

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-CO₂ 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 (C_p) and specific heat at constant volume (C_v) 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 Isomorphous 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 °C and its standard entropy at 25 °C is 9.95 cal/deg/ mole. **07**
 Calculate the standard entropy of Zinc at 750 °C. Heat of fusion of Zn at the melting point is H_f = 1.74 KCal/m.
 Given Data
 $\Delta S_{298}^0 = 9.95 \text{ Cal/ d/m.}$
 $C_p < \text{Zn} > = 5.35 + 2.40 \times 10^{-3} T \text{ Cal /d / m.}$
 $C_p \{ \text{Zn} \} = 7.50 \text{ Cal / d/ m}$
- (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**
 $2B + 3H_2 + 3O_2 = 2H_3BO_3$. $\Delta H^0_{298} = -512.8 \text{ Kcal.}$
 $B_2O_3 + 3H_2O (l) = 2H_3BO_3$. $\Delta H^0_{298} = -4.12 \text{ Kcal.}$
 $H_2 + \frac{1}{2} O_2 = H_2O (l)$. $\Delta H^0_{298} = -68.73 \text{ Kcal.}$ Calculate the standard heat of formation of B_2O_3 in terms of per mole of 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
 $<Ni> + \frac{1}{2} (O_2) = <NiO>$ $\Delta G^0_{298} = -58,450 + 23.55T \text{ cal.}$
 $(H_2) + \frac{1}{2} (O_2) = (H_2O)$ $\Delta G^0_{298} = -58,900 + 13.1T \text{ cal.}$
 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 $(P + a/V^2) \cdot (V - b) = RT$
 Prove that : $(\partial P / \partial V)_T \cdot (\partial V / \partial P)_T = 1$ **04**
 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**
