

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]

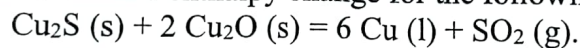
- a) A 1 mole piece of copper at 400 K is brought in contact with another 1 mole piece of copper at 300 K and allowed to reach thermal equilibrium. The entropy change for this process is how much? Given: Specific heat capacity, C_p (between 250 - 500 K) is 22.6 J/K/mol. - CO1
- b) At equilibrium, maximum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

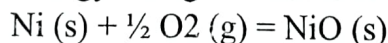


Given the values of standard enthalpy changes of formation at 1523 K as follows:

	$\text{Cu}_2\text{S (s)}$	$\text{Cu}_2\text{O (s)}$	Cu (l)	$\text{SO}_2 \text{(g)}$
$\Delta H_{f,1523}^0, \text{kJ/mol}$	-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 $C_p = 6.2 + 0.0017 T$. - CO1
- (b) Calculate the standard free energy change of the reaction:



At 327°C from the following data:

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

$$S_{298, \text{NiO(s)}}^0 = -38.07 \frac{\text{J}}{\text{K}}/\text{mol} \quad S_{298, \text{O}_2\text{(g)}}^0 = 205.09 \frac{\text{J}}{\text{K}}/\text{mol}$$

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

$$C_{p, \text{O}_2\text{(g)}} = 29.96 + 4.18 \times 10^{-3} T - 1.67 \times 10^{-5} T^2 \text{ J/K/mol}$$

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

Q3.

[8]

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

- CO2