Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–III • EXAMINATION – WINTER • 2014

Subject Code: 132102 **Date: 30-12-2014**

Subject Name: Metallurgical Thermodynamics

Time: 02.30 pm - 05.00 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)**	i) What is the effect of pressure on Phase transformation?	**03**
		ii) Explain how the liquidus line is obtained for any eutectic system.	**04**
	(b)	i) What is Gibb's phase rule? Explain the importance of phase rule. Derive Gibb's phase rule.	**04**
		ii) Explain the differences between a liquidus line and solidus line.	**03**
Q.2	**(a)**	Explain how Ellingham diagrams can be useful in the extractive metallurgical process.	**07**
	(b)	i) Explain C- CO & C-CO_2 line in the Ellingham diagram?	**04**
		ii) Explain the advantages and limitations of Ellingham diagram.	**03**
		OR	
	(b)	i) State & Define 1st law of Thermodynamics & its Significance.	**04**
		ii) Explain Quasi- static process.	**03**
Q.3	**(a)**	Define and explain the terms specific heat at constant pressure (Cp) and specific heat at constant volume (Cv) and derive the thermodynamics relationship between them.	**07**
	(b)	What is the importance of equilibrium constant (K) & how this can be calculated from standard free energy changes?	**07**
		OR	
Q.3	**(a)**	i) Prove that when HENRY'S law is obeyed by the solute, solvent obeys Raoult's law.	**04**
		ii) Draw free energy- composition diagram for Isomerphous system at various phases.	**03**
	(b)	i) Distinguish between ideal solutions and regular solutions.	**02**
		ii) Derive Gibb's- Duhem equations.	**05**
Q.4	**(a)**	Zinc melts at 420 ^{O}C and its standard entropy at 25 ^{O}C is 9.95 cal/deg/ mole. Calculate the standard entropy of Zinc at 750 ^{0}C. Heat of fusion of Zn at the melting point is H_f = 1.74 KCal/m. Given Data ΔS^0_{298} = 9.95 Cal/ d/m. Cp < Zn> = 5.35+ 2.40* 10^{-3}T Cal /d / m. Cp{Zn} = 7.50 Cal / d/ m	**07**
	(b)	i)Explain Von- Hoff equation.	**04**
		ii) State & Derive Entropy of a system.	**03**
		OR	

Q.4 **(a)** i) The enthalpy changes for the following reactions are as follows **04**

$2B + 3H_2 + 3O_2 = 2H_3BO_3$. $\Delta H^0_{298} = -512.8$ Kcal.

$B_2O_3 + 3H_2O$ (l) $= 2H_3BO_3$. $\Delta H^0_{298} = -4.12$ Kcal.

$H_2 + ½ O_2 = H_2O$ (l). $\Delta H^0_{298} = -68.73$ Kcal. Calculate the standard heat of formation of B_2O_3 in terms of per mole o B_2O_3 & per gm of B_2O_3. Atomic wt of B & O are 10.82 & 16.

ii) Calculate the work done in Reversible Adiabatic expansion. **03**

(b) i) State and explain Sievert's law. **03**

ii)State & Derive Maxwell's equation from combined statement of 1st & 2nd law. **04**

Q.5 **(a)** i) Calculate the equilibrium constant for the reaction. **05**

<NiO > + (H_2) = <Ni> + (H_2O) at 1023 K

<Ni > + ½ (O_2) = <NiO > $\Delta G^0_{298} = -58,450 + 23.55T$ cal.

(H2) + ½ (O_2) = (H_2O) $\Delta G^0_{298} = -58,900 + 13.1T$ cal.

Could pure Ni sheet be annealed at 1023 K in an atmosphere of 95% H_2O & 5%H_2 by volume with oxidation?

ii) Explain fugacity. **02**

(b) i) The equation of the state of a gas is given by the expression $(P + a/V^2).(V-b) = RT$ **04**

Prove that : $(\delta P / \delta V)_T * (\delta V / \delta P)_T = 1$

ii) Explain Homogenous & Heterogeneous system. **03**

OR

Q.5

(a) What is blast f/c slag & its composition, Explain briefly the kinetics of Slag- metal reaction. **07**

(b) Explain the following:

(i) Chemical Potential **03**

(ii) Slag basicity **02**

(iii) Hess's Law **02**

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