COLLEGE OF ENGIEERING PUNE
End Semester Exam
Metallurgical Thermodynamics

Class: S.Y.B.Tech. (Met.Engg)
F.Y.M.Tech.

Time: 3 hours
Marks: 50

Instructions:

a) **Q1 is compulsory** and solve any **Four** from remaining questions
b) Assume suitable data if necessary.
c) Use of calculators is allowed.
d) Assumptions and Figures will carry marks

Q1 State **True** or **False** and **Justify to the point.** **2 x5**

a. In an aqueous electrochemical cell, the free energy change of a dissolved species in presence of alloy metal can be represented as $\Delta G = RT \ln a$.
b. Entropy of fusion of a metallic liquid solidifying at its melting point follows Richard' rule.
c. A solution exhibits non-ideal behaviour if the activity coefficient is one.
d. Solubility of Argon gas can be estimated if its partial pressure is known.
e. In binary system containing two elements A and B, the atom % A is equal to wt % A.

Q2a The following cell is set up for determination of the activity of zinc in a Zn-Sn-Cd-Pb alloy- **5**

Zn (pure) | LiCl-KCL-ZnCl2 | Zn (in the alloy)

The reversible e.m.fs are as follows-

Temp.°C	441	484	532	569	604
E, mV	12.76	16.30	20.26	23.32	26.20

Calculate the activity of Zinc in the above alloy at these temperatures.

One Faraday = 96487 J/V/g-equivalent

Q2b	The activity coefficient of copper in Cu-Zn alloys at 1027°C is given below- X_{Cu} | 0.9 | 0.8 | 0.7 | 0.6 γ_{Cu} | 0.981 | 0.922 | 0.837 | 0.728 Calculate the integral molar free energy of mixing and excess integral molar free energy of solutions for an alloy containing 80 atom% and also confirm whether the given solution exhibits real behaviour or regular behaviour.	**5**
Q3a	Determine the temperature above or below which the reduction of MgO by Al becomes thermodynamically feasible at 1 atm pressure (101325 N/m^2). $2\{Al\} + \frac{3}{2}(O_2) = <Al_2O_3>$ $\Delta G^o = -1679876 + 321.79\,T$, J $(Mg) + ½(O_2) = <MgO>$ $\Delta G^o = -731154 + 205.39\,T$, J	**5**
Q3b	Will a blast furnace gas analyzing 28% CO, 13%CO_2 and 58%N_2 (by vol)reduce wustite (FeO) at 727 °C. How do you predict reduction of FeO from Elligham diagram? <Fe> + ½ (O_2) = <FeO> $\Delta G^o = -259617 + 62.55\,T$, J $(CO) + ½(O_2) = (CO_2)$ $\Delta G^o = -282420 + 86.82\,T$, J	**5**
Q4	Calculate the equilibrium partial pressure of Zinc vapour and CO at 1200°C according to the following reaction- <ZnO> + <C> = (Zn) + (CO) $\Delta G^o = 371\,204 + 42.30T \log T - 432.33\,T$, J Assume that the reaction is carried out in a closed retort containing no air.	**10**
Q5	Calculate the equilibrium composition of a Cu-Ni alloy (in wt%) capable of existing in equilibrium with Cu_2O and NiO at 727°C from the following data- $\Delta G^o_{Cu2O} = -76274$ J/mol ; $\Delta G^o_{NiO} = -126\,148$ J/mol Atomic weights of Cu and Ni are 63.54 and 58.7 respectively.	**10**
Q6	At 1570°C liquid iron dissolves 0.039 wt% nitrogen in equilibrium with nitrogen at 1 atm (101325 N/m^2) pressure and 0.0025 wt% hydrogen in equilibrium with hydrogen at 1 atm pressure. Ammonia gas (NH_3) was passed over iron at that temperature at such a rate that equilibrium was attained with fully dissociated ammonia at a net pressure of 1 atm. Calculate the hydrogen and nitrogen contents of the melt.	**10**

---------**The End**-------