculate the liquid yield.

b). A Carnot refrigerator requires 1.1 kW per ton of refrigeration to maintain a region at a low temperature of -30°C. Determine COP of the Carnot refrigerator, higher temperature of the cycle and the heat rejected in kW per ton of refrigeration. One ton of refrigeration=3.52 kW. (5,5)

Q.4 Explain the vapor absorption refrigeration cycle? What is the function of the analyzer and the rectifier? (10)

P.T.O.

SECTION-B

Q.5. The vapour pressures of benzene (1) and ethyl benzene (2) can be evaluated by the Antoine equations

$lnP_1^s(kPa) = 13.8858 - \frac{2788.51}{T(K)-52}$ $\quad lnP_2^s(kPa) = 14.0045 - \frac{3279.47}{T(K)-60}$

Assuming that the solution formed by benzene and ethyl benzene is an ideal solution, Calculate

1. x_1 and y_1 at 373 K and 101 kPa
2. P and y_1 at 373 K and $x_1 = 0.5$
3. P and x_1 at 373 K and $y_1 = 0.5$
4. The fraction of the system that is liquid at 373 K and 101 kPa if the overall composition of the system is 85 mole% benzene. (10)

Q.6a). The partial molar volumes of acetone and chloroform in a mixture in which mole fraction of acetone is 0.5307 are 74.166×10^{-6} m^3/mol and 80.235×10^{-6} m^3/mol respectively. What is the volume of 1 kg of the solution?

b). Define fugacity and fugacity coefficient. (5+5)

Q.7. Determine the equilibrium constant at 2600 K for the reaction $CO\ (g) + \frac{1}{2}O_2(g) \rightarrow CO_2(g)$. Initially a mixture of 1 mol of CO and 0.5 mol of O_2 is present in the reactor. Determine the equilibrium composition of this mixture at 1 bar.

Given that the standard heat of reaction and standard free energy of reaction at 298 K is -283 kJ/mol and -257.12 kJ/mol respectively. The specific heat (J/mol K) data is given below

$C_{p_{CO}} = 28.07 + 4.63 \times 10^{-3}T - 0.26 \times 10^{-5}T^{-2}$

$C_{p_{O_2}} = 28.01 + 4.21 \times 10^{-3}T - 1.89 \times 10^{-5}T^{-2}$

$C_{p_{CO_2}} = 45.37 + 8.69 \times 10^{-3}T - 9.62 \times 10^{-5}T^{2}$ (10)

x-x-x