VEER SURENDRA SAI UNIVERSITY OF TECHNOLOGY (VSSUT), ODISHA
Odd Mid Semester Examination for Academic Session 2024-25

COURSE NAME: B.Tech SEMESTER: 3rd

BRANCH NAME: Metallurgical & Materials Engineering

SUBJECT NAME: Metallurgical Thermodynamics & Kinetics

FULL MARKS: **30** TIME: **90 Minutes**

Answer **All** Questions.

The figures in the right hand margin indicate Marks. *Symbols carry usual meaning.*

Q1. Answer all Questions. **[2 × 3]**

a) A 1 mole piece of copper at 400 K is brought in contact with another 1 mole piece of copper at 300 K and allowed to reach thermal equilibrium. The entropy change for this process is how much? Given: Specific heat capacity, C_p (between 250 - 500 K) is 22.6 J/K/mol. - CO1

b) At equilibrium, maximum number of phases in a 3-component system at 1 atm pressure is how much? Prove that $\left(\frac{\partial P}{\partial T}\right)_V = \left(\frac{\partial S}{\partial V}\right)_T$ and $\left(\frac{\partial V}{\partial T}\right)_P = -\left(\frac{\partial S}{\partial P}\right)_T$ - CO2

c) State and express third law of thermodynamics. Write the metallurgical consequences of third law of thermodynamics. - CO3

Q2. **[8]**

(a) Prove that the entropy of mixing for an ideal solution is $\Delta S_{ideal}^{mix} = -R[X_A \ln X_A + X_B \ln X_B]$. - CO1

(b) Calculate the standard enthalpy change for the following reaction at 1523 K.

Cu_2S (s) + 2 Cu_2O (s) = 6 Cu (l) + SO_2 (g).

Given the values of standard enthalpy changes of formation at 1523 K as follows:

	Cu_2S (s)	Cu_2O (s)	Cu (l)	SO_2 (g)
$\Delta H^0_{f,1523}, kJ/mol$	-86.7	-176.4	0	-278.4

OR

(a) Find out the increase in molar entropy change of Cu, when it heated from 127°C to 927°C. The molar sp. heat of Cu is given by Cp = 6.2+0.0017 T. - CO1

(b) Calculate the standard free energy change of the reaction:

Ni (s) + ½ O2 (g) = NiO (s)

At 327°C from the following data:

$\Delta H^0_{298,NiO(s)} = -240.58\ kJ/mol$ $\quad S^0_{298,Ni(s)} = -29.79\frac{J}{K}/mol$

$S^0_{298,NiO(s)} = -38.07\frac{J}{K}/mol$ $\quad S^0_{298,O2(g)} = 205.09\frac{J}{K}/mol$

$C_{P,Ni(s)} = 25.23 + 43.68 \times 10^{-6}T^2 - 10.46 \times 10^{-3}T$ J/K/mol

$C_{P,O2(g)} = 29.96 + 4.18 \times 10^{-3}T - 1.67 \times 10^{5}T^{-2}$ J/K/mol

$C_{P,NiO(s)} = 54.01$ J/K/mol.

Q3. **[8]**

(a) Prove that $\left[\frac{d(\Delta G^0/T)}{dT}\right] = -\left[\frac{\Delta H^0}{T^2}\right]$. - CO2