Lecture 30

Thermodynamics of Reactive Systems

Tutorial - Problem Solving

A. K. M. B. Rashid
Professor, Department of MME
BUET, Dhaka

Example 8.4

Calculate the standard entropy change for the reaction

<Pb> + ½ (O_2) = <PbO>

at 800 K from the following data:

S^0_{298} <PbO> = 16.20 cal/deg-mol; S^0_{298} <Pb> = 15.50; S^0_{298} (O_2) = 49.02
T_m, Pb = 600 K; L_f, Pb = 1150 cal/mol
C_P <PbO> = $10.60 + 4.0 \times 10^{-3}$ T cal/deg-mol
C_P <Pb> = $5.63 + 2.33 \times 10^{-3}$ T ; C_P {Pb} = $7.75 – 0.74 \times 10^{-3}$ T
C_P (O_2) = $7.16 + 1.0 \times 10^{-3} T – 0.4 \times 10^5 T^{-2}$

8.19 Calculate the equilibrium constant and the equilibrium partial pressure of oxygen for the reaction at 1000 K.

<MgO> = {Mg} + 1/2(O_2)

$$\Delta G^0 = 145350 + 0.24\, T \log T - 26.95\, T \text{ cal}$$

Also, predict the possibility of decomposing a pure magnesia crucible under a vacuum of 0.01 atm at that temperature.

8.21 Calculate the vapour pressure of magnesium exerted at 1400 C by the system in which the reaction equilibrium

$$4<MgO> + <Si> = 2(Mg) + (Mg_2SiO_4)$$

is established. Given data:

$2<MgO> + <SiO_2> = (Mg_2SiO_4)$; $\Delta G^0 = -63260$ Joules

$<Si> + (O_2) = <SiO_2>$; $\Delta G^0 = = -902000 + 174\ T$

$<Mg> + 1/2(O_2) = <MgO>$; $\Delta G^0 = -759800 - 13.39\ T \ln T + 316.7\ T$

8.23 The standard free energies of formation of cuprous oxide and cupric oxide are given by the equations

$<Cu_2O> = 2<Cu> + 1/2(O_2)$; $\Delta G^0 = 40500 + 3.92\ T \log T - 29.5T$ cal

$<CuO> = <Cu> + 1/2(O_2)$; $\Delta G^0 = 37725 + 5.01\ T \log T - 36.9T$ cal

Determine which oxide is formed when oxygen at 20 mm Hg pressure is passed over pure copper at 900 C.

8.25 Compute the partial pressure of oxygen in an atmosphere that is equilibrated at 700 °C with zinc oxide and a gold-zinc alloy with X_{Zn}=0.005. Assume the Henry's law constant for this dilute solution is 8.5 at 700 °C. Use $K = 7.0\text{x}10^{26}$ for the system.

8.26 The commercial ammonia is produced by the reaction

$$1/2(N_2) + 3/2(H_2) = (NH_3)$$

is $\Delta G°_T = 12.31\ T \log T - 12.03\ T - 9170$ cal/mol.

Determine the maximum possible conversion rate of ammonia if a stoichiometric quantities of gas are used at 400 °C and 30 atm.

Next Class

Lecture 31

Thermodynamics of Interfaces

Surface Free Energy and Surface Tension