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Total number of printed pages – 2

B. Tech
PCMT 4202

Third Semester Examination – 2013
METALLURGICAL THERMODYNAMICS AND KINETICS

BRANCH : MME, MM

QUESTION CODE : C-501

Full Marks – 70

Time : 3 Hours

Answer Question No. 1 which is compulsory and any **five** from the rest.

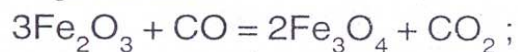
The figures in the right-hand margin indicate marks.

1. Answer the following questions : 2 × 10
- (a) Differentiate between Reversible and Irreversible process.
 - (b) Differentiate between Isolated and Closed system.
 - (c) Differentiate between Ideal and Non-ideal solution
 - (d) Differentiate between Homogeneous and Heterogeneous reactions.
 - (e) Differentiate between Molecularity and Order of reaction.
 - (f) What do you mean by Standard State of a system ?
 - (g) What do you mean by Degree of reduction ?
 - (h) What is Zeroth law of thermodynamics ?
 - (i) What is basic principle of TGA ?
 - (j) What do you mean by rate determining step in reduction of iron ore ?
2. Write short note on any **two** of the following : 5 × 2
- (i) Heat Capacities
 - (ii) Thermal Analysis
 - (iii) Excess Function
 - (iv) Gibbs-Duhem Equation
 - (v) Transformation formula
3. (a) Derive relation between cell emf and Free energy of Cell reaction. 5
- (b) Calculate the standard emf of a Denial Cell which is working at 25°C with Standard Free Energy Change of the cell reaction ΔG° is – 413.75 kJ/mol at STP. 5

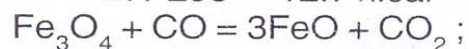


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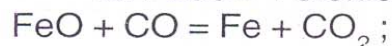
4. (a) What do you understand by equilibrium constant for a reaction and derive the relationship between the standard free energy change and the equilibrium constant. 5
- (b) The reduction of iron oxide in the blast furnace proceeds according to the following reactions : 5



$$\Delta H^\circ_{298} = -12.7 \text{ k.cal}$$



$$\Delta H^\circ_{298} = +9.8 \text{ k.cal}$$



$$\Delta H^\circ_{298} = -4.4 \text{ k.cal}$$

Calculate ΔH°_{298} for the reaction $\text{Fe}_2\text{O}_3 + 3\text{CO} = 2\text{Fe} + 3\text{CO}_2$

5. (a) Discuss the important characteristics of an ideal solution in terms of molal thermodynamic potential and entropy. 5
- (b) Find the enthalpy change for the reaction $\langle \text{CaO} \rangle + \langle \text{CO}_2 \rangle = \langle \text{CaCO}_3 \rangle$ at 600°C . 5

The values of ΔH°_f at 298 K for $\langle \text{CaO} \rangle$, $\langle \text{CO}_2 \rangle$ and $\langle \text{CaCO}_3 \rangle$ (in kJ/mole) are -634.3 , -393.5 and -1206.7 respectively.

$$C_p \langle \text{CaCO}_3 \rangle = 104.516 + (21.924 \times 10^{-3} T) - (25.945 \times 10^5 T^{-2}) \text{ J/gm.mol.K}$$

$$C_p \langle \text{CO}_2 \rangle = 44.141 + (9.037 \times 10^{-3} T) - (8.535 \times 10^5 T^{-2}) \text{ J/gm.mol.K}$$

$$C_p \langle \text{CaO} \rangle = 49.622 + (4.519 \times 10^{-3} T) - (6.945 \times 10^5 T^{-2}) \text{ J/gm.mol.K}$$

6. (a) Derive Maxwell's relations. 5
- (b) What do you mean by fugacity ? Explain how fugacity departs from P-V isotherm. 5
7. (a) Decrease in free energy gives maximum work and decrease in Gibb's Potential during isothermal, isobaric process gives network, Justify. 5
- (b) Zinc melts at 420°C and its standard entropy at 25°C is 10 cal/deg/mole . Calculate the standard entropy of zinc at 750°C . 5

Data given :

Heat of fusion of zinc at its melting point,

$$\Delta H_f = 2 \text{ kcal/mole}$$

$$C_p \langle \text{Zn} \rangle = 5.5 + 2 \times 10^{-3} T \text{ cal/deg/mole}$$

$$C_p (\text{Zn}) = 7.5 \text{ cal/deg/mole}$$

8. What do you mean by entropy ? Discuss important characteristics of entropy and explain there would occur a net increase in entropy in an irreversible cyclic process. What is temperature dependence of entropy ? 10

