Seat No.: _____ *Enrolment No._____*

GUJARAT TECHNOLOGICAL UNIVERSITY

B.E. Sem-III Examination December 2009

Subject code: 132102 Subject Name: Metallurgical Thermodynamics

Date: 23 / 12/ 2009 **Time: 11.00 am – 1.30 pm**

Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** What do you understand by Ellingham Diagrams?Draw such diagram for some very common metal oxides and explain its silent features. **07**

(b) Explain the inter-relationship of PO_2,CO/CO_2 and H_2/H_2O ratios and method of determining these graphically. **07**

Q.2 **(a)** State Raoult's law and Henry's law.Explian that in a binary dilute solution;if the solute obeys Henry's law ,solvent obeys Raoult's law. **07**

(b) Derive Gibb's-Duhem equation in terms of partial molar quantities. **07**

OR

(b) i) Derive Gibbs'Helmholtz equation. **04**

ii) Give the combined statement of 1st and 2nd law of thermodynamics and from that derive all the Maxwell's relations. **03**

Q.3 **(a)** What do you understand by Hess's law and Kirchoff's law?Discuss the silent features of these laws schematically. **08**

(b) Calculate the standard heat of formation of $WO_{3(s)}$from$W_{(s)}$ And $O_{2(g)}$ at 25°C and 1 atm pressure from the following data: **06**

$<W> + \{ O_2\} = \{WO_2\}$ ΔH^o_{298}= -560.66 KJ/mole

$3<WO_2> + \{ O_2\} = \{W_3O_8\}$ ΔH^o_{298}= - 550.2 KJ/mole

$<W_3O_8> +1/2 \{ O_2\} = 3<WO_3\}$ ΔH^o_{298}= - 92.75 KJ/mole

OR

Q.3 **(a)** Define thermodynamics.Discuss its applications in metallurgy. **04**

(b) Write a note on Nernest heat theorem. **05**

(c) Derive the Clausius-Clapeyron equation. **05**

Q.4 **(a)** Calculate the standard entropy change for following reaction: **04**

$Cr_2O_{3(s)}+3C_{(s)} \rightarrow 2Cr_{(s)}+3CO_{(g)}$

S^o_{298} $Cr_2O_{3(s)}$= 81.17 J/K/mole

S^o_{298} $C_{(s)}$= 5.69 J/K/mole

S^o_{298} $Cr_{(s)}$= 23.76 J/K/mole

S^o_{298} $CO_{(g)}$= 197.90 J/K/mole

(b) i)Calculate ΔG for the process:$Al_{(s)} \rightarrow Al_{(l)}$ at 1000°K.Given melting point of Al is 660°C,heat of fusion(ΔH_f)=10.9 KJ/mole,$CpAl_{(l)}$=29.3 J/K/mole, $CpAl_{(s)}$=32.5 J/K/mole. **05**

(c) Calculate Equilibrium constant and equilibrium partial pressure of oxygen at 1727^oC for the reaction, **05**

$ZrO_2 \rightarrow Zr+O_2$

$\Delta G = 1087589+18.12TlogT-247.36T$ J/mole.

OR

Q.4 **(a)** What is phase diagram?Explain co-relation of free-energy composition and temperature composition diagram for binary alloy system. **07**

(b) Explain 1 wt% standard state in detail. **07**

Q.5 **(a)** For the reaction $CO_{2(g)}+C_{(S)} \rightarrow 2CO$. $\Delta G^o=170707.2-174.5T$ J. Find out the T at which graphite powder in equilibrium with CO and CO_2 mixture containing 30%CO. **05**

(b) Calculate the entropy Fe(l) at melting point 1808 ^oK and Lf=15.4 KJ/mole, S^o298=27.2 J/K/mole,CpFe=25.2 J/K/mole **05**

(c) Standard enthalpy change of Combustion at 298^oK for H_2 (g),CO(g) and $CH_3OH_{(l)}$ are-286,-283,-714 KJ/mole respectively.Calculate the value of change of enthalpy for following reaction: **04**

$CO(g)+2H_2(g) \rightarrow CH_3OH_{(l)}$

OR

Q.5 **(a)** Explain the concept of basicity of index for slag. **05**

(b) Differentiate the following: **05**

Extensive and Intensive Properties

(c) Explain in brief:Fugacity and Activity **04**

****